

Correlating Evolution of Dietary Guidelines and Cancer Incidence Trends: A Comparative Study of the United States and Australia

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Abstract. Diet habits have been shown to affect numerous diet-related cancers, for instance, colorectal cancer, oral, nasopharyngeal, and esophageal cancers, pancreatic cancer, lung cancer, etc. This study investigates the relationship between the evolution of dietary guidelines and incidence rates for certain diet-related cancers in the United States (U.S.) and Australia over a 15-year period (2003-2017). Employing an extensive comparative analysis, the study aims to unveil potential associations or divergences between advocated dietary habits and the occurrence of distinct diet-related cancers. The findings reveal a correlation between shifts in recommended dietary patterns and changes in colorectal cancer incidence rates. Notably, changes in guidelines emphasizing reduced red and processed meat intake align with consistent downward trends in colorectal cancer incidence rates. Pancreatic cancer incidence rates, on the other hand, exhibit upward trends despite guidelines promoting increased vegetable and fruit consumption, reinforcing the inconclusiveness regarding the relationship between dietary habits and the occurrence of pancreatic cancer. This investigation marks a crucial initial step in understanding the intricate relationship between recommended dietary patterns and their potential impact on mitigating certain cancer types.

Keywords: dietary guidelines; colorectal cancer; pancreatic cancer; cancer incidence rate; correlation.

1. Introduction

Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020, equating to approximately one in every six deaths [1]. While numerous factors contribute to cancer development, compelling and substantiated evidence suggests that dietary habits play a pivotal role in influencing cancer risk, especially certain diet-related cancers [2, 3].

Dietary guidelines serve as fundamental frameworks pivotal for healthy eating habits. The importance of dietary guidelines cannot be overemphasized. However, the variance in dietary guidelines across different nations can be immense stemming from the unique mixture of distinct eating habits, social-cultural conditions, as well as a wide array of food sources. Moreover, even within the same country, these guidelines tend to evolve over time, propelled by multifaceted factors and evolving societal needs.

This paper delves into cancer incidence rates spanning a 15-year timeframe, from 2003 to 2017, examining various diet-related cancers prevalent in both the United States (U.S.) and Australia. Then, an extensive comparative analysis as well as the similarities and differences explicitly outlined in the most recent dietary guidelines published by these two countries. By aligning the evolving dietary guidelines with the prevailing cancer incidence rates over this extensive period, the aim is to unveil potential associations or divergences between the advocated dietary habits and the occurrence of distinct diet-related cancers. This investigation serves as a foundational step towards comprehending the intricate interplay between recommended dietary patterns and their potential impact on mitigating certain forms of cancer in both the U.S. and Australia.

2. Methods

2.1. Data Acquisition

Examining data from 2003 to 2017 (Figure 1), this study conducts a comparative analysis between the United States and Australia, stratified by gender to account for gender-related inherent biological and genetic disparities affecting cancer development. The cancer data utilized in this analysis is from reputable sources, including the International Agency for Research on Cancer (IARC) under the World Health Organization (WHO) and the International Association of Cancer Registries (IACR), collecting data from population-based cancer registries worldwide.

To streamline the data for comparative analysis, this study employs a number of systematic approaches and adjustments as follows: 1) Aggregating more specific cancer types into five broader categories pertinent to diet-related cancers. 2) For some years, the U.S. cancer data is primarily from the National Program of Cancer Registries (NPCR) which covers approximately 96% of the US population [4]. 3) For some years, the Australia cancer data is the aggregate of the following major regions which covers approximately 95% of the Australia population: New South Wales, Queensland, South Australia, Victoria, and Western Australia.

The analyzed diet-related cancers are 1) colorectal cancer, including colon, rectum, and anus cancers; 2) oral, nasopharyngeal and esophageal cancers: include lip, tongue, mouth, salivary glands, tonsil, other oropharynx, nasopharynx, hypopharynx, pharynx unspecified, and esophageal cancers; 3) breast cancer; 4) pancreatic cancer; 5) lung cancer.

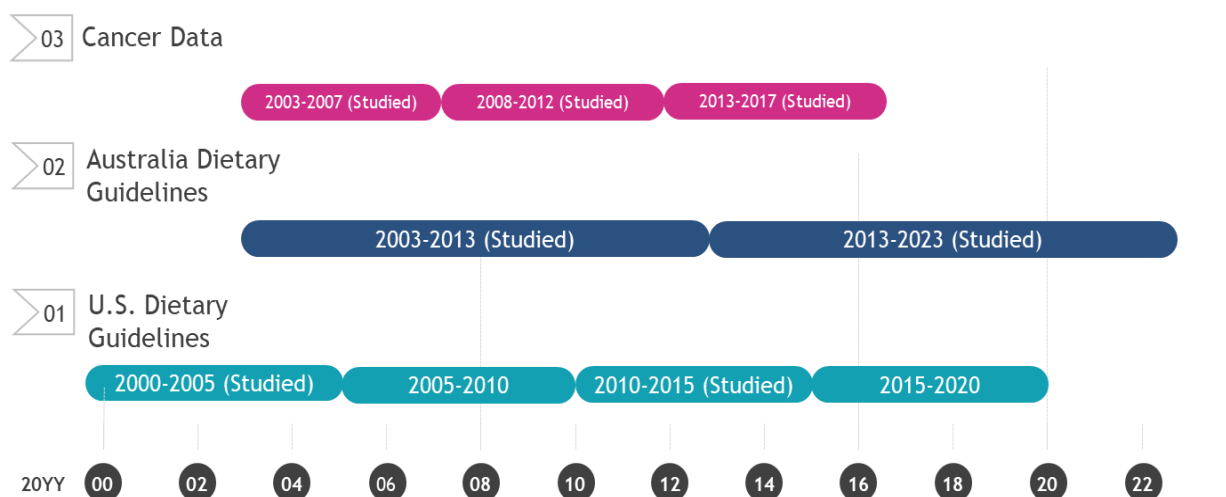


Fig 1. Study timeline of dietary guidelines and cancer data.

2.2. Data Analysis

Incidence rate is the number of new cases arising in a given period in a specified population expressed as person-years at risk. The rate provides an approximation of the average risk of developing cancer. Further, the incidence rates presented in this paper are age-standardized rates (ASRs). They are rates that a population would have if it had a standard age structure. Standardization is necessary when comparing several populations that differ with respect to age structure, because age usually has a powerful influence on the risk of cancer. Using ASRs allows us to see how cancer incidence rates vary without age differences. The most frequently used standard population is the world standard population, which is used in this paper to calculate ASRs. The age distribution of the world standard population used for age standardization is in Table 1 and expressed per 100,000 [5].

Table 1. Age distribution of the world standard population

Age Group	Age Distribution	Age Group	Age Distribution	Age Group	Age Distribution
0-4	12,000	30-34	6,000	60-64	4,000
5-9	10,000	35-39	6,000	65-69	3,000
10-14	9,000	40-44	6,000	70-74	2,000
15-19	9,000	45-49	6,000	75-79	1,000
20-24	8,000	50-54	5,000	80-84	500
25-29	8,000	55-59	4,000	85+	500
Total	100,000				

3. Results

3.1. Cancer Incidence Rates

Figures 2 to 6 exhibit the cancer incidence rates categorized by gender for the period spanning 2003 to 2017, between the U.S. and Australia and across five distinct diet-related cancers - colorectal cancer (Figure 2), oral, nasopharyngeal and esophageal cancers (Figure 3), breast cancer (Figure 4), lung cancer (Figure 5), pancreatic cancer (Figure 6), respectively.

Particularly, in the case of colorectal cancer (Figure 2), notable and consistent downward trends have been observed in incidence rates for both the male and female populations in both the U.S. and Australia over the observed period from 2003 to 2017. For example, the male population in the U.S. displays a consistent decrease of -1.2% annually during this period.

Conversely, pancreatic cancer (Figure 5) has seen steady and significant upward trends in incidence rates across both genders in both countries during the same timeframe. For instance, the female population in Australia displays a consistent increase of +1.2% annually during this period.



Fig 2. Colorectal cancer incidence rates from 2003-2017, by Gender - U.S. vs Australia. The incidence rate was expressed as a number per 100,000.

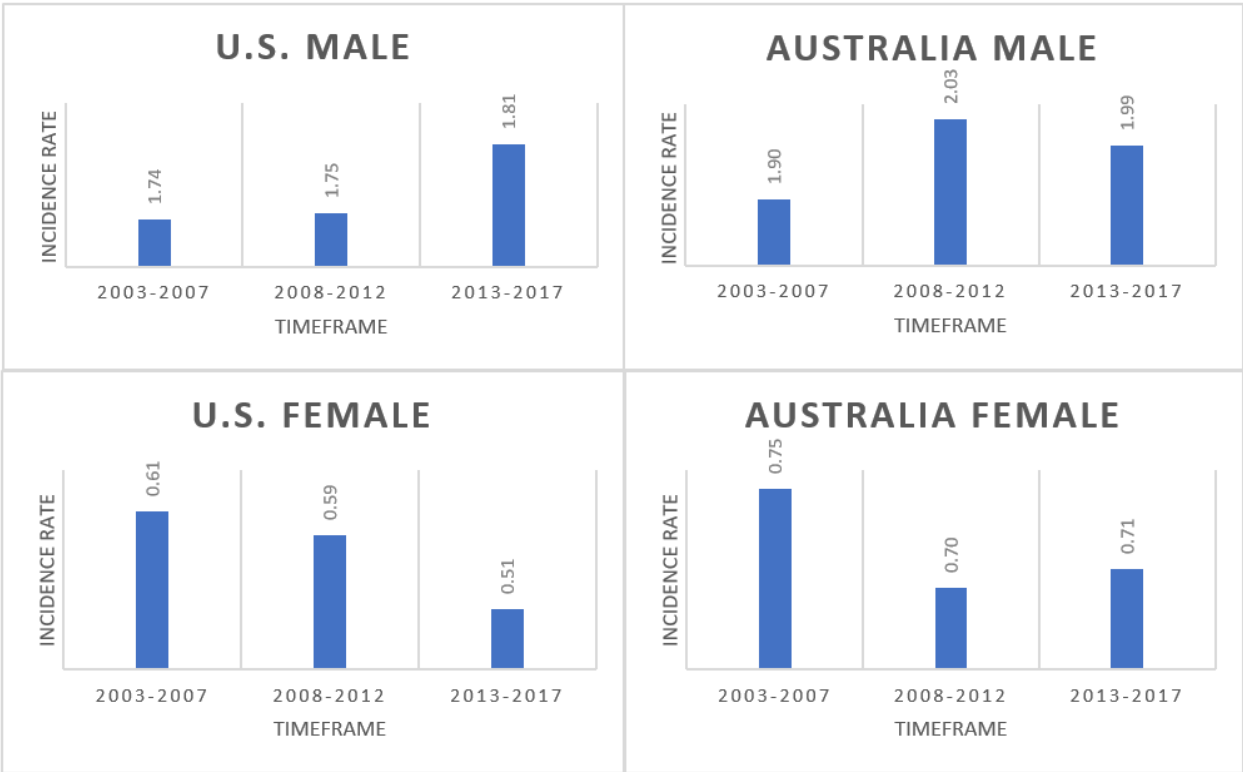


Fig 3. Oral, Nasopharyngeal and Esophageal Cancers Incidence Rates from 2003-2017, by Gender - U.S. vs Australia. The incidence rate was expressed as a number per 100,000.



Fig 4. Breast cancer incidence rates from 2003-2017, by gender - U.S. vs Australia. The incidence rate was expressed as a number per 100,000.



Fig 5. Pancreatic cancer incidence rates from 2003-2017, by gender - U.S. vs Australia. The incidence rate was expressed as a number per 100,000.

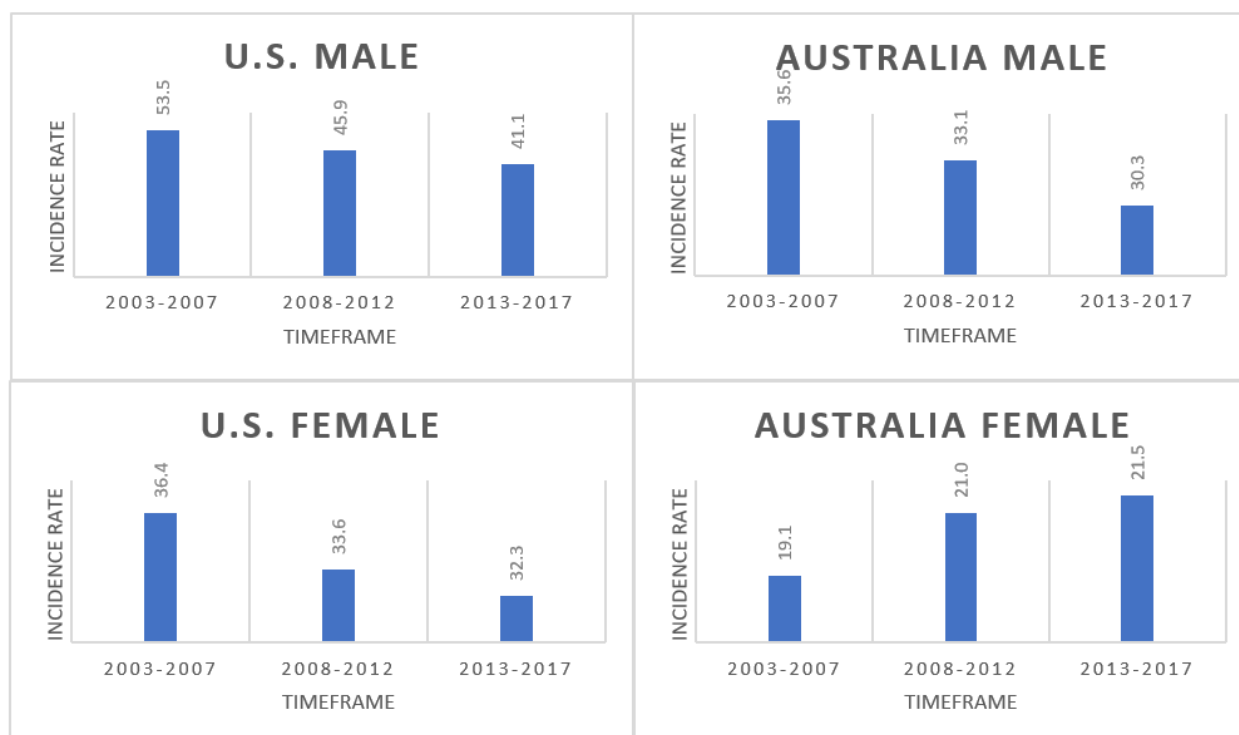


Fig 6. Lung cancer incidence rates from 2003-2017, by gender - U.S. vs Australia. The incidence rate was expressed as a number per 100,000.

3.2. Dietary Guidelines in the U.S. vs. Australia

Dietary guidelines form the cornerstone of shaping healthy eating practices. They are comprehensive recommendations established by health authorities or governmental bodies to guide individuals in making informed food choices and creating balanced eating habits. These guidelines typically outline the ideal consumption of various food groups, nutrient intake, and dietary patterns

necessary for maintaining overall health. These guidelines also act as educational tools, instrumental in empowering individuals to make informed decisions about their diet-related choices. The importance of dietary guidelines cannot be overemphasized. However, their variability across countries can be significant reflecting the diverse cultural, societal, and environmental landscapes. Thus, this study did a comparative analysis of the most recent dietary guidelines published in two significant nations, the U.S. and Australia, listing major similarities and differences [6, 7].

The similarities of guidelines are listed in Table 2. Briefly, the similarities include 1) focus on meeting food group needs: both the U.S. and Australian guidelines prioritize the consumption by food groups, including vegetables, fruits, grains, dairy, and protein, as essential for a balanced diet; 2) moderation in consuming unhealthy ingredients: both guidelines advocate for moderation in consuming added sugars, saturated fats, and sodium to reduce the risk of chronic diseases like obesity and heart disease; 3) portion control: both guidelines stress the importance of portion control and mindful eating habits to maintain a healthy weight and overall well-being; 4) physical activity: both guidelines emphasize on maintaining an active lifestyle as a crucial component of overall health; 5) hydration: both guidelines recommend adequate hydration as a part of a healthy diet.

Table 2. Similarities of dietary guidelines in the U.S. and Australia

Terms	The U.S. guidelines	Australia guidelines
Food group needs	Guideline 3 urges the focus on nutrient-dense foods and beverages to meet food group needs while staying within calorie limits	Guideline 2 advocates for the daily enjoyment of a diverse array of nutritious foods from five groups
Moderation in consuming unhealthy ingredients	Guideline 4 advises restricting the consumption of foods and beverages high in added sugars, saturated fat, and sodium, as well as limiting alcoholic beverages.	Guideline 3 recommends limiting the intake of foods containing saturated fat, added salt, added sugars, and alcohol.
Portion control	The recommendation suggests that a shift to healthier choices and consuming smaller portions is essential for achieving a healthy dietary pattern within an appropriate caloric range	Strong evidence supporting a positive relationship between portion size and body weight, highlighting the significance of mindful portion control.
Physical activity	Adults should engage in at least 150 to 300 minutes of moderate-intensity aerobic activity each week to derive optimal health benefits from physical activity	Advises a minimum of 30 minutes of moderate-intensity physical activity on most days.
Hydration	Emphasis on the primary beverages being calorie-free (water) or those containing beneficial nutrients (fat-free and low-fat milk, and 100% juice)	Underscore the importance of maintaining adequate fluid intake in a healthy diet with plain water being the preferred choice.

Except for the similarities, the dietary guidelines showed differences in U.S. and Australia, listing in Table 3. Briefly, these differences include 1) guideline development process; 2) serving size information; 3) socioeconomic considerations 4) focus on sustainability and environment; 5) discussion on diet-related diseases especially on some forms of cancer.

Table 3. Differences of dietary guidelines in the U.S. and Australia

Terms	The U.S. guidelines	Australia guidelines
Guideline development process	Developed and updated by the Departments of Agriculture (USDA) and Health and human services (HHS) jointly every five years. The current edition was published in 2020.	Updated less frequently (about every ten years) by the national health and medical research council. The current edition was published in 2013.
Serving size information	Provide detailed serving size information such as 2.5 cups of vegetables per day for adults	Are broader without explicit serving sizes, emphasizing the importance of diversity without precise measurements.
Socioeconomic considerations	Focus less explicitly on socioeconomic factors	Emphasize considerations for diverse socio-economic populations, providing recommendations that cater to different economic situations. The word “socioeconomic” appears 61 times throughout the guidelines compared to only 4 times in the U.S. guidelines.
Focus on Sustainability and Environment	Focus less explicitly on sustainability or environmental impacts of dietary choices	Emphasize considerations for sustainability, encouraging environmentally friendly food choices and practices
Discussion On Diet-Related Diseases especially on Some Forms of Cancer	Focus less on the association between dietary choices and certain forms of cancer.	Emphasize the association between dietary choices and certain forms of cancer. The word “cancer(s)” appears 512 times throughout the guidelines compared to only 22 times in the U.S. guidelines.

4. Discussion

4.1. Prevalent Diet-Related Cancers

While cancer development is influenced by a multitude of factors, substantial evidence indicates that dietary habits significantly shape the risk of cancer. Thus, it is important to catalog and synthesize a spectrum of research papers and their findings on several diet-related cancers, elucidating the intricate relationship between dietary choices and cancer risk.

Studies indicated that diets high in red and processed meats may contribute to an increased risk of colorectal cancer. Conversely, diets high in fiber-rich foods, such as fruits, vegetables, and whole grains, appeared protective [2, 3]. Some studies suggested that consuming vegetables is associated with a reduced risk of oral and nasopharyngeal cancers. Conversely, the evidence also suggests that consumption of preserved vegetables (such as salted or pickled) is associated with an increased risk of these cancers [8, 9]. For breast cancer research suggested that dietary factors, such as high-fat diets, excessive alcohol consumption, and low intake of fruits and vegetables, might have implications for breast cancer risk [10]. In more recent studies, there is no evidence to suggest an association between total vegetable consumption and pancreatic cancer. Evidence is also limited and/or inconclusive for an association regarding fruit consumption and pancreatic cancer [11]. Moreover, while smoking is the primary risk factor for lung cancer, certain dietary components like beta-carotene-rich foods and antioxidants from fruits and vegetables might play a protective role in some cases [12].

4.2. Unraveling Correlations: Evolution of Dietary Guidelines and Colorectal and Pancreatic Cancers

Dietary guidelines published by both countries during this approximate 15-year timeframe are studied. By aligning the evolving dietary guidelines with the cancer incidence rates over this extensive period, the aim is to unveil potential associations or divergences between the recommended dietary habits and the occurrence of colorectal and pancreatic cancers.

The timeline depicts three specific 5-year time periods used for calculating cancer incidence rates together with various editions of the dietary guidelines published by the U.S. and Australia during the same entire 15-year period. Australia dietary guidelines are released every 10 years, aligning the 2003 and 2013 editions with this study's scope. The U.S. dietary guidelines are published every five years. For this study's purposes, the analysis includes the U.S. 2000 and U.S. 2010 editions. The primary objective is to uncover potential correlations or disparities between the recommended dietary habits and the occurrence of dietary cancers.

4.2.1. Colorectal cancer

As previously mentioned, studies indicate that diets high in red and processed meats may contribute to an increased risk of colorectal cancer [2, 3]. The comparison between the 2000 and 2010 U.S. dietary guidelines reveals a substantial shift in the recommended diets, with greater emphasis placed on reducing red and processed meat intake. For Australia, the guidelines even totally flipped their stance between the 2003 and 2013 editions. Initially, the guidelines suggested no conclusive association between red meat consumption and colorectal cancer. However, in the later edition, they indicated a probable link between red meat intake and an increased risk of colorectal cancer.

These findings on the evolution of dietary guidelines resonate with the consistent and notable downward trends observed in colorectal cancer incidence rates in both the U.S. and Australia over the observed duration. These insights substantiate a correlation between the recommended dietary habits and the occurrence of colorectal cancer.

In 2000 U.S. Dietary Guidelines, there is no explicit mention of "red meat" throughout the entire guidelines. The guidelines emphasize only on "lean meat". On page 17, there's a recommendation that growing children, teenagers, women, and older adults require increased iron intake, with a particular reference to beef (which is a red meat) as a good source of iron. The word "processed" appears only 8 times. Page 15 even includes a mention of two ounces of processed cheese within the Food Guide Pyramid.

In 2010 U.S. Dietary Guidelines, the guidelines do specifically call out the term "Red meat". For instance, on page 23, reference is made to the DASH diet which emphasizes an intake rich in fruits and vegetables while limiting red meat, sweets, and sugar-containing beverages. The word "processed" appears 13 times. Moreover, the guidelines specifically note that there is moderate evidence linking increased intake of processed meats (e.g., franks, sausage, and bacon) with increased risk of colorectal cancer. There's a strong emphasis within the guidelines on the USDA Food Patterns, advocating reduced intake of red and processed meats and promoting higher consumption of seafood compared to typical American diets.

In 2003 Australia Guidelines, the National Nutrition Survey indicates that 79 percent of individuals consume red meat at least three times per week. The Australian Guide to Healthy Eating recommends that red meat be eaten three to four times a week. The guidelines align with certain studies that found no conclusive association between fresh red meat and colorectal cancer and that the current levels of red meat consumption in Australia are not linked with the development of cancer.

In 2013 Australia, the guidelines have totally shifted their stance, now supporting evidence indicating a probable link between red meat consumption and an increased risk of colorectal cancer. Additionally, the World Cancer Research Fund (WCRF) reported a convincing correlation between the intake of red and processed meats and an increased risk of colorectal cancer. On page 23, the guidelines advocate "Foundation Diets" characterized by higher vegetable and fruit intake, while recommending lower consumption of starchy vegetables, refined grains, and red meats. On page 49,

the guidelines highlight an association between red meat consumption and an increased risk of renal cancer.

4.2.2. Pancreatic cancer

In comparing the evolution of dietary guidelines, there is a shift in the recommended diets, with greater emphasis placed on increasing vegetable and fruit intake. At first glance, these findings seem to be in contradict with the consistent and notable upward trends observed in pancreatic cancer incidence rates in both the U.S. and Australia over the observed duration. However, after more careful analysis, these findings are consistent with most of the recent research papers indicating that evidence is limited and/or inconclusive for an association regarding vegetable and fruit consumptions and pancreatic cancer. Instead, other non-diet related factors such as smoking, inherited genetic syndromes are the most important risk factors for pancreatic cancer [13].

5. Conclusion

Through an in-depth analysis of the cancer incidence rates spanning a 15-year timeframe, from 2003 to 2017, examining various diet-related cancers prevalent in both the U.S. and Australia, followed by an extensive comparative analysis of both countries' dietary guideline evolution during the same period, this study substantiates a correlation between the recommended dietary habits and the occurrence of colorectal cancer. In addition, this study also reinforces the inconclusiveness regarding the relationship between dietary habits and the occurrence of pancreatic cancer. This investigation marks a crucial initial step in understanding the intricate relationship between recommended dietary patterns and their potential impact on mitigating certain cancer types.

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