Is certain food and nutrients associated with the risk of lung cancer? A systematic review

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Abstract:

This review explores the intricate relationship between dietary factors and lung cancer risk based on a thorough examination of relevant literature and articles. The findings highlight a significant association between specific dietary elements and lung cancer risk. Increased intake of fiber, fruit, and vitamin C is linked to a notable reduction in risk, particularly for squamous cell carcinoma. Notably, vegetables exhibit a risk reduction for current smokers, while offal, red meat, and processed meat may elevate risk, especially in heavy smokers. Contradictory evidence surrounds dairy products, with fermented dairy inversely correlated. Beer and cider consumption are associated with an increased risk, primarily among current smokers. In contrast, avocados demonstrate a promising link to decreased lung cancer risk. Vitamin K intake shows an inverse relationship, particularly in males and ever smokers. High retinol intake may elevate risk, potentially modifying the effects of tobacco exposure. Nuts consumption is significantly linked to reduced lung cancer risk and overall cancer mortality. Dietary polyunsaturated fatty acids demonstrate a noteworthy risk reduction for lung cancer, with supplementation improving overall survival in patients with the disease. Palmitic acid, a component of saturated fatty acids, is implicated in promoting lung metastasis, emphasizing the intricate nature of dietary influences on cancer. In summary, while lung cancer is primarily associated with tobacco smoking, this review underscores the multifaceted interplay between diet and lung cancer risk. Further research is crucial to unravel underlying mechanisms and provide definitive evidence on the impact of specific dietary factors, emphasizing the importance of continued exploration in this complex field.

Conflict of interest statement

The authors declare no competing interests.

Introduction

Lung cancer, encompassing both nonsmall cell and small cell lung cancer, stands as the most commonly diagnosed cancer in men and the third most prevalent cancer in women, retaining its position as the primary cause of cancer-related mortality – over the last forty years, the mortality rate stood at 59,0/100,000 person-years.. [1,10]

Lung cancers encompass a diverse range of entities with variations in both histology and molecular profiles. From a histological perspective, they fall into two categories: non–small cell lung carcinoma (NSCLC), constituting 85% of all lung cancers, and small cell lung carcinoma (SCLC), accounting for 15% of cases. NSCLCs are commonly further classified into adenocarcinoma, squamous cell carcinoma (SqCC), and large-cell carcinoma. The survival rates for both NSCLC and SCLC are notably low. Despite recent advancements in diagnostic, medical, and surgical approaches, the overall outcomes continue to be unfavorable. [21]

While tobacco smoking overwhelmingly constitutes the major risk factor for lung cancer, other factors like genetic susceptibility, occupational exposures, air pollution, radon, lifestyle factors, and diet may also contribute. Given that smoking is the predominant risk factor for lung cancer, associations between diet and lung cancer may be confounded by or vary based on smoking status. Additionally, there exists a possibility that dietary factors alter the effects of tobacco exposure, and protective or harmful effects may be limited to or more pronounced in smokers. [1]

Review

Based on searched articles, there is a significant connection between certain dietary factors and lung cancer risk.

Fibre, fruit and vitamin C

Increased consumption of fiber, fruit, and vitamin C was linked to a 9% decrease in the risk of lung cancer. [1,10,18,19] When examining the histological subtypes of lung cancer, the intake of fiber, fruit, and vitamin C seemed to show an inverse association with squamous cell carcinoma (hazard ratios per 1 SD increment in intake per day = 0.87, 95% CI 0.78-0.97; 0.86, 95% CI 0.76-0.98; and 0.87, 95% CI 0.76-1.00, respectively). These were weakly inversely associated with adenocarcinoma (hazard ratios = 0.95, 95% CI 0.88-1.02; 0.93, 95% CI 0.86-1.02; 0.93, 95% CI 0.85-1.02) and showed no association with small cell carcinoma. [1,4,6,11] Antioxidant-rich foods could yield greater benefits in smokers, potentially explaining why the observed associations were limited to ever smokers and squamous cell carcinoma. [1,4,6,10] Further analyses indicated that individuals with the highest intake of citrus fruit, compared to the lowest intake, experienced a 9% reduction in lung cancer risk [odds ratio 0.91 (95% CI 0.84-0.98)]. [7,8,10] In a cohort study comprising 34,198 participants, it was observed that the consumption of dried fruit three or more times per week was linked to a reduced risk of lung cancer, with a relative risk of 0.89. [11]

Vegetables

For current smokers, the intake of vegetables showed a significant association with a reduced risk of lung cancer (summary RR = 87%; 95% confidence interval: 0.78, 0.94), while no such association was observed for former smokers and never smokers. The analysis revealed a 3% decrease in the risk of lung cancer among current smokers for every 100-gram per day increase in vegetable consumption (95% confidence interval: 0.96, 1.00). [10,16,18,19] Researchers also identified a noteworthy correlation between cruciferous vegetables and species rich in organic sulfur compounds, such as garlic, and a diminished risk of lung cancer. [10]

Offal, red meat and processed meat

A comprehensive analysis of studies revealed no link between offal intake and lung cancer risk in nonsmokers; however, heavy smokers enrolled in a lung cancer screening program in Italy exhibited an elevated risk of lung cancer associated with increased offal consumption. [1,11] Earlier investigations have demonstrated a heightened risk of lung cancer — up to a 12% increase — linked to greater consumption of red meat and processed meat, even among nonsmokers (in the case of red meat) [8,11,15,18]. In contrast, no association was identified in the EPIC and NCS study. [1] While there are conceivable mechanisms connecting meat consumption to carcinogenesis (often influenced by cooking methods), specific mechanisms related to lung cancer remain unidentified. The absence of association in the systematic diet-wide association study suggests that the consumption of red or processed meat is unlikely to exert a significant impact on lung cancer risk. [1,8,15]

Dairy

The existing evidence regarding the prospective connections between dairy product consumption, dairy fat intake, lactose intake, and the risk of lung cancer is both limited and inconclusive. The overall intake of dairy products did not exhibit an association with lung cancer risk (hazard ratio [95% confidence interval] = 1.03 [0.89-1.18]), comparing the highest quartile to the lowest. [5] Conversely, the intake of fermented dairy was inversely correlated with the risk of lung cancer (0.85 [0.72-0.99]). [5,11] However, there were no statistically significant associations observed for low-fat, full-fat, or non-fermented dairy product intakes. Opting for whole milk as a beverage was linked to a higher lung cancer risk compared to preferring <0.5% fat milk (1.24 [1.03-1.49]). [5] Notably, total fat, saturated fat, and lactose intakes from dairy products were each found to have no association with lung cancer risk. [5,8,11]

Beer/cydre

Within the EPIC study, an elevated risk of lung cancer was linked to the consumption of beer/cider, with no such association found for other types of alcoholic beverages (wine, spirits) or total alcohol intake. [1] Despite a meta-analysis revealing a positive connection between beer consumption and lung cancer risk among individuals consuming an average of one or

more drinks per day, this association did not extend to other alcoholic beverage types or overall alcohol intake. Beer/cider intake demonstrated a positive correlation with lung cancer risk in current smokers (with an identical point estimate for former smokers) but showed no association with lung cancer in never smokers. [1,11] While the association between beer/cider consumption and lung cancer risk within EPIC did not significantly differ by histological subtype, a heightened risk of adenocarcinoma was evident, whereas little evidence of an association was observed for squamous cell carcinoma or small cell carcinoma. [1]

Avocados [3,14]

Avocados, with their rich array of nutrients and phytochemicals, show promise in cancer prevention. Drawing data from the Health Professionals Follow-Up Study (HPFS, 1986–2016) encompassing 45,289 men and the Nurses' Health Study (NHS, 1986–2014) with 67,039 women [3], the research indicates that in the HPFS subset, the consumption of ≥1 weekly serving of avocados is linked to a reduced risk of lung cancer (HR 0.71; 95% CI 0.57–0.90). Furthermore, men in the HPFS cohort who consume one or more weekly servings of avocados experience a 15% lower risk of total cancer compared to those with less than one serving per month (95% CI 0.80–0.91). Notably, men who include at least one weekly serving of avocados also demonstrate a significantly decreased risk of lung cancer (HR 0.71; 95% CI 0.57–0.90), and these findings hold true even when excluding current smokers [3,12].

Vitamin K

Vitamin K intake demonstrates an inverse correlation with the risk of lung cancer, as evidenced by a multivariable hazard ratio [HR] of 0.67 for the highest versus lowest quartiles. The study, encompassing 16,341 men and 25,825 women with a median follow-up of 14.6 years, reveals a dose-response pattern wherein higher vitamin K consumption is linked to a reduced risk of lung cancer. The statistically significant inverse relationship between vitamin K intake and lung cancer risk is observed specifically in men, exhibits greater strength in ever smokers than never smokers, and remains consistent across age, BMI, and alcohol intake status [2].

Retinol

The VITamins And Lifestyle (VITAL) cohort study revealed an elevated risk of lung cancer associated with long-term retinol supplement use. [1,17] Moreover, there is evidence indicating that the consumption of high-dose beta-carotene supplements, a precursor to retinol, is linked to an increased risk of lung cancer in both current and former smokers. [1,20] EPIC study findings, indicating a positive association between retinol intake and lung cancer risk specifically in ever smokers and not in never smokers, suggest that retinol may potentially modify the effects of tobacco exposure [1].

Nuts

Consuming nuts is markedly linked to a decrease in both cancer risk and mortality. Specifically, a substantial association exists between nut intake and a reduced risk of lung cancer (ES: 0.86; 95% CI: 0.81-0.91, $P < 0.001$) as well as gastric cancer. Noteworthy is the finding that a daily increase of 10 g in tree nuts intake corresponds to a notable 20% reduction in overall cancer mortality [8, 15].

Polyunsaturated Fatty Acids

Dietary polyunsaturated fatty acids (PUFA) demonstrated a significant reduction in the risk of lung cancer for both men (RR 0.99, 95% CI 0.98 to 1.00) and the U.S. population (RR 0.99, 95% CI 0.98 to 1.00). Analysis of dose-response indicated that a 5 g/day increase in dietary PUFA was associated with a 5% lower risk of lung cancer (RR 0.95, 95% CI 0.91 to 0.99). Furthermore, supplementation with PUFA significantly improved overall survival in patients with lung cancer (RR 1.98, 95% CI 1.09 to 3.59) [8, 14].

Palmitic Acid

A constituent of saturated fatty acids, palmitic acid (PA), is implicated in tumor proliferation in melanomas, although the signal transduction pathway it mediates remains ambiguous. Research indicates that palmitic acid can stimulate lung metastasis in melanomas, and findings suggest a potential link between PA and TLR4 as a ligand. This connection may

facilitate lung metastasis by initiating downstream TRIF-Peli1-pNF-κB signaling, thereby promoting cell migration and invasion [9].

Summary

Lung cancer is a leading cause of cancer-related mortality, and is primarily associated with tobacco smoking. However, various factors, including diet, may influence lung cancer risk. A significant connection exists between certain dietary factors and lung cancer risk. Increased consumption of fiber, fruit, and vitamin C is associated with a 9% decrease in risk, particularly for squamous cell carcinoma. Vegetables show a reduced risk for current smokers. Offal, red meat, and processed meat may elevate risk, especially in heavy smokers. Dairy product impact is inconclusive, with fermented dairy inversely correlated. Beer and cider consumption is linked to elevated risk, primarily in current smokers. Avocado consumption is associated with decreased lung cancer risk. Vitamin K intake shows an inverse relationship, stronger in males and ever smokers. Retinol's impact is inconsistent, potentially modifying tobacco exposure effects. Nuts intake is linked to reduced lung cancer risk and overall cancer mortality. Dietary PUFA is associated with lower lung cancer risk and improved survival. Palmitic acid, a component of saturated fatty acids, may promote lung metastasis.

The complex interplay between diet and lung cancer risk underscores the need for further research to understand underlying mechanisms and provide more definitive evidence on the impact of specific dietary factors.

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