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A Mini-Review on Cancers and Food Consumption

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Abstract

Background: Cancers remains to be the high mortality disease in the world. Despite significant advances in the basic research and clinical practice, treatments such as surgery and chemoradiotherapy have side effects. And the research on food and cancers has grown exponentially over the decades. Objective: The purpose of this minireview is to summarize the relationship between various food and cancers. **Methods:** The search strategy uses the keywords "cancer AND food consumption AND diet" in Title/Abstract part from 2014 to 2024 years in Pubmed papers written in English. **Results:** This minireview summarized the latest findings on the relationship between various food and cancers including cancer incidence/mortality/treatment. The foods include fermented foods, dietary patterns, ultra-processed foods, organic food, food nutrition, bioactive peptides, and so on. The cancers involved include breast cancer, lung cancer, ovarian cancer, urinary system cancer, gastrointestinal cancer, esophageal cancer, head and neck cancer, hepatocellular cancer, pancreatic cancer, and obesity-related cancer. **Conclusion:** Food can prevent or cause cancers, and can worsen or reduce cancer progression. This minireview should help develop dietary strategies for public health regarding cancers.

Keywords

Cancers, Cancer Incidence/Mortality, Fermented Food, Ultra-Processed Foods, Food Treatments, Mediterranean Diet, Inflammatory Diet, Metabolism

1. Introduction

Cancers is the second highest cause of death globally, and it is estimated that up

to 20 million cases per year of cancer cases will be increased by 2030. Cancers can be treated in a variety of ways, including surgery, radiation and chemotherapy, which have side effects of reducing the life quality for patients [1]. Despite undeniable advances in basic research and clinical practice, the number of cancer patients worldwide continues to grow. Tumors with a higher incidence are breast cancer, lung and urinary system tumors [2]. In addition, the early detection of many tumors makes treatment time longer and healthcare costs significantly higher. Therefore, global control of the prevention of these diseases is the most cost-effective long-term strategy. A specific diet without side effects is one of the important ways to reduce the risk of cancer. In many cases, plant foods rich in natural anti-angiogenic chemicals may have a vascular protective or preventative effect. Inhibition of angiogenesis may help to slow the progression of tumors at different stages, at which level it is implemented depending on the target population [3].

The relationship between cancers and food is rich, and cancers can involve breast cancer, urinary system cancer, lung cancer, ovarian cancer, gastrointestinal cancer, esophageal cancer, head and neck cancer, hepatocellular cancer, pancreatic cancer, obesity-related cancer, etc. Foods may relate to types, dietary patterns, ultra-processed foods (UPF), food nutrition, bioactive peptides, sensory or feeding functions, and food security. Food can prevent or cause cancers, and can worsen or reduce cancer progression. For decades, the research on food and cancers has been growing exponentially [4]. Chinese tradition of medicinal and edible homologous food gives Chinese people a rich experience in food care. “Huangdi Neijing Tai Su” has recorded: “fasting food for food, patients eat for medicine”. Many foods are both drugs, but also food. The grain is the nourishment. The mining of Chinese medicine and food homologous nursing experience is beneficial for health protection.

The purpose of this minireview is to illustrate the relationship between various food and cancers, further to analyze the relationship between food and cancer incidence/mortality/treatment. This minireview will help to develop dietary strategies for public health.

2. Food Patterns or Types and Cancer

2.1. Food Patterns

This part takes colorectal cancer and breast cancer as examples. Colorectal cancer, which accounts for about 10% of all cancers. For anatomical reasons, food has a strong influence on the formation of colorectal cancer. Colorectal cancer is more prevalent in developed countries, which is closely related to Western food with high meat content [5]. A plant-based and frugal feeding pattern is recognized as a healthy eating pattern. Eating patterns based on meat and animal foods are considered unhealthy eating patterns. Adherence to unhealthy eating patterns may lead to an increased risk of breast cancer, whereas high adherence to healthy eating patterns is associated with a 38% lower risk of breast cancer [6].

Multiple studies have reported that breast cancer survivors tend to have poorer feeding habits, as intake of plant foods such as fruits, vegetables, and legumes tends to be reduced. Breast cancer survivors often gain weight during treatment, which in turn leads to increased rates of recurrence and mortality, so improving food nutrition may have significant benefits for the overall health of patients. The Mediterranean diet is a style of eating based on fruits and vegetables, whole grains, beans, and olive oil. It is effective and easy to adhere to. It has several beneficial effects on health, such as controlling overweight. This dietary pattern contains a nutrient bank of a variety of nutrients, such as bioactive compounds and foods with anti-inflammatory and antioxidant properties. Recent scientific advances have shown that nutritional supplements can amplify the benefits of the Mediterranean diet and can help mitigate the side effects of chemotherapy and radiotherapy [7]. Breast cancer has been the most common type of cancer among women in Saudi Arabia for the past few years. Firas S Azzeh *et al.* included postmenopausal women in Mecca, Saudi Arabia, to investigate the relation between preventive dietary factors of the Mediterranean diet and the incidence of breast cancer. The findings suggest the Mediterranean diet can be a factor in the prevention of breast cancer in postmenopausal women in the Mecca region [8]. However, more consistent and reliable conclusions regarding dietary patterns and breast cancer risk in Asians are needed in the future [6].

Poor dietary habits are significantly associated with the pathogenesis of colorectal cancer and are increasingly associated with worsening outcomes, including the risk of cancer recurrence and death. Dietary assessment is the use of a computer in a clinic or at home to assess the dietary patterns of patients with colorectal cancer who are being monitored for their cancer. Dietary quality was defined by the 2015 Healthy Eating Index score, and statistical significance was determined using Pearson correlation and ANOVA. No differences in diet quality were found in education, tumor site (colon and rectum), or sex, while a significant negative association was found between longer time after diagnosis and lower diet quality. Patients who were older, non-obese, unmarried, and near completion of cancer treatment had higher diet quality scores. Research integrating computer evaluation into cancer care will improve diet quality through personalized interventions targeting specific dietary patterns [9].

2.2. Food Types

1) Fermented food

The common fermented foods include pickles, coffee, wine, sauerkraut, miso, tempeh, yogurt, kimchi, cheese, kefir, kombucha, oil, and sourdough bread. Fermented food is a promising food intervention that alters the composition of gut microbiota and thus enhances immunity, and plays a key role in improving overall cancer survival. Fermented foods may change the gut microbiota faster than high-fiber foods. Fermented foods contain a variety of microbes, which may include some probiotics or non-probiotics. About 70% immune system is located in the

gastrointestinal tract of the body, and fermented foods may play a key role in health effects through immune regulation. The fermentation increases the functional and nutritional properties of foods, improves food tolerance, increases the bioavailability of vitamins and nutrients, and promotes human health [10].

Despite the improved benefits of ingesting fermented foods for cancer development and progression, there are still some key questions to be answered, one of which is whether microorganisms in fermented foods can survive digestion and reach the gut and be bioavailable. Because current study designs in human epidemic populations vary and are highly heterogeneous, there is little evidence to show how changes in the gut microbiome mediate the link between fermented foods and health outcomes. Supplementation with probiotics can be useful, and it is recommended to add fermented foods to the daily diet. However, daily use of probiotics is generally not recommended, and fermented foods may be a safer choice than medications. Fermentation is one of the forms of microbial metabolism in the gut microbiome. A wide variety of bioactive metabolites result from the production of fermented foods, which may impact immune, metabolic status and disease severity. A fermented food diet is one of the gut microbiome targeted diets that may provide a long-term treament for cancer survivors and cancer patients, but no studies have been conducted to date that use fermented foods as a viable food intervention for cancer survivors. Future research may integrate microbiome with genomics, proteomics, and metabolomics approaches to use fermented foods as a probiotics alternative improve health, cancer treatment response, and cancer prognosis. Future research may still focus on humans, because the anatomy of the mouse gastrointestinal tract and about 85% of the microbes that colonize the gut are quite different from humans. Future goals contain feeding control of the individual microbiome to enhance the immunotherapy effects [10].

2) Ultra-processed foods

Studies from a prospective European cohort on cancer and nutrition show that how alternative diets can reduce the risk of certain cancers. This is the largest multicenter prospective cohort study conducted to date, with multiple cancer endpoints and multiple tests, and the results are robust. The EPIC cohort included participants recruited from 23 universities, university hospitals and cancer research centers in 10 European countries between 1991 and 2001. Cox proportional risk model was used for substitution analysis to replace 10% processed foods and UPF with 10% minimally processed foods to observe the impact on cancer risk at 25 anatomical sites [11]. The findings suggest that a diet with minimal processed and fresh foods, including whole grains and non-starchy vegetables, may reduce the risk of several cancers, while a diet with more processed and UPF increases the risk. When 10% of processed foods were replaced by minimally processed foods, there was an overall 4% reduction in cancer risk, with significant reductions in the risk of several specific cancer types including esophageal adenoma (43%) and hepatocellular carcinoma (23%). Replacing 10% UPF with minimally pro-

cessed foods only reduced the risk of overall cancer by 1%, esophageal squamous cell carcinoma by 20%, and hepatocellular carcinoma by 27%. Researchers speculate that a diet of UPF is associated with obesity, often with low diet quality and high energy density, so UPF may increase the risk of cancer for low nutritional value and obesogenic properties, and obesity is a known risk factor for more than 13 site cancers [11].

UPF in Europe may be similar to those in the United States, where they recommend eating a variety of whole grains, vegetables, and fresh fruits, and limiting processed meats, sugary drinks, and red meat. A major limitation of most ultra-processed food consumption survey studies is that foods can be misclassified due to the lack of access to detailed information on each food item. And food processing contaminants and additives may also play a role. A wide variety of highly processed foods may contain many non-nutritional ingredients, such as preservatives, emulsifiers, flavorings and other chemicals, and future dietary recommendations may take into account the potential health effects of food composition and composition. Carefully designed clinical trials are needed to further evaluate the effects of food processing on canning related biomarkers and health [11].

Guo-Chao Zhong *et al*. identified a population-based cohort of 101,729 U.S. adults. Consumption of fried foods was assessed using a validated food frequency questionnaire. The results show that the average follow-up was 8.86 year), and 402 cases of pancreatic cancer occurred. They found that eating fried foods was inversely associated with the risk of pancreatic cancer in the United States population. The role of fried foods in reducing pancreatic cancer risk appears to be largely due to potato chips [12].

3) Food types and multiple cancers

Foods of plant origin, such as fruits and vegetables, have been shown to reduce the risk or have beneficial effects on survival for a variety of cancers, including breast cancer, digestive tract cancer, obesity-related cancer and urinary tract cancer. In particular, dandelion, which contains many healthy nutrients, inhibits a variety of tumors, including hepatocellular carcinoma and its related cancer diseases, female cancers such as breast or cervical cancer, and the proliferation and migration of gastric cancer by regulating long non-coding RNA. Dandelion is a common plant, its global growth distribution is relatively wide. Dandelion has been widely used as a folk medicine and food, with no side effects in the treatment of cancer, especially female cancer, liver disease and kidney disease.

Asma Kazemi *et al* examined the relationship between food groups and breast cancer in a variety of studies, and the studied foods including grains/cereals, nuts, legumes, soy, processed meats, red meat, fish, poultry, eggs, vegetables, fruits, dairy products and sugar-sweetened beverages. No other food group was obviously related to the risk of breast cancer. Milk intake >450 g/day increased breast cancer risk, while no relation was observed at lower intake. High intake of vegetables, fruits, cheese, and soy products, as well as lower intake of red and processed meats, are associated with a lower risk of breast cancer [13]. Consumption of vegetables and fruits reduces breast cancer risk. Intake of soy protein and isoflavones

reduced the risk of breast cancer by 35% and 32%, respectively. Alcohol consumption increases breast cancer risk by 75%. There were no significant differences between green tea consumption/meat/soy foods and breast cancer risk [6].

Yuko Minami *et al*. investigated the relationship between intake of six Japanese food pretreatments and risk of death in patients with gastrointestinal cancer. Frequent intake of soy foods was inversely associated with all-cause risk in patients with stomach cancer, and frequent intake of seaweed was inversely associated with all-cause mortality in patients with colon cancer. These results suggest that food factors may affect the prognosis of digestive tract cancer, and Japanese foods such as soy products and seaweed may have a favorable impact on patients' survival rates for gastric and colorectal cancer [14]. Switching from an animal-based diet to a plant-based diet can reduce the incidence of colorectal cancer. Studies by Rilla Tammi *et al* have found that replacing red meat (100 g/week) or processed meat (50 g/week) with vegetables, fruits, or a combination of fruits, whole grains and vegetables, using Cox proportional risk models to calculate core-specific hazard ratios for colorectal cancer. There was a slight reduction in colorectal cancer risk (1%), with 1,124 colorectal cancers diagnosed during 28.8 years of follow-up. In conclusion, even small-scale, easy-to-implement plant-based food can reduce colorectal cancer risk in people with high meat consumption [15].

40% of all cancers are obesity-related cancers in USA, and the International Agency for Research on Cancer found a link between 13 types of cancer and obesity. It has been shown that healthy food consumption can reduce the mortality of obesity-related cancer. Based on high death rates and low death rates, the results found that for a total of 3,038 counties with higher death rates from obesity-related cancers, the proportion of people over 65 years of age and higher rates of poverty were higher. In U.S. counties or equivalent counties filled with food swamps with fast food restaurants and low-nutrient foods, the odds of a high rate of obesity-related cancer death increased by 77%. Together, the results of this cross-sectional ecological study suggest that policymakers, community stakeholders and funding agencies should adopt sustainable methods to combat obesity and cancers, and obtain healthier food opportunities [16].

Some plant-derived foods can prevent urinary cancers. Melissa Garcia-Caballero *et al*. provided epidemiological evidence in a review, highlighting the role of plant-derived foods in bioactive phytochemicals for vascular cancer prevention [3].

3. Food and Cancer Incidence/Mortality

The most common tumor that causes cancer deaths in women is breast cancer, which is one of the most common cancers worldwide. Breast cancer is strongly influenced by environmental factors. It has been established that foods and specific nutrients are key factors in the development of breast cancer, and dietary components can inhibit and/or promote cancer by modifying the epigenetic environment. Overall omics studies on food and breast health have found that food can not only target tumor suppressor genes and oncogenes to change their methylation levels, but also affect non-coding RNA pathways, histone chemical modi-

fications and microbiome metabolism. The potential application prospect of this study is the prevention and treatment of breast cancer [17].

A lower incidence of stomach cancer was associated with overall organic food consumption compared to patients who did not eat organic food. And there was an association between whether or not to eat organic food as opposed to organic food intake and overall cancer incidence. Julie Louise Munk Andersen *et al* estimated the relationship between cancer incidence and organic food consumption. They used data from the Danish Diet, Cancer and Health cohort on organic food categories including fruits, dairy, vegetables, meat, eggs, bread and cereal products. There were 9,675 first cases of cancer among the 41,928 participants followed over 15 years. The literature on organic food intake and overall cancer incidence is sparse and has shown conflicting results with specific cancer risks [18]. Energy and protein intakes calculated by food diaries are often associated with loss of appetite (intake ≤ 70% of guideline recommended levels) and weight loss in patients with lung or gastrointestinal cancers. The loss appetite of patients are assessed using a specific anorexia questionnaire and the Functional Assessment of Anorexia/Cachexia Therapy. Because negative protein and negative energy balance may play an key role in the cachexia pathogenesis, and early multimodal strategies are urgently needed to improve food intake [19].

An important cause of primary liver cancer is chronic inflammation, which may be influenced by dietary habits. And a more inflammatory diet is associated with a higher risk of primary liver cancer incidence and mortality. Increased intake of food components with anti-inflammatory properties and reduced intake of pro-inflammatory components are attractive strategies for reducing the incidence and mortality of primary liver cancer [20].

The following text focuses on the relationship between the intake of modern UPF and carcinogenesis and a variety of cancers.

3.1. Intake of Ultra-Processed Foods and Carcinogenesis

UPF are becoming increasingly dominant globally and have become a staple food in many countries. In some cases UPF account for 60% of total daily energy intake, being accompanied by an increased risk of cancers. Epidemiological evidence suggests that a global shift in food processing may be part of the reason for chronic disease burden and the global obesity epidemic. Existing evidence suggests that UPF may increase cancer risk through exposure to potentially carcinogenic compounds and obesogenic properties. However, prospective studies looking at the relationship between cancer outcomes and UPF consumption are limited, and priority areas for policy implications and future research include improving understanding of the potential harms of UPF to cancer risk and the environment [21].

Irja Minde Isaksen did a review assessing the association between UPF intake and cancer risk. It was showed that an obvious positive relationship between ultra-processed food intake and all cancers evaluated except prostate cancer. When the proportion of UPF in the diet increased by 10%, the breast cancer and overall can-

cer risk increased. High intake of UPF is associated with an increased risk of pancreatic and colorectal cancer [22].

Replacing processed and UPF with equal amounts of minimally processed foods may reduce the risk of various cancers. Nathalie Kliemann *et al.* used Cox proportional risk models to assess the effect of replacing 10% of processed and UPF with 10% of microprocessed foods on cancer risk at 25 anatomical sites. Replacing 10% of processed foods with an equal amount of the lowest processed foods was associated with a reduced risk of overall cancer (head and neck cancer, esophageal squamous cell cancer, rectal cancer, colon cancer, hepatocellular cancer, and postmenopausal breast cancer). Replacing 10% of processed foods with 10% of microprocessed foods is associated with a reduced risk of head and neck cancer, hepatocellular carcinoma and colon cancer [23].

The highest UPF intake was associated with an increased risk of colorectal, colon, and breast cancer in men, but not colorectal and prostate cancer. In summary, high UPF intake was related to an obvious increased risk of some site-specific cancers, particularly those of the hormone-related and digestive tract cancers. Meanwhile, prospective experimental studies are rigorously designed to understand causal pathways better [24]. There is limited prospective evidence that higher UPF are associated with cancer outcomes. A large UK cohort study conducted by Kiara Chang *et al.* provides evidence of a positive association between UPF consumption and the risk of morbidity and mortality from both overall and some site-specific cancers. This study was designed to examine the relationship between UPF consumption and overall/site-specific cancer incidence and cancer mortality risk using a UK Biobank cohort. Although this study adopted a conservative approach to classify foods into lower processing categories, there are limitations such as insufficient details of some foods. And further research on the mechanism pathway is necessary to better determine the intervention target [25].

Overall, UPF intake was obviously related to both overall cancer and multiple cancer risks. This data can provide the updated dietary guidelines, policymakers, and the public to improve public health.

3.2. Intake of Ultra-Processed Foods and Mortality

For the prospective cohort study of 13,640 UK Biobank participants with a history of cancer, higher UPF intake in participants with a history of cancer was associated with a higher risk of death. UPF consumption was calculated using the weight ratio of UPF to total food consumption, and the association between participant mortality and UPF intake was assessed using Cox proportional risk models. 1611 deaths were recorded during a median follow-up period of more than 10 years [26].

3.3. Ultra-Processed Foods and Many Cancers

UPF have become a major component of the diet in most middle - and high-income countries. And UPF consumption is significant associated with the risk of many cancers, including pancreatic cancers, breast and colorectal [27].

Although the exact mechanism of the relationship between certain cancers and UPF consumption is unclear, the evidence so far suggests that cancer risk may be increased by UPF through obesogenesis, alcohol intake, food quality factors, and non-nutritious food processing compounds. For example, UPF intake may increase the risk of kidney cancer through obesity, and experimental studies based on more population are needed to confirm these associations and elucidate the possible mechanisms [27].

High consumption of UPF prior to cancer diagnosis significantly increased lung mortality associated with all-cause risk. On the other hand, cancer does reduce the intake of UPF before diagnosis, which may improve the overall survival rate of lung cancer patients [28]. However, UPF consumption is also not associated with some cancers and is not associated with ovarian cancer risk [29]. In conclusion, food policy and public health should include concerns about food processing when developing dietary guidelines.

1) Breast cancer

The relationship between breast cancer and UPF consumption risk has been examined by several epidemiological studies with inconsistent results. Some studies have shown no relationship between breast cancer and UPF. Jian-Yuan Pu *et al*. analyzed the all-cause mortality and cancer-specific mortality of 2443 breast cancer patients with consumption of UPF, and found no correlation [28]. Unconditional multivariate logistic regression was used to evaluate, and no association between UPF consumption and breast cancer was found [30].

Long Shu *et al*. found that UPF were significantly associated with breast cancer, and a systematic review and meta-analysis was conducted to explore whether there was an association between high consumption of UPF and breast cancer risk. Compared to the lowest intake, the highest intake of UPF was related to a higher risk of breast cancer. Linear dose response analysis showed that every 10% increase in UPF consumption was associated with a 5% increase in breast cancer risk. For subgroups of case-control studies and subgroups with sample size <5000, there was a significant positive association between intake and breast cancer risk. However, further research, especially large prospective cohort studies, is needed to confirm these results [31]. A large-scale cohort of the European Prospective Investigation into Cancer and Nutrition (18,814 breast cancer cases/500,000 participants) reveals a mechanism by which UPF consumption is positively associated with breast cancer risk. Western populations, Latin American populations (20% women under 45 years of age), and young women in Los Angeles are included in the study conducted by Inge Huybrechts *et al*. whose results show that a positive correlation between UPF consumption and breast cancer. Therefore, given the widespread nature of UPF consumption, global action to reduce intake is urgently needed to address the cancer burden [32].

2) Prostate cancer

UPF intake was not related to increased risk of prostate cancer. At present, five epidemiological studies with 764,261 participants have focused specifically at the

association between cancer risk and UPF intake for the urinary system, including prostate, bladder, and kidney cancers. And UPF intake is not associated with an elevated risk of prostate cancer. Every 10% increase in UPF intake was not associated with the risk of prostate cancer [26]. Dora Romaguera *et al.* used unconditional multivariate logistic regression to show that there is no correlation between UPF and the incidence of prostate cancer [30].

However, Jian-Yuan Pu *et al.* found that prostate cancer patients who consumed a large amount of UPF before cancer diagnosis had an increased risk in a non-linear dose-response manner. And reducing the intake of UPF before cancer diagnosis might improve the survival rate of some prostate cancer patients. Patients with BMI <25 had prostate cancer, while patients with BMI ≥25 did not have prostate cancer-specific mortality [28].

3) Colorectal cancer

A higher intake of highly processed foods increase risk of colorectal cancer precursors, and UPF may be a controllable factor in early colorectal cancer prevention [33]. Research by Jian-Yuan Pu *et al.* suggests that reducing the intake of UPF before cancer diagnosis may improve cancer-specific survival in some colorectal cancer subgroups. Subgroup analysis showed that UPF intake was significantly positively associated with colorectal cancer-specific mortality in patients with stage I and II colorectal cancer, but not stage III and IV colorectal cancer [28].

Dora Romaguera *et al.* used a case-control study based on population and unconditional multivariate logistic regression to evaluate the association between UPF and colorectal cancer. And the results showed that there was a correlation between colorectal cancer and UPF consumption [30].

4) Pancreatic cancer

Whether UPF consumption is associated with pancreatic cancer risk has not been established. Guo-Chao Zhong *et al.* conducted a prospective study to determine whether UPF consumption is associated with pancreatic cancer risk. A cohort based on population of 98,265 U.S. adults was identified from cancer screening trials of the prostate, lung, colorectal, and ovarian.

During an average follow-up period of 8.86 years, 387 cases of pancreatic cancer were found. High consumption of UPF has been found to increase pancreatic cancer risk. These findings suggest that reducing the consumption of UPF may be beneficial in reducing the incidence of pancreatic cancer [12].

The core content of this section is summarized in **Figure 1**.

4. Food Treatments and Cancers

4.1. Food Nutrients and Compound Components

1) Food nutrition

Food nutrition in cancer patients is insufficient, but food nutrition does not play a major role in cancer risk. Alessio Molfino used food diaries to calculate nutrient intake, and the results showed that insufficient nutrient intake is very common in patients with lung or gastrointestinal cancer [19].

Fermented food enhance immune (-)

Vegetables and fruits (-)

Carcinogenesis
Mortality

1) Breast cancer
2) Prostate cancer
3) Colorectal cancer
4) Pancreatic cancer

UPF, low nutritional value and obesogenic properties (+)

(−) inhibit cancers; (+) promote cancers.

Figure 1. Food patterns and cancer carcinogenesis/mortality.

However, the European Prospective Investigation into Cancer and Nutrition conducted by Alicia K Heath *et al.* did not show that intake of 92 specific foods and nutrients played a major role in the risk of primary lung cancer, but it showed that retinol and beer/cider intake were positively correlated with the risk of lung cancer without gender differences [33].

It has been identified that many natural products as being able to fight various cancers with fewer side effects, and it may be feasible to improve cancer patients through food nutrition. Taking nutrient fatty acids as an example, fatty acids are biomarkers of cancer onset and progression, so personalized therapies based on fatty acids are also feasible. The use of foods based on fatty acid and nutrients to support cancer treatment is a multidisciplinary subject on molecular and clinical research. While taking other important factors into account such as formulation and bioavailability, the nutritional status of the patient highly influenced the successful treatment of a tumor. Recently, vitamins and minerals have been taken by most cancer patients to improve standard treatment and/or reduce adverse side effects of treatment as well as potential disease. A holistic approach that needs to integrate nutrition and drug strategies in an appropriate way is a further development of cancer treatment, where appropriate types of complementary micronutrients such as those in oncology should be taken at appropriate time [34] [35].

2) Food components of compound

Fruits and vegetables are rich in a large number of bioactive food ingredients, and the literature on bioactive food ingredients is growing from 2000 to 2020. And food containing these ingredients are beneficial to health and are protective factors. Bioactive food ingredients that have been shown to improve many types of cancer (breast, lung, colorectal, leukemia, and liver cancer, among others) include curcumin, resveratrol, quercetin, sulforaphane, and capsaicin. Bioactive food ingredients can be used as adjuvants to enhance the efficacy of conventional colo-

rectal cancer treatment [5].

As a single phytochemical, isopentenated flavonoids are present in many food resources. So far, more than 1000 kinds of this compound have been identified, and it has good safety and anti-cancer effect [36]. However, various foods showed better efficacy as complete extracts than their respective phytochemicals, suggesting a synergistic effect between food components. Combining bioactive drugs with existing chemotherapy drugs helps to synergize the anti-cancer effects of both to overcome drug resistance [4].

The molecular mechanism of anticancer action of bioactive food ingredients has also been studied. In a review, Manas Yogendra Agrawal *et al*. explained the molecular mechanisms of anticancer effects of bioactive food ingredients (mainly based on plant or microbiome) in several cancer models. The primary cell death mode of most food bioactive substances is apoptosis, and the main oncogenic signaling axis such as Akt/PI3K, JAK/STAT, and NF-κB [4].

Cancer's ability to divide uncontrollably stems from serial mutation in normal cells that can occur due to DNA damage caused by high ROS levels in normal cells. High ROS levels that cause oxidative stress trigger the proliferation of cancer cells, and the cytotoxic effects of elevated ROS levels can be used for anticancer therapy. Some biologically active compound from natural foods, such as fruits, vegetables, herbs and honey, regulate reactive oxygen species levels in the body to prevent oxidative stress. And these bioactive compounds are promising sources of natural antioxidants [1].

4.2. The Bioactive Peptides From Food

Bioactive peptides are specific peptides, usually containing 2-20 amino acid residues, that ultimately affect health by actively exerting various functions and biological activities. Strategies that target programmed cell death are potential approaches to treating inflammatory diseases and cancers. Zhao Deng *et al*. reviewed the literature from 2015 to present and introduced the role of bioactive peptides from food proteins in regulating programmed cell death (including autophagy, apoptosis, pyroptosis, iron death, and necrotic apoptosis) on inflammatory diseases or cancers. Most studies on programmed cell death and bioactive peptides have focused on apoptosis, pyroptosis, and iron death. Apoptosis and autophagy can inhibit the overexpression of inflammatory cytokines. Necrotic apoptosis, pyroptosis, and iron death can damage tissues and exacerbate inflammatory progression. In conclusion, in addition to oxidative stress and inflammation, bioactive peptides play a role in maintaining body health by regulation of programmed cell death [37].

4.3. Mediterranean Diet and Cancer

A clinical trial conducted by Brianna I Harvey *et al*. investigated that the effects of an 8-week Mediterranean diet intervention on cancer-related fatigue, which helped to understand patients' experiences with nutritional interventions to opti-

mize dietary plans during chemotherapy [38]. Ashly Liu *et al.* evaluated the effect of polyphenol diet in the Mediterranean diet on children with cancers, and found that there was no significant correlation between total daily polyphenol intake and cancer treatment intensity, type and other indicators. Further large-scale studies are needed in the future, and these studies will help to evaluate the value of dietary patterns rich in polyphenols for nutrition intervention in children with cancers [39].

The core content of this section is summarized in Figure 2.

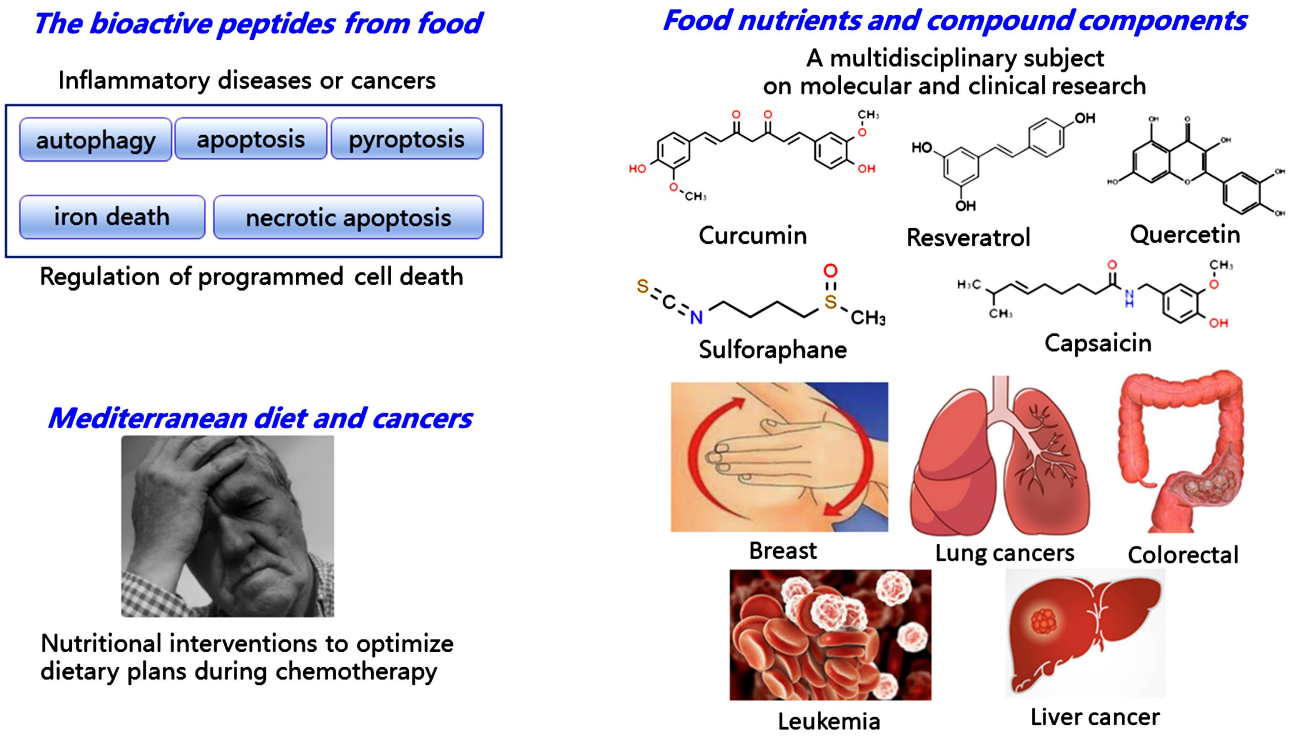

Figure 2. Food treatments and cancers.

5. Food and Various Cancers

5.1. Breast Cancer

1) The onset risk of breast cancer

Vijith Shetty *et al.* conducted a hospital-based case-control study of a tertiary care center in India and concluded that "the most important risk factor for breast cancer is a high-fat, low-fiber diet [40]. The existing studies have found that the data on the relationship between breast cancer risk and consumption of dairy products are contradictory. Heba Mohammed Arafat *et al.* evaluated the relationship between dairy consumption and the development of breast cancer through 18 articles (9 prospective studies, 7 retrospective studies and 2 cross-sectional studies). The results found that the risk of breast cancer was negatively associated with dairy consumption, and future studies should consider the use of dairy products in a balanced diet [41]. Oscar F Herran *et al.* conducted an ecological study

of 95 percent of women living in 24 geographical population units in Colombia. There is an inverse relationship between breast cancer rate and duration of breastfeeding (β = −3354.1) [42]. The results showed that breast cancer could be prevented by increased duration of breastfeeding, following traditional food consumption patterns and ensuring health education, regardless of the type of food consumed [42]. Luan Miranda de Godoy *et al.* explored the relationship between dietary components/their quality and the incidence of breast cancers. The quality of diet as modified by the Brazilian Healthy Diet Component Assessment and its index was not associated with breast cancers [43].

2) The treatment of breast cancer

Mariana T M Lima *et al.* conducted a study on 84 patients using Tamoxifen at a university hospital in Brazil between March 2015 and March 2016. The results showed that the higher the frequency of eating and the earlier the time of food intake, the better the quality of the diet [44]. Inarie Jacobs *et al.* investigated the relationship between breast cancer risk and dietary intake in black South African women. The results suggested black women in South Africa eat a diet high in fruits and vegetables, while reducing the consumption of micronutrient-deficient, less energy-dense foods, such as salty foods. These recommended approaches should be affordable and implemented in health intervention strategies [45]. In a dietary assessment of 55 women with breast cancer during treatment, Isis Danyelle Dias Custodio *et al.* found that becoming more pro-inflammatory was associated with higher abdominal fat, suggesting that breast cancer patients treated for adverse effects of chemotherapy need to maintain good nutrition [46]. Studies by Mohammad Hassan Sohouli *et al.* found that a reduced risk of breast cancer was associated with a higher average adequacy ratio index, and dietary patterns reflected by these scores were incorporated into possible guidelines for the prevention of breast cancer in Iranian women [47].

5.2. Cancers of the Digestive System

1) Carcinoma of the esophagus

Faezeh Salamat *et al.* used multivariate logistic regression to assess the association between main diets of food consumption and the risk of esophageal cancer in high – and low-risk areas of esophageal cancer in northern Iran. It was concluded that dietary intake may be an important cause of the incidence of esophageal cancer in northern Iran, and further studies are needed to evaluate the role of dietary factors in this high-risk population [48]. Michela Dalmartello *et al.* analyzed data from a multicentre case-control study of esophageal squamous cell carcinoma conducted in Italy and Switzerland between 1992 and 2009. The results of the study identified three dietary patterns: a "prudent" pattern, a "Western" pattern, and a "low-consumption mix pattern." The "prudent" pattern is a diet rich in fruits and vegetables. The "Western" pattern is a lower intake of fruit and vegetable foods and a higher intake of sugar. The "low-consumption mix pattern" is most of the poor nutrient diets, including several specific types of vegetables, fish,

potatoes and meat. They concluded that the "Western" model and the "low consumer mix" model were associated with an increased risk of esophageal squamous cell carcinoma compared to the " prudent " model [49].

2) Gastric adenocarcinoma

Stela V Peres *et al.* analyzed the consumption of ultra-processed foods and processed foods in patients with gastric adenocarcinoma in Brazil, and found that the consumption of a variety of processed foods was independently associated with the risk of gastric adenocarcinoma, especially processed foods such as yellow cheese, fried fish, processed meat, candy, salty bread, fried and grilled meat [50].

3) Colorectal cancer

Lu Wang *et al.* investigated the relationship between colorectal cancer risk and ultra-processed food consumption, using food frequency questionnaires to assess dietary intake in three large prospective US cohorts every four years, and found that no association was observed between colorectal cancer risk and overall ultra-processed food consumption in the female population. However, an increased risk of colorectal cancer was observed to be associated with a high intake of ultra-processed foods in men and certain subgroups, and further research into the potential properties of ultra-processed foods that cause colorectal cancer is needed in the future [51].

Wen Liu *et al.* aimed to explore the relationship between the intake of specific food components and intestinal symptoms, and used multiple linear regression analysis to analyze the collected data. The study found that the main dietary factors that influenced the protection of intestinal symptoms in patients after sphincter surgery included cholesterol, fruit and protein intake, and the interaction of dairy and grains. The interaction between dairy products and cereals was positively correlated with the sense of abnormal bowel movements, and fruit intake was negatively correlated with the sense of abnormal bowel movements. The results of this study provide a basis for medical staff to formulate a scientific diet education program in the future, to improve the quality of life of patients and relieve intestinal symptoms [52].

5.3. Cancers of Urinary System

1) Prostate cancer

Erica Line de Oliveira Pedron *et al.* investigated the effects of anti-fermentation diet on diet intake and body of elderly patients with prostate cancer. The conclusion of this study is that anti-fermentation diet has a negative effect on diet and body composition in elderly patients with radiotherapy for prostate cancer [53]. There are many inconsistencies in many studies on the association between plant/animal food intake and prostate cancer risk. The literature review of their relationship by John Shin *et al.* suggests that more plant food consumption may reduce prostate cancer risk, while more dairy consumption may increase prostate cancer risk [54].

2) Bladder cancer

Matteo Di Maso *et al.* analyzed the relationship between food groups and the

risk of bladder cancer. As a result, their study further proved the role of diet in the etiology of bladder cancer, indicating that the risk of vegetable and yogurt/milk consumption was reduced, and the risk of meat consumption was increased, especially stewed or roasted meat [55].

5.4. Other Cancers

1) Head and neck cancer

The role of dietary factors in head and neck cancer in European and East Asian populations is similar. A high intake of fruits and vegetables reduces the risk of head and neck cancer, and an intake of processed meat increases the risk [56].

2) Thyroid cancer

Yu-Jin Kwon *et al.* used a large number of Korean population data to comprehensively investigate the prevalence of thyroid cancer and three iodine-rich food groups. Their findings suggest that adequate seaweed intake may prevent thyroid cancer and that a dairy diet may reduce the incidence of thyroid cancer in the Korean population, but the most significant limitations of this study are the lack of 24-hour urine samples (for iodine status assessment), and the lack of clinical data (for thyroid cancer diagnosis) [57].

3) Skin cancer

UV exposure is a major risk factor for the development of the most common cancer among Americans (non-melanoma skin cancer). Human and laboratory studies have found that skin cancer prevention shows significant promise in certain dietary reactive oxygen species, which protect against DNA damage and tumorigenesis [58].

4) Cervical cancer

The second leading cause of death among women of reproductive age worldwide is cervical cancer, which is a global public health problem, and diet is one of several factors that affect the risk of persistent HPV infection and tumor progression. The study conducted by Luz Adriana Meneses-Urrea *et al.* is an ecological study of dietary patterns and cervical cancer in a group of women aged 35 to 64 years across Colombia. The incidence of cervical cancer in Colombia is associated with having diabetes and participation in a state-subsidized health care system. However, conservative dietary habits and rural areas have been shown to be protective factors, and these results indicate the need to promote healthy lifestyles as a public policy [59].

6. Conclusions

We have found that fermented food is healthy for cancers, however, UPF increases cancer risk and is associated with a higher risk of death. What's more, we have found that many cancers are related with food, mainly breast, cancers of digestive system and cancers of urinary system.

In recent decades, the number of studies related to food and cancer has increased significantly, and the experience of the homology of medicine and food in China

provides better support for cancer conservation. Fermented food, which can influence food safety, can improve the overall cancer survival rate through changing the composition of intestinal microbiota and improve immunity. Future studies on fermented food may still focus on humans not on mice. And dietary control of individual microbiome is required. However, the literature on organic food intake and overall cancer incidence is sparse and has shown conflicting results with specific cancer risks. The carefully designed clinical trials are needed to further evaluate the health effects of food products. Several epidemiological studies have examined the relationship between UPF intake and breast cancer risk with inconsistent results. In general, further studies, especially large prospective cohort studies, are needed to confirm these results. Given the widespread nature of ultra-processed food consumption, there is an urgent need for global action to reduce intake to address the cancer burden. Prospective trials examining show that food insecurity screening and food insecurity interventions should be provided to all cancer patients. And that future food safety is an important part of cancer patient care.

The mechanism of the role of diet in cancer includes three parts: metabolic aspect, dietary index and dietary inflammation. Cancer cells acquire a variety of metabolic adaptations needed to grow and proliferate faster. While these metabolic adaptations help to enhance antioxidant defenses and regulate metabolism, there is reduced metabolic flexibility and increased dependence on nutrient absorption, and the main source of nutrients that support tumor growth is diet [60]. Hypercatabolism caused by tumors can lead to impaired nutritional status and reduced food consumption, leading to weight loss [61]. Dietary index was negatively associated with the risk of breast cancer in any of the molecular subtypes (luminal, HER2+, or triple-negative cases) [62]. Diets that cause higher inflammation (higher dietary inflammation score and dietary inflammation index) increase the risk of breast cancer risk [63].

In conclusion, the cancers and food consumption are closely related, which deserve to study the action mechanism and application strategy for better disease prevention/treatment. This mini-review have given the importance and impact of foods for cancers. To fully explore the nursing resources of the medicinal and edible homologous food in Chinese, and to combine them with modern science and technology and research methods, food recuperation methods for cancers are under study and promoted.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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