

The Nutritional Risk Factors and Prevention Measures of Breast Cancer

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Abstract. This study focuses on the epidemiological association between breast cancer in Chinese women and nutritional factors. It is based on the data of 357,200 cases registered by the National Cancer Center in 2022 and the large sample data from the "Report on the Nutrition and Chronic Disease Status of Chinese Residents (2020)". The research shows that an unhealthy plant-based dietary pattern (such as high-sugar beverages and refined grains) increases the risk of breast cancer to 2.23 times that of the control group, while a healthy plant-based diet can reduce the risk by 36%. Persistent binge eating behavior significantly increases the risk of breast cancer in postmenopausal women by 13% to 26% through the mechanism of obesity, with obesity alone causing a 30% to 60% increase in risk. For every 10 grams per day increase in alcohol intake, the overall risk increases by 7.1%, and for postmenopausal women, it reaches 11.1%. In terms of nutritional intervention, consuming soy products more than five times a week can reduce the recurrence rate by 19%. Vitamin D and dietary fiber play a protective role by regulating estrogen metabolism and inhibiting the proliferation of cancer cells. It is worth noting that other cancers such as lung cancer, gastric cancer, and colorectal cancer also exhibit specific nutritional risk patterns. For instance, as high cooking fume exposure elevating lung cancer risk, and high-salt diets increasing stomach cancer likelihood. Therefore, nutritional imbalance is a key modifiable factor for various cancers. Scientifically adjusting the dietary structure and formulating targeted nutritional intervention strategies for different types of cancer have significant public health significance.

Keywords: Breast cancer risk factors, nutritional preventive measures, obesity-cancer link, dietary patterns, plant-based diets.

1. Introduction

Breast cancer, as the most common type of tumor in female cancer patients, has great harm and poses a great threat to women's health. In 2020, female breast cancer surpassed lung cancer with a proportion of 11.7 %, becoming the most common cancer worldwide. According to the data released by the National Cancer Center in 2024, the number of breast cancer cases in China in 2022 is about

357,200, and the number of deaths is about 75,000. This group of alarming data always reminds us that exploring the risk factors of breast cancer and formulating effective preventive measures are of great significance for reducing the incidence of breast cancer in China.

In recent years, with the change of Chinese people's lifestyle and the adjustment of diet structure, high fat diet has become more and more common. The resulting obesity, hyperlipidemia, and a range of unhealthy lifestyles, including alcohol consumption, make it difficult for many people to maintain good nutritional status. These adverse factors are intertwined, which greatly increases the risk of breast cancer. According to relevant studies, the risk of breast cancer in obese women is 30 % -60 % higher than that in normal weight women.

The pathogenesis of breast cancer is extremely complex. It is a multi-factor and multi-step process, involving multiple aspects such as genetics, living environment, lifestyle and eating habits. From a genetic point of view, women with BRCA1 and BRCA2 gene mutations have a lifetime risk of breast cancer of up to 40 % -80 %. In terms of living environment, long-term exposure to polluted environment, radiation environment, etc., may also increase the risk of disease. In terms of lifestyle, lack of exercise, long-term mental stress, etc., all play a role in the pathogenesis of breast cancer. The eating habits are closely related to the occurrence and development of breast cancer.

In recent years, the change of nutritional status has gradually become the focus of academic attention, which is considered to be one of the direct factors affecting the disease progression, treatment tolerance, recurrence risk and quality of life of breast cancer patients. Reasonable nutritional status is helpful to maintain the normal physiological function of the body and enhance immunity, so as to better resist the invasion of breast cancer. For example, a diet rich in vitamins, minerals and dietary fiber can provide adequate nutritional support for the body, reduce inflammation, and reduce the risk of breast cancer. Malnutrition or overnutrition may interfere with the balance of hormones in the body, affect cell metabolism and proliferation, and create conditions for the occurrence of breast cancer.

Based on the registration data of the National Cancer Center and the rich data samples provided by the " Chinese Residents Nutrition and Chronic Disease Status Report (2020), " this study aims to deeply reveal the specific relationship between different types of nutritional status and breast cancer risk in women. Through the analysis of a large amount of data, the key nutritional factors affecting the incidence of breast cancer are accurately identified, which provides a solid and reliable scientific basis for women to rationally adjust their nutritional status and effectively prevent breast cancer, and helps women stay away from the haze of breast cancer and embrace healthy life.

2. The nutritional risk and measures of cancer

2.1. Poor dietary patterns and breast cancer risk

2.1.1. Unhealthy plant-based diet patterns

According to a case-control study on breast cancer in Iranian women, an unhealthy plant-based diet patterns significantly increases the risk of breast cancer [1,2]. The study found that people who consumed large amounts of Less healthy plant foods such as sugary drinks, refined grains, and sweet desserts had a 2.23 times higher risk of breast cancer than those with low intake. On the contrary, a diet mainly consists of healthy plant-based foods such as whole grains, fruits, and vegetables can reduce the risk by 36%. At the same time, emphasizing the quality of diet rather than merely the proportion of plant-based foods is the key, poor choices of plant-based foods may instead promote the occurrence of breast cancer.

2.1.2. Persistent Binge Eating Disorder (BED)

According to a prospective cohort study by the University of Southern California in the United States, persistent binge eating disorder (BED) significantly increases the risk of breast cancer. Meanwhile, according to clinical research, the incidence of binge eating among breast cancer patients is significantly higher than that among healthy people due to treatment stress, such as side effects of chemotherapy and psychological distress like anxiety and body dysmorphic disorders) [3]. Mechanistically, binge eating behavior indirectly increases the risk of breast cancer by promoting obesity: long-term binge eating can lead to abnormal weight gain, and obesity has been confirmed as an independent risk factor for breast cancer, which may cause fat cell hypertrophy and hyperplasia, inhibit fat differentiation and promote adipose tissue fibrosis; Necrotic adipocytes trigger macrophage infiltration, stimulate the release of pro-inflammatory cytokines, such as IL-1 β and IL-6, induce chronic inflammation. At the same time, the imbalance of adipokine dysregulation leads to an increase in leptin levels and aggravates insulin resistance. In addition, obesity upregulates aromatase activity and increases the bioavailability of estrogen, especially in postmenopausal women, further driving tumor development [4]. Furthermore, epidemiological evidence shows that binge eating increases the risk of breast cancer in postmenopausal women by 13-26%, and the estrogen concentration in the breast tissue of obese patients with binge eating is 31% higher than that of those with simple obesity [3].

2.2. The main nutritional risk factors for breast cancer

In 2007, the World Cancer Research Fund and the American Institute for Cancer Research jointly (WCRF/AICR) published a consensus report, which established the consensus results between key dietary factors and the risk of breast cancer and pointed out that alcohol is the most relevant dietary exposure to the risk of breast cancer. At the same time, it was believed that weight gain and obesity in adulthood are associated with an increased risk of breast cancer, mainly in postmenopausal women [5]

2.2.1. Alcohol and breast cancer

Alcohol consumption is a recognized risk factor for breast cancer in women. Alcohol is mainly metabolized into acetaldehyde in the body: a strong carcinogen that primarily forms DNA Adducts. These adducts can disrupt DNA function and interfere with repair mechanisms, potentially leading to DNA damage and mutations. At the same time, the metabolic process also induces the production of a large amount of reactive oxygen species (ROS), leading to oxidative stress and cell damage. In addition, alcohol can stimulate aromatase activity, increase estrogen levels, chronically activate the estrogen receptor pathway, and promote the growth of hormone-sensitive breast cancer [6].

A recent analysis by the Nurses' Health Study confirmed that even low to moderate alcohol intake may increase the risk of breast cancer, especially for postmenopausal women [5]. A prospective cohort study analyzed 43,350 participants of breast cancer and found that for every 10g per day increase in total alcohol intake, the risk of breast cancer increased by 7.1%, and for postmenopausal women, the risk increased by 11.1%. And a follow-up 9,577 women showed that heavy drinkers had a significantly higher risk of breast cancer compared to non-drinkers (adjusted HR = 1.76, 95% CI: 1.30 -2.38), with the association being particularly strong among premenopausal women [6].

2.2.2. Obesity and breast cancer

Unhealthy dietary habits, such as high-fat and high-sugar diets, have been the core driving force behind obesity. Over the past three decades, they have continuously pushed up the global obesity rate. As of 2023, the overweight and obesity rate among Chinese adults has reached as high as 56.9%, posing a significant public health issue. Obesity, as a clear carcinogenic risk factor, can promote the onset and progression of at least 15 types of cancer, including breast cancer in postmenopausal women [4]. Eliassen and the colleagues' research confirmed that overweight postmenopausal women have an independently increased risk of breast cancer by 12%, while obese postmenopausal women have a 25% increased risk of breast cancer [7]. Other medical evidence indicates that obesity is also associated with the recurrence and mortality rate of breast cancer. It is also worth noting that although obesity is an independent risk factor, it is regulated by factors such as different races, tumor subtypes, reproductive characteristics, and weight changes throughout the life cycle.

2.3. The nutritional prevention of breast cancer

A large number of studies have shown that dietary and nutritional interventions have a significant effect on the prevention and treatment of breast cancer. Through the rational combination of diet and ensuring a balanced nutritional intake, it can effectively inhibit or delay the occurrence and development of breast cancer.

Li Junyao's study proposed that in dietary intervention, soybeans and soybean products have a particularly significant inhibitory effect on the incidence of breast cancer, which is related to the intake of soybean proteins, isoflavones and other substances in soybean products [8]. Long-term intake of soybean foods such as tofu, soymilk, and natto can effectively reduce the risk of breast cancer recurrence. For example, a study by the Chinese Academy of Medical Sciences found that some breast cancer patients consume soybean products more than 5 times a week, and the risk of recurrence can be reduced by about 19 % [9]. For women with high estrogen levels in the body, such as premenopausal women, isoflavones can exhibit anti-estrogen effects and reduce the risk of breast cancer.

Also mentioned food is green tea. Tea polyphenols contained in green tea have the effects of anti-oxidation, anti-inflammation and regulation of cell signaling pathways, which may inhibit the proliferation of cancer cells. However, it should be noted that cancer patients during treatment should pay attention to the intake of green tea, and excessive drinking may affect drug absorption. For healthy people, green tea can be used as part of the daily diet, and its antioxidant properties may help reduce the risk of cancer.

At the same time, in the ' Nutrition Expert Consensus for Breast Cancer Patients ', it is also mentioned that protein intake is essential to reduce the incidence of breast cancer and breast cancer patients [10]. Some studies suggest that long-term intake of some animal proteins, such as red meat or processed meat, may lead to a slight increase in the risk of breast cancer, which is related to saturated fatty acids, heme or nitrosamines and other carcinogens produced in the production process of these meats. Most plant proteins have a certain protective effect on the breast.

In addition, the intake of vitamins and dietary fiber may also reduce the risk of breast cancer. Zhang Xue et al. have pointed out that diets containing higher levels of natural folic acid, riboflavin, vitamin D and calcium are closely related to reducing the risk of breast cancer [9]. Vitamin D is involved in regulating cell proliferation, differentiation and immune function, and can inhibit the growth of breast cancer cells. Vitamin D can be supplemented by intaking deep-sea fish, egg yolk,

fortified dairy products, etc. Dietary fiber can promote the excretion of estrogen in the intestine, reduce its reabsorption, and improve the intestinal flora as a prebiotic, indirectly affect immunity and metabolism, and help control body weight. These mechanisms it participates in may reduce the risk of breast cancer. Whole grains, vegetables, fruits, etc. can be used as a source of intake [11].

Therefore, in the daily diet, women who eat more foods with high dietary fiber, protein and vitamin content have a lower risk of breast cancer; in contrast, the intake of red meat and many meats and animal offal with high fat content may lead to increased risk. The role of a single nutrient is limited, and in the prevention and treatment of breast cancer, it is necessary to comprehensively benefit from a diversified diet.

2.4. The nutritional risk factors for other cancers

2.4.1. Lung cancer

The occurrence of lung cancer is related to many factors, among which nutritional factors cannot be ignored. Lack of β -carotene, vitamin A, C, E and trace element selenium will increase the risk of lung cancer. These nutrients have antioxidant effects and can protect cells from free radical damage. When lacking, cells are prone to cancer. High-risk groups such as long-term smokers, tuberculosis patients and silicosis patients should eat more foods rich in these nutrients, such as green vegetables, sweet potatoes, carrots, spinach, etc. There are also factors that affect bad eating habits that cannot be ignored: getting used to high-temperature cooking pots and inhaling too much oil fumes containing carcinogens will increase the risk of lung cancer. Kitchen fume contains a variety of harmful substances, long-term inhalation may damage lung cells, causing cancer. Cooking habits should be changed, such as reducing oil temperature, using range hood, etc., to reduce smoke inhalation.

2.4.2. Gastric cancer

Gastric cancer was once known as 'poor disease', which was closely related to poor dietary nutrition, especially low protein content and low proportion of high-quality protein. Protein is an important part of the body, which is essential for maintaining the normal function and repair of gastric mucosa. Lack of protein will affect the normal physiological function of the stomach and increase the risk of gastric cancer. People who are prone to gastric cancer, such as patients with atrophic gastritis and gastric ulcer, should often eat foods rich in high-quality protein, such as deep-sea fish and shrimp, lean meat and eggs. High-salt diet and high consumption of pickled food are important causes of gastric cancer. Eating too much salt will corrode the gastric mucosa and cause atrophic gastritis, which is an important precancerous lesion of gastric cancer. Pickled salted fish and pickles contain carcinogens such as nitrosamines, which will further increase the risk of cancer. To prevent gastric cancer, it is necessary to reduce salt intake, eat less pickled and smoked food, and eat more fresh fruits and vegetables.

2.4.3. Colon cancer

Inadequate intake of dietary fiber is an important nutritional risk factor for colon cancer. The proportion of high-fat and high-protein foods in the modern diet increases, and dietary fiber intake decreases. High-fat and high-protein food decomposition products contain higher carcinogens than cellulose, and act on the intestinal mucosa for a long time. Lack of dietary fiber will prolong the residence time of these carcinogens in the colon mucosa, thus inducing intestinal cancer. Eating

more foods rich in dietary fiber such as barley, beans, and carrots can help prevent colorectal cancer. Increased intake of milk and calcium is associated with a moderate reduction in the risk of colorectal cancer. Calcium may form a complex with secondary bile acids and heme in the intestinal cavity to protect against colorectal cancer. High folic acid intake is associated with a reduced risk of colorectal cancer, but excessive folic acid content may also promote the growth of colorectal tumors, and its substantial impact on the risk of colorectal cancer is uncertain. Adequate intake of milk, calcium and folic acid, to avoid excessive intake of folic acid, help prevent colorectal cancer.

3. Conclusion

With the increase of material level and the change of people's life and diet structure, the incidence of breast cancer is increasing year by year. Therefore, it is very important to formulate a scientific nutritional preventive measure based on the scientific basis of nutrition to reduce the nutritional risk.

Based on different dietary patterns, this paper counted and discussed the effects of different types of nutritional patterns on the incidence of breast cancer and analyzed the dietary composition of each part behind it. Overeating and drinking behaviors are positively correlated with breast cancer development, so these behaviors should be reduced. And protein, vitamins. The intake of dietary fiber is negatively correlated with the development of breast cancer, so it is suggested that it should be appropriately increased in the daily diet. However, there are still some limitations. 1) Some studies are clinical studies conducted in foreign regions, and there is a lack of nutritional intervention studies for specific regions in China. 2) Whether there are other factors that increase or decrease the incidence of breast cancer (such as smoking) in the study. However, based on this study, targeted nutritional prevention measures should be encouraged in daily life to reduce the risk of breast cancer.

Authors contribution

All the authors contributed equally and their names were listed in alphabetical order.

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