VIA MEDICA

NOWOTWORY Journal of Oncology
2024, volume 74, number 1, 57–65
DOI: 10.5603/njo.98446

ISSN: 0029–540X, e-ISSN: 2300-2115
www.nowotwory.edu.pl

Review article

Cancer prevention and public health

The role of nutrition in oncological prevention

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In the global battle against cancer, the second leading cause of death, research aims to identify preventative measures, with over 40% of worldwide cancer fatalities and disability-adjusted life years linked to modifiable lifestyle aspects. Understanding the multi-stage, long-term process of carcinogenesis is vital, as is the identification of contributing factors. By controlling certain lifestyle factors like diet, exercise, smoking and alcohol consumption, we can mitigate cancer risk. Leading institutions such as the World Cancer Research Fund and American Institute for Cancer Research have formulated guidelines to reduce cancer risk. These tenets include maintaining a healthy weight, engaging in physical activity, adhering to a balanced diet, limiting alcohol, refraining from smoking, avoiding excessive sunlight and taking breastfeeding into account. Many of these principles centre on dietary habits, advocating for a varied intake of fruit, vegetables, whole grains and legumes, while limiting red and processed meats and alcoholic drinks.

Emerging research highlights the considerable influence of diet on cancer risk, leading to the formulation of dietary guidelines to minimize this risk. This paper delves into these recommendations and examines the impact of various dietary components and patterns on cancer development.

Key words: dietary intake, cancer, neoplasms, food intake

Introduction

In Poland, like many regions of the world including Europe, the number of cancer patients is steadily increasing. According to the European Commission's estimates published in the European Cancer Information System (ECIS), the number of new cancer cases in Europe increased by 2.3% in 2022 compared to 2020, reaching 2.74 million. Similarly, the number of deaths due to cancer increased by 2.4% compared to 2020 [1]. The four most common cancer causes of death in the EU are lung (19.5% of all cancer deaths), colorectal (12.3%), breast (7.5%), and pancreatic cancer (7.4%).

In Poland, cancer is the second most common cause of death behind cardiovascular disease, responsible for 24.5% of all deaths [2]. Cancer diseases account for 22.8% of the total disease burden (disability-adjusted life years – DALY) in Poland for men, and 19.6% for women. In Poland, the number of malignant tumour cases has reached more than 164,000 a year. The most common cancers for men are prostate (19.7%), lung (16.8%) and colorectal (12.3%) cancers, whereas for women these are breast (22.5%), colorectal (9.9%) and lung (9.4%) cancers [2].

With cancer being the second most common cause of death worldwide, researchers' attention has been focused on finding ways to prevent these diseases. More than 40% of global cancer deaths and disability-adjusted life years are attributed to modifiable lifestyle factors [3]. It is important to understand that the process of carcinogenesis consists of many stages and can take several to several dozen decades. Undoubtedly, many factors contribute to the development of cancer. Knowledge of these factors, combined with the ability to modify those within our control (such as diet, physical activity, smoking, alcohol consumption, etc.), can help reduce the risk of cancer.

How to cite:

Wolnicka K. ***The role of nutrition in oncological prevention.*** *NOWOTWORY J Oncol* 2024; 74: 57–65.

The European Code Against Cancer (ECAC) promotes raising awareness of health-promoting behaviours among the public, with the goal of reducing exposure to cancer-promoting factors (e.g., smoking, being overweight, physical inactivity, alcohol, sun exposure, carcinogens, unhealthy diet). ECAC also stresses the importance of other measures, such as vaccination programmes and screening [4].

The World Cancer Research Fund/American Institute for Cancer Research are the leading centres that have developed recommendations aimed at reducing cancer risk. According to the AICR, the ten principles of cancer prevention include maintaining a healthy body weight, adequate physical activity, adhering to a healthy diet, limiting alcohol consumption, avoiding smoking and excessive sunlight, and taking breastfeeding into account. Most of these principles apply to diet-related factors. It is recommended to consume a variety of fruit and vegetables, whole grain cereal products and legume seeds, while limiting red meat consumption as well as avoiding processed meat products and alcoholic beverages [5].

A growing body of research indicates that diet has a significant impact on cancer risk, leading to the development of dietary recommendations aimed at reducing this risk. This paper discusses recommendations and research findings on the effects of various dietary elements and patterns on cancer development.

Consumption of animal products and cancer risk

Red meat and processed meats

According to the International Agency for Research on Cancer (IARC), excessive consumption of red meat and especially processed meats such as cold cuts, sausages, frankfurters, snack stick sausages or bacon can increase the risk of certain cancers [5]. In 2015, the International Agency for Research on Cancer (IARC) released a report that included the results of more than 800 studies conducted over the past 20 years examining the relationship between meat consumption and cancer incidence. The report showed that eating pork, beef and other types of red meat regularly may lead to the development of cancer. Red meat has been classified in Group 2A, which includes agents that are potentially carcinogenic to humans and definitely carcinogenic to laboratory animals, including haem iron, heterocyclic amines, etc. Research shows that there is a link between red meat consumption and the incidence of cancer, especially colorectal, pancreatic and prostate cancers. Studies show that the risk of colorectal cancer increases by 17% with every 100 grams of red meat consumed daily [5, 7, 8].

Processed meat that has undergone processes such as prolonged frying, grilling, smoking, salting, curing, marinating or fermentation is even more harmful. Such meat is classified as a Group 1 carcinogen, which also includes alcohol, tobacco, asbestos or aflatoxins [5].

Scientific studies have shown that regular consumption of processed meat promotes the development of colorectal cancer. Furthermore, daily consumption of 50 grams of processed meat raises the risk of colorectal cancer by 18%. The risk of death from cardiovascular diseases also increases with consumption of such meat [5, 7, 8]. According to the comprehensive systematic review and meta-analysis study, high red meat intake was positively associated with the risk of breast cancer, endometrial cancer, colorectal cancer, colon cancer, rectal cancer, lung cancer and hepatocellular carcinoma; high processed meat intake was positively associated with the risk of breast, colorectal, colon, rectal and lung cancers [9]. The European Prospective Investigation into Cancer and Nutrition (EPIC), which is a multicentre prospective study, investigated the relationship between diet-related exposures and incidence or mortality from the four most common cancers in the European population: colorectal, breast, lung and prostate cancer. A higher consumption of fish and lower consumption of red and processed meat were related with a lower risk of colorectal cancer; and a higher consumption of fatty fish with a lower risk of breast cancer [6].

Therefore, it is recommended to limit the consumption of red meat and its products to 350–500 grams per week [5]. These recommendations are not intended to avoid meat consumption completely. Meat can be a valuable source of nutrients, especially protein, iron, zinc and vitamin B_{12}. However, it is strongly recommended to avoid processed meat products. Depending on the processing method, they have a high content of harmful substances such as polycyclic aromatic hydrocarbons and heterocyclic amines, nitrites, N-nitroso compounds, as well as components that, in excess, are harmful to health, such as salt, saturated fats and cholesterol. Eating meat is not an essential part of a healthy diet. For those who eat it, poultry and fish are preferred as valuable substitutes for red meat. Eggs and dairy products are also a valuable source of protein and minerals. It is worth replacing red meat and processed meat with low-fat poultry, fish, legume dishes and nuts, not only for one's own health but also for the health of our planet. People who opt for a meatless diet can get adequate amounts of essential amino acids through careful selection of legume and grain-based foods. Iron is present in many plant foods, although its bioavailability is lower than in meat.

Based on the results of a prospective cohort study, it was found that simultaneous consumption of a small amount of fruit and vegetables and a large amount of processed meat was associated with a higher incidence of 15 cancers (men: HR = 1.85, 1.91; women: HR = 1.44, 1.49) and accelerated time to cancer occurrence (men: 6.5 and 7.1 years respectively, and women 5.6 and 6.3 years), compared to a high consumption of fruit and vegetables combined with a low consumption of processed meat [10]. Low intake of fruit and vegetables was associated with a higher incidence of all cancers and accelerated time to cancer occurrence at every level of processed meat consumption studied, among both men and women. The results show that diet should be looked at comprehensively;

the carcinogenic effects of processed meat can be somewhat mitigated by keeping a healthy diet rich in non-starchy fruit and vegetables, especially with low and moderate levels of processed meat consumption. Less clear and consistent relationships were observed when analysing whole grain cereal and fibre consumption and red meat consumption [10]. The results of these studies provide preliminary evidence for improving existing cancer prevention recommendations to optimize the intake of specific food groups in the general adult population.

A study conducted for more than a decade in the UK found that people who consume little meat and eat fish as well as vegetarians are less likely to develop cancer compared to those who regularly consume meat. The study population was divided into 4 groups: those who regularly consumed meat, including processed meat, red meat (beef, pork, lamb) or poultry, more than five times a week; those who consumed meat less frequently; those who gave up red meat, processed meat and poultry, but continued to eat fish; and vegetarians who did not consume meat, poultry or fish.

A detailed analysis showed that the risk of colorectal cancer was significantly lower in people who consumed little meat compared to those who consumed meat regularly. As regards postmenopausal breast cancer, the risk of developing the disease was slightly lower among those who consumed little meat and fish than among those who regularly ate meat, but only among vegetarians was the lower risk statistically significant. Further analysis showed that lower risk in vegetarians was strongly associated with a lower Body Mass Index (BMI). As for prostate cancer, fewer cases were recorded among men who eat fish and vegetarians than among regular meat eaters. No difference was found in the risk of developing this cancer between those who regularly consume meat and those who consume it in small amounts [11].

It is also worth noting the results of a study published in PLOS Medicine journal that enable us to look at diet more broadly, taking into account the proportions of each product group in the overall diet. The researchers analysed data from already existing databases such as the Global Burden of Diseases to create a model that estimates the effect of dietary changes on life expectancy. The authors of the analysis conclude that at the age of 20, a person can add more than a decade to their life (10.7 years among women and 13 years among men) by switching from a typical Western diet to a healthy diet that includes eating less red or processed meat and more legumes, whole grain cereal products and nuts. Changing the diet to this health-promoting pattern at the age of 60 could increase life expectancy by eight years for women and 8.8 years for men. Even an 80-year-old adult could gain an average of 3.4 years from such dietary changes. According to the authors, looking at diet as an outcome of our choices and understanding the relative health potential of different food groups in the overall diet can enable people to achieve real and significant health benefits [12].

Recommendations to reduce red meat consumption and avoid processed meat are crucial for public health, especially given the high consumption of these products. However, the results of many studies indicate an additional direction for future prevention efforts, which should focus on simultaneously promoting the consumption of non-starchy vegetables and fruit as well as plant-based protein sources such as legume seeds as an overall dietary pattern.

Calcium and dairy products

The WCRF/AICR considers it "probably" that a diet high in calcium and rich in dairy products may reduce the risk of developing colorectal cancer. Evidence suggesting that a diet high in calcium could lower the risk of breast cancer has been considered "limited/suggestive evidence". Similarly "limited/suggestive evidence" suggests that calcium and dairy products may increase the risk of prostate cancer. According to the WCRF/AICR, 400 grams of dairy products consumed daily (which is equivalent to nearly two glasses of milk) increases the risk of prostate cancer but additional studies are needed. A long-term diet high in calcium (more than 2,000 mg per day) is associated with a higher risk of prostate cancer. The recommended daily amount of calcium in an adult's diet is about twice as low, ranging from 1,000 to 1,200 mg, and is often not achieved in the diet. Research results indicate that a diet rich in dairy products with a high content of calcium reduces the risk of breast and colorectal cancer. However, since it has also been shown to increase the risk of prostate cancer, the WCRF has not indicated recommendations for this food group [5].

A possible mechanism of the effect of high amounts of calcium-rich dairy products on increasing prostate cancer risk may involve exposure to the growth factor IGF-1. In the Adventist Health Study-2 cohort study, the researchers focused on dairy products and calcium intake, while paying particular attention to people who are vegans, i.e. those who do not consume dairy, getting their calcium from other sources. The study included 28,737 men affiliated with Seventh-day Adventists in the US and Canada. The observation lasted an average of 7.8 years. The results of this study showed that men who consume 430 g/d of dairy products, compared to those who consume 20.2 g/d, have a 27% higher risk of prostate cancer. Compared to non-dairy eaters, those who consumed the most dairy products had a 60% higher risk. This was mainly related to milk consumption, unrelated to cheese and yoghurt. In contrast, a higher consumption of non-dairy products and calcium supplements did not increase the risk of prostate cancer. According to the authors, the results of this study do not conclusively support a relationship between calcium intake and prostate cancer. However, they indicate that prostate cancer risk is associated with a higher consumption of dairy products or some other causal factor related to dairy consumption [13]. In the EPIC study, calcium and yoghurt intake was found to protect against colorectal and prostate cancer [6].

Plant-based products and cancer risk

Whole grain cereal products, vegetables, fruit and legumes such as beans and lentils, peas and chickpeas, for example, should make up the bulk of our diet. Research indicates that eating mostly plant-based foods, like whole grain products, vegetables, fruit and legumes, plays an important role in cancer prevention and is beneficial to health [14].

Plant-based foods are rich in fibre, having many nutrients and phytochemicals that can reduce the risk of cancer. In addition, plant foods containing high amounts of dietary fibre can be helpful in weight control. Excess body weight is a significant risk factor for cancer.

According to the American Institute for Cancer Research, there is strong scientific evidence that whole grain cereal products and dietary fibre are likely to reduce the risk of colorectal cancer [5, 14, 18, 22]. It has also been shown that a higher intake of vegetables or fruit is likely to show protective effects against many cancers [5, 17, 6]. For example, according to the Nurses' Health Study and Health Professionals Follow-up Study, fruit and vegetable consumption had a protective effect against colorectal, breast and lung cancers, whereas only fruit consumption had a protective effect against prostate cancer [6].

Non-starchy fruit and vegetables contain a large number of potential anticancer components, such as dietary fibre, carotenoids, vitamins C and E, selenium, glucosinolates and indoles, isothiocyanates, flavonoids, phenols, protease inhibitors or plant sterols. Whole grain products, on the other hand, are a rich source of various bioactive nutrients and non--nutritional compounds, including vitamin E, selenium, copper, zinc, lignans, phytoestrogens and phenolic compounds, as well as dietary fibre. Many of these compounds, largely found in the bran and germ of grains, have probable anti-carcinogenic properties [14].

Although researchers have identified some plausible biological mechanisms that could explain how various components of these foods might affect cancer risk, the protective effect cannot currently be attributed to any specific single ingredient. According to the 2018 AICR report, there is limited evidence to suggest that eating foods containing carotenoids reduces the risk of developing lung and breast cancer, and that eating foods containing vitamin C reduces the risk of developing lung cancer (in current smokers) and colon cancer. Consuming foods containing isoflavones can probably reduce the risk of developing lung cancer (in people who have never smoked). Single substances or nutrients can have a beneficial effect on maintaining health, however, the research results are inconclusive and show that it is not a matter of providing a single selected ingredient but of changing the entire dietary pattern to one based on products of plant origin [5, 14–21].

The recommendations therefore refer to dietary patterns that reflect the proportion and amount of food consumed altogether on a daily basis. This approach of considering the evidence indicates that most diets that protect against cancer are based on foods of plant origin. It is likely that the combination of all these nutrients and non-nutrients in the diet is responsible for a lower risk of certain cancers.

One of the key anti-cancer components of a plant-based diet is fibre, which is a nutrient that most people do not consume in sufficient amounts. A higher intake of dietary fibre can lower the risk of colorectal cancer by reducing intestinal transit time and increasing faecal volume. This reduces the potential for mutagenic components to affect the mucosa of the large intestine and also reduces the production of secondary bile acids.

Plant-based products such as whole-grain cereals, legumes, vegetables and fruit are sources of dietary fibre, which can also have a beneficial effect on the microflora of the large intestine, reducing the risk of cancer. Dysbiosis, which is caused by dysregulation of the microbiota, can increase chronic inflammation and reduce immune responses, leading to increased cancer incidence [15, 17]. Fibre is fermented or metabolized by the microflora of the large intestine, and this can affect the types and number of bacterial populations found in the colon [20, 22, 23]. Fermentation in the large intestine results in the formation of short-chain fatty acids such as butyrate, which, according to experimental studies, can have an antiproliferative effect on colon cancer cells [16, 17]. Maintaining a healthy gut microbiome supports a healthier immune system and glucose regulation while reducing inflammation.

Findings suggest that daily consumption of legumes may play a role in protecting against cancer development [21, 23]. High antioxidant activity is demonstrated by phenolic compounds, which are present in large amounts in the seed coat of legumes. The study also revealed the presence of flavonoids, anthocyanins and tannins [24, 25]. It has been shown that certain specific types of proteins, such as lectins (carbohydrate--binding proteins), exhibit anti-cancer properties. For instance, it is believed that lectins derived from leguminous plants bind to cancer membranes, inhibit cell proliferation, stimulate the immune system and induce apoptosis [25].

The effect of fibre on colorectal cancer risk is the best documented, but there is little evidence on the effect of fibre on other cancers. The UK Biobank study, with over 8.8 years of follow-up, found that those consuming less dietary fibre compared to the higher intake group (<9.6 *vs.* ≥19.1 g/day) had an overall 10% lower risk of cancer in general. The greatest impact on reducing the risk of disease was observed for cervical cancer (HR: 0.33, 0.14; 0.82), oesophageal cancer (HR: 0.66, 0.52; 0.84), lung cancer (HR: 0.67, 0.59; 0.76), bladder cancer (HR: 0.72, 0.56; 0.91) and kidney cancer (HR: 0.75, 0.61; 0.92). Fibre from cereals, fruit and vegetables showed the greatest impact on risk reduction.

A recent systematic review and meta-analysis has shed new light on the correlation between fibre intake and mortality risk from various causes. This exhaustive study encompassed 64 prospective cohort studies, involving a staggering

3.5 million participants from diverse global regions. Individuals with the highest fibre intake had significantly lower mortality risks compared to those with the least fibre intake – 22% lower for cancer-related death. Higher intakes of fibre derived from cereals, whole grains, vegetables, or legumes corresponded with an 8-16% decrease in all-cause mortality. The consumption of insoluble fibre appears to be more successful in decreasing the overall risk of death, as well as mortality from cardiovascular diseases and cancer, compared to the consumption of soluble fibre. Furthermore, consumption of soluble and insoluble fibre was linked with a 16% and 23% lower risk respectively. Insoluble fibre may bind with carcinogens and other compounds within the gut, which could partially explain the 20% reduction in risk of cancer mortality associated with insoluble fibre intake [26].

The impact of plant-based dietary patterns on cancer risk

A growing number of studies confirm the beneficial effects of a dietary pattern based on products of plant origin and limiting the consumption of meat and other zoonotic products [6, 28–30]. One of these recommended dietary patterns for maintaining health is the traditional Mediterranean diet. The European Prospective Investigation into Cancer and Nutrition (EPIC) is a prospective study conducted at 23 centres in 10 European countries on the relationship between diet and cancer incidence or mortality. Based on the results from this study, it was found that a high consumption of fruit and vegetables showed a protective effect against colorectal, breast and lung cancers, whereas only fruit had a protective effect against prostate cancer. Following the traditional Mediterranean diet pattern, i.e. based on foods of plant origin including vegetables and fruit, legumes, whole grain cereal products, nuts, olive oil and a small amount of fish and dairy products has been shown to be a protective factor for colorectal and breast cancers [5, 6]. In a recent prospective study, it was found that consuming a diet rich in healthy plant-based foods can potentially lower the risk of aggressive forms of prostate cancer. This correlation seems to be particularly strong in men who are under the age of 65. Men with the highest plant-based diet score had a 19% lower risk of fatal prostate cancer, compared to men with the lowest diet score. These discoveries highlight the significant role that dietary intervention could play in the prevention of prostate cancer, especially among younger men [30]. An analysis of the results of two studies of the Adventist Health Study-2 (AHS-2) and the European Prospective Investigation into Cancer and Nutrition-Oxford (EPIC-Oxford), involving a large proportion of people following plant-based diets, showed that in the first study vegans have 16% reduced risk while in the second study vegans, vegetarians and fish-eaters have 11–19% lower risk for all cancers compared to non-vegetarians [31].

A new (recent) meta-analysis involving 49 studies provides solid evidence on the effect of a plant-based diet on gastrointestinal cancer risk. The study evaluated different dietary patterns based on products of plant origin and a plant-based diet while limiting the intake of animal origin food and highly processed foods. Participants included both vegans and semi vegetarians (i.e. people who consume dairy products, eggs and a certain amount of red meat, poultry and fish at least once a month but less than once a week), people who prefer a diet based on a high intake of vegetables, fruit, pasta, potatoes, soy products, mushrooms and seaweed, vegetarians, people who follow a Mediterranean diet and pesco-vegetarians. The results indicate that a plant-based diet has a protective effect on the development of gastrointestinal cancers, reducing their risk by 20–30%. Plant-based diets have been shown to reduce the risk of pancreatic cancer by 29%, colorectal cancer by 24%, rectum cancer by 16%, colon cancer by 12%, stomach cancer by 19%, and liver cancer by 39%. Similar risk reductions were observed in both men and women, regardless of geographic region. The effects of a vegan diet were evaluated in detail and found to be comparable to those of other plant-based dietary patterns. These findings should form the basis for cancer prevention guidelines [32].

However, the findings suggest paying attention to the quality of the plant-based diet [33–36]. Not all plant-based products are beneficial to health, such as white bread, sugary snacks, or plant-based meat substitutes high in salt or fats.

In this cohort study involving 126,394 UK Biobank participants, greater adherence to a healthy plant-based diet (whole grain products, legumes, fruit and vegetables, nuts) was associated with a lower risk of total mortality, cancer and cardiovascular disease. However, similar relationships have not been observed in those who follow a plant-based diet such as processed plant products as meat substitutes and highly processed cereal products, potatoes or sweet drinks and sweets [34]. Reducing the consumption of animal products and consuming more unprocessed plant-based products has health benefits.

The quality of the plant-based diet and the beneficial effect of a properly balanced plant-based diet pattern on reducing cancer risk are also highlighted by the authors of the analysis of data from 3 prospective cohorts: Nurses' Health Study, Nurses' Health Study II and the Health Professionals' Follow-Up Study. A healthy plant-based diet was associated with a reduced risk of digestive system cancers in general, as well as individual cancers of the gastrointestinal tract and accessory organs [35]. Another new study provides evidence that adhering to a healthy plant-based diet can reduce the risk of breast cancer [36].

Experts from Newcastle University analysed data on the link between adherence to the 2018 World Cancer Research Fund/American Institute for Cancer Research Cancer Prevention Recommendations and the incidence of various

cancers. Greater adherence was associated with lower risk of breast, colorectal and lung cancers.

The results of the analyses indicate that among the modifiable cancer risk factor was a healthier lifestyle, including maintaining an appropriate body weight, limiting the consumption of red meat and processed meat, having a diet with plenty of fruit and vegetables as well as legumes; this can help avoid several types of cancer [37].

Highly processed foods high in sugars, salt and fat and cancer risk

Reducing the intake of some ultra-processed foods (UPFs) by replacing them with similar but less processed products may be beneficial in preventing cancer. Limiting the intake of highly processed foods high in fat, sugars and salt helps control caloric intake and keep body weight in check. Consumption of sugar--sweetened beverages is a proven factor leading to weight gain and, consequently, overweight and obesity in both children and adults. A "Western-type" diet, characterized by a high intake of free sugars, meat and fat, can have a similar effect. There is strong evidence that excessive body fat is the cause of many cancers: oral cavity, pharynx and larynx, oesophagus (adenocarcinoma), stomach (heart), pancreas, gall bladder, liver, colorectal, breast (post-menopausal), ovary, endometrium, prostate (advanced) and kidney cancers. There is also strong evidence that glycaemic load (the increase in blood glucose and insulin after eating food) is a cause of endometrial cancer [5, 38–40].

There is a lot of talk about the adverse effects of so-called highly processed products. However, it is worth noting that not all highly processed products have the same effect on health. These discussions relate to NOVA's classification of these products, which does not take all aspects into account. For example, plant-based beverages and plant-based meat alternatives may fall under the definition of highly processed products even if their composition has health-promoting qualities. A prospective cohort study from the EPIC (European Prospective Investigation into Cancer and Nutrition) trial found that UPF intake was associated with an increased risk of cardiometabolic diseases and type 2 diabetes, as well as cancer. Each additional 260 g/d of these products consumed was associated with a 9% higher risk of developing two of these diseases. It is worth emphasizing, however, that increased BMI explained this increase in risk partially but not completely. However, not all ultra-processed foods (UFPs) were associated with similar risks. The highest risk was associated with the consumption of animal-based products and artificially and sugar-sweetened beverages. Other subgroups such as ultra-processed breads and cereals or plant-based alternatives were not associated with risk [41]. Moreover, it was observed that the consumption of bread and cereal was even inversely related to the risk of these chronic conditions.

The authors in the discussion suggest that reasons other than dietary nutritional value may be the source of the adverse health effects of some UPF foods. The potential impact of some UPF components on the endocrine system or the gut microbiome could be the reason for this; e.g., contaminants from packaging materials or others may have an effect on increasing the risk of later diseases [42].

Consuming more ultra-processed foods (UPFs) may be associated with a higher risk of developing head and neck cancers and oesophageal adenocarcinoma (oesophageal cancer), [43]. The authors of this study suggest that excessive weight related to product consumption may be a risk factor. However, they suggest that further research is needed to identify other mechanisms, such as food additives and contaminants, that may explain the observed association.

Another prospective cohort study conducted in the UK showed that people who consumed the highest amounts of ultra-processed foods (UPFs) had a 7% higher risk of developing any type of cancer compared to those who consumed the least. An increase in risk has been shown for lung and brain cancers and one specific type of non-Hodgkin's lymphoma, but not for breast, colorectal or 22 other cancers. In addition, each 10% increase in intake of ultra-processed foods was associated with a 2% increase in overall cancer risk and persisted after taking into account smoking, low physical activity level, BMI and other known risk factors. Each 10% increase in intake was associated with a 19% increase in the risk of ovarian cancer and more deaths from cancer in general and breast or ovarian cancers. However, due to the small number of ovarian cancer cases in the study group, there is a need for further research to confirm the demonstrated relationship [43].

Body weight and cancer risk

One important recommendation for cancer prevention is to maintain a normal body weight and avoid weight gain in adulthood [5, 45, 46]. There is strong compelling evidence that excessive body fat increases the risk of cancers of the oesophagus (adenocarcinoma), pancreas, liver, large intestine, breast (post-menopause) and kidney. Obesity also contributes to an increased risk of endometrial cancer. Greater body fatness is also likely to cause cancers of the mouth, pharynx and larynx, stomach (gullet), gall bladder, ovary and prostate. Weight gain in adulthood is a compelling cause of postmenopausal breast cancer [5]. Each 5 point increase in BMI was associated with a:

- 50% higher risk of endometrial cancer,
- 48% higher risk of oesophageal adenocarcinoma,
- 30% higher risk of kidney cancer,
- 30% higher risk of liver cancer,
- 12% higher risk of postmenopausal breast cancer,
- 10% higher risk of pancreatic cancer, and
- 5% higher risk of colorectal cancer.

Significant weight gain in adulthood is a compelling cause of postmenopausal breast cancer and endometrial cancer.

Each 11-pound weight gain in adulthood was significantly associated with a 16% higher risk of endometrial cancer and a 6% higher risk of postmenopausal breast cancer. The mechanism underlying carcinogenesis is complex and has not yet been fully understood. Altered secretion and metabolism of fatty acids, remodelling of the extracellular matrix, the secretion of anabolic and sex hormones, deregulation of the immune system, chronic inflammation and changes in the gut microbiome have been linked to carcinogenesis, metastasis development and cancer progression in obesity [45].

Conclusions

In recent years, researchers have increasingly emphasized the role of diet in cancer prevention. Proper plant-based nutrition is considered a key element in the prevention of diseases such as cancer. Experts stress the importance of consuming whole grains, non-starchy vegetables, fruit, legumes and nuts for health, noting that they contain significant amounts of dietary fibre and many nutrients, and have low or relatively low energy density, which is key to maintaining a healthy weight. These products, rather than foods of animal origin, should form the basis of a normal daily diet.

According to AICR recommendations, people should consume at least 30 grams of fibre per day. Vegetables and fruit should make up half of what we eat. A total of at least 400 grams of non-starchy vegetables (excluding potatoes) and fruit should be consumed. Examples of non-starchy vegetables include, among others, green leafy vegetables, broccoli, aubergine, zucchini, tomatoes, cabbage, carrots, artichokes, celery, beets but not, for example, potatoes. It is advisable to eat more vegetables than fruit considering as many types and colours as possible (for example, red, green, yellow, white, purple and orange).

Whole grain products include wholemeal bread, graham rolls, wholemeal pasta, brown rice, groats (such as buckwheat, barley), and oatmeal. They should make up ¼ of the plate for our main meals. Products like white bread, rice or pasta should be reduced in favour of whole grain cereal products.

Legumes (such as beans, soybeans, peas and lentils) are an excellent and healthy alternative to animal protein products, while providing a number of nutrients. It is also worth using a range of products made from them, such as high-quality soy-based foods (like tofu or tempeh). When choosing ready-made processed products such as veggie burgers, it is important to pay attention to their composition and choose those with less sodium, and particularly saturated fats, which can come from tropical oils, or other additives that are not good for health.

Red meat consumption should be limited, and consumption of processed meat should be avoided. Processed meat is the one that has been processed by salting, curing, fermentation, smoking or other processes to enhance flavour or improve preservation. In addition, there is strong evidence that diets containing large amounts of fast food and other highly processed foods high in unhealthy fats, starch or sugars, as well as eating a "Western-type" diet (characterized by large amounts of added sugar, meat and fat), are the cause of weight gain, being overweight and suffering from obesity, which are risk factors for many cancers. Consumption of diets that largely consist of ultra-processed foods (UPFs) has been linked to decreased nutritional quality. This decrease manifests itself in various ways, such as a lower intake of dietary fibre and essential vitamins. Conversely, these diets often lead to an increased intake of free sugars and saturated fats, further compromising the nutritional value.

There is also strong evidence that consumption of alcoholic beverages causes cancers of the mouth, pharynx and larynx, oesophagus (squamous cell carcinoma), liver, large intestine and breast (especially after menopause). Evidence suggests that alcoholic beverages of all kinds have a similar effect on cancer risk. Therefore, this recommendation covers all types of alcoholic beverages, whether beer, wine, spirits (liquor) or any other alcoholic beverages, as well as other sources of alcohol.

Research in earlier years focused on the isolated effects of individual foods and food components on cancer risk. It is increasingly concluded that foods or individual nutrients are not consumed in isolation, but can interact to generate a combination effect of influences on various pathways involved in carcinogenesis. The pattern of a healthy and balanced diet based on products of plant origin is the one most often cited as recommended for cancer prevention.

Understanding the interactions between nutrients and their impact on the process of carcinogenesis is key to developing effective cancer prevention strategies. A plant-based diet, because of its richness in nutrients that can synergistically act against carcinogenesis, should be a major component of these strategies. Further research in this area is needed to fully understand the mechanisms of these interactions and to be able to use them in preventive measures.

Article information and declarations

Author contributions

Katarzyna Wolnicka – wrote the manuscript, conceived the original idea and supervised the article.

Conflict of interest

None declared

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Received: 7 Dec 2023
Accepted: 20 Dec 2023

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