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Inflammation Levels and the Health Impact of Anti-Inflammatory Diets on Chronic Obstructive Pulmonary Disease: An NHANES Study

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Background: Chronic obstructive pulmonary disease (COPD), the third leading cause of death globally, is closely associated with systemic inflammation in its pathophysiological mechanisms. Previous studies have primarily focused on localized airway inflammation, while the relationship between systemic inflammation markers such as the systemic immune-inflammation index (SII) and the systemic inflammation response index (SIRI)and COPD remains controversial. Additionally, the role of the composite dietary antioxidant index (CDAI) in modulating COPD risk requires further investigation.

Methods: This cross-sectional study used data from NHANES (2007–2012) to investigate the association between systemic inflammation levels and COPD prevalence. SII and SIRI levels were stratified by interquartile range (IQR). Generalized linear models (GLM) combined with logistic regression models were used to analyze the association between SII, SIRI, and COPD risk. Interaction analysis was used to evaluate the modulating effects of CDAI on inflammation levels and COPD risk.

Results: A total of 8,601 participants were included in the study, among whom 881 were COPD patients. The analysis revealed that for each 1 IQR increase in SII and SIRI, the OR for COPD prevalence significantly increased by 1.28 (95% CI: 1.12–1.47) and 1.45 (95% CI: 1.26–1.67), respectively. Compared to the lowest SII group (Q1), the prevalence of COPD in the other groups increased by 1.01%, 1.43%, and 3.53%, respectively. Similarly, compared to the lowest SIRI group (Q1), the prevalence of COPD in the other groups increased by 1.54%, 4.08%, and 7.42%, respectively. In the low CDAI population, the risk of COPD associated with SII and SIRI was even higher, with ORs of 1.24 (95% CI: 1.01–1.52) and 1.34 (95% CI: 1.09–1.64), respectively.

Conclusion: SII and SIRI, as systemic inflammation markers, are closely associated with the risk of COPD. Adjusting dietary patterns may have significant potential to slow the onset and progression of COPD.

Keywords: COPD, inflammatory response, anti-inflammatory diet

Introduction

Chronic obstructive pulmonary disease (COPD) is an inflammatory condition characterized by persistent airflow limitation, and its global disease burden continues to rise. According to World Health Organization data, COPD was the fourth leading cause of death globally in 2021, responsible for approximately 3.5 million fatalities, which accounted for about 5% of all deaths worldwide. Notably, nearly 90% of these deaths in people under 70 years of age occur in low- and middle-income countries.[1] According to the Global Burden of Disease Study 2019, COPD is a leading cause of global morbidity and mortality, responsible for millions of disability-adjusted life years (DALYs). This burden falls disproportionately on low- and middle-income countries, which exhibit the highest age-standardized DALYs rates.[2] Despite this substantial burden, a significant proportion of affected individuals face a poor prognosis, with approximately 24% dying within five years of diagnosis. However, evidence suggests that mortality rates can be reduced through comprehensive prevention and treatment strategies.[3] In the United States (US), an estimated 27 million adults were affected by COPD in 2011, with reportedly around 135,000 deaths annually. In 2010, the US government spent nearly $49.9 billion on COPD, including $29.5 billion in direct healthcare expenditures, $8.0 billion in indirect morbidity costs,

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and $12.4 billion in indirect mortality costs.[4] Epidemiological surveys reveal a significant age gradient in COPD prevalence: the prevalence is only 2.7% in individuals under 40 years old, but it surges to 9.7% in those over 40, exhibiting an exponential increase with advancing age.[5,6] Although bronchodilator therapy can alleviate symptoms, current interventions are unable to reverse the disease progression. Therefore, identifying modifiable risk factors, such as inflammation and nutrition, holds significant importance for the primary prevention of COPD.[7,8]

Traditionally, the pathophysiological core of COPD has been attributed to localized airway inflammation leading to parenchymal lung destruction and small airway fibrosis.[9] However, growing evidence suggests that COPD is also a systemic disease accompanied by the activation of systemic inflammation. A study based on the ECLIPSE cohort identified persistent systemic inflammation as a significant clinical phenotype of COPD, characterized by sustained elevation of multiple circulating inflammatory biomarkers. Patients with this phenotype exhibited significantly higher all-cause mortality and an increased risk of acute exacerbations.[10] This systemic inflammation involves various biomarkers. For example, while C-reactive protein (CRP) levels rise during acute exacerbations of COPD, existing reviews indicate that CRP alone has limited sensitivity and specificity as an independent prognostic predictor.[11] Furthermore, biomarkers such as Interleukin-6 (IL-6) have been highlighted in relevant reviews as key indicators for assessing disease activity and prognosis.[12] To conveniently quantify the systemic inflammatory status using routine clinical data, researchers have developed composite indices based on peripheral blood cell counts. Among these, the Systemic Immune-Inflammation Index (SII) and the Systemic Inflammation Response Index (SIRI) have garnered attention due to their cost-effectiveness.[13] The SII, calculated by integrating neutrophil, lymphocyte, and platelet counts, aims to reflect the overall state of the immune-inflammatory-coagulation system, whereas the SIRI focuses more on assessing the degree of myeloid inflammatory activation.[13] Cohort studies have confirmed that these inflammatory indices are associated with the risk of various diseases. For instance, elevated SII levels have been independently associated with poorer prognosis in patients with small-cell lung cancer.[14] Similarly, SIRI has been demonstrated to be an independent predictor of cardiovascular mortality risk in patients with cardiovascular-kidney-metabolic syndrome.[15] However, the association of these two indices with COPD requires further investigation.

Dietary patterns, as modifiable lifestyle factors, may influence the occurrence and progression of COPD through multiple pathways. Previous studies have shown that a Western diet (high in red meat, refined carbohydrates, and saturated fats) can promote systemic inflammatory responses.[16] In contrast, the Mediterranean diet (rich in ω-3 fatty acids and polyphenols) helps preserve lung function by enhancing the antioxidant defense system.[17,18] The composite dietary antioxidant index (CDAI), which quantifies the synergistic effects of six key dietary antioxidants (vitamins A, C, E, carotenoids, selenium, and zinc), provides an integrated measure for assessing the anti-inflammatory potential of diets.[19,20] Some studies have found that consuming antioxidant-rich diets can increase plasma antioxidant levels and further reduce systemic oxidative stress, although their preventive value in the general population remains unclear.[21,22]

In recent years, the global strategy for COPD has been evolving from reactive treatment towards proactive and comprehensive disease management. The Rome Proposal, a major international consensus, reframes COPD as a preventable and treatable condition and strongly advocates for early prevention and integrated management through the identification and intervention of modifiable risk factors, which include systemic inflammation and nutritional status.[23,24] Within this strategic framework, investigating the role of systemic inflammatory biomarkers and anti-inflammatory dietary patterns holds direct practical value for advancing these clinical management goals.

This study aims to explore the association between systemic inflammation levels and the risk of COPD, as well as to analyze the differences in the health impact of inflammation levels among populations with different dietary patterns. The findings are expected to provide robust evidence for the daily risk management of COPD patients.

Methods

Study Population and Design

The National Health and Nutrition Examination Survey (NHANES) is a research program designed to assess the health and nutritional status of adults and children in the United States. This study is based on data from NHANES 2007–2012 to analyze the association between systemic inflammation levels and the risk of COPD, as well as to evaluate the interaction between inflammation levels and dietary anti-inflammatory potential.

From the original cohort of 11,831 participants, records with missing values were excluded, resulting in a final study population of 8,601 individuals.

Exposure Factors and Outcome Variables

Dietary data were collected using the standardized 24-hour dietary recall method from the National Health and Nutrition Examination Survey (NHANES).[25] Specifically, trained interviewers conducted two non-consecutive 24-hour dietary recalls for each participant using the Computer-Assisted Dietary Interview (CADI) system: the first was conducted in person at the Mobile Examination Center (MEC), and the second was conducted by telephone 3 to 10 days later to capture dietary variations between weekdays and weekends. Data from the first interview were used for analysis in this study.

Daily intake of dietary nutrients, including vitamin A, vitamin C, vitamin E, total carotenoids, zinc, and selenium, was automatically calculated by NHANES using the USDA Food and Nutrient Database for Dietary Studies (FNDDS).[26] CDAI for each participant was computed based on a single 24-hour dietary recall, reflecting short-term dietary antioxidant intake status. This calculation followed the method developed by Wright et al (2004)[21] using the formula:

$$\mathrm{CDAI} = \sum \frac{\mathrm{X_i} - \mu_\mathrm{i}}{\mathrm{SD_i}}$$

Among these, i represents the dietary antioxidant (vitamins A, C, E, total carotenoids, zinc, selenium), X_i denotes an individual's intake of this nutrient, μ_i is the mean intake of this nutrient in the study population, and SD_i is its standard deviation.

COPD status was assessed using pulmonary function test results. A pulmonary function test was considered abnormal if the ratio of forced expiratory volume in 1 second (FEV1) to forced vital capacity (FVC) was less than 70%. Participants underwent one or two pulmonary function tests: if the first test result was abnormal, participants inhaled a β2-adrenergic bronchodilator and underwent a second test. A participant was diagnosed with COPD if the first test result was abnormal but no second test was performed, or if both the first and second test results were abnormal.

Peripheral blood samples were analyzed using the MECs automated analyzer (Beckman Coulter MAXM; Beckman Coulter Inc.), and complete blood cell counts were recorded. Platelet, neutrophil, lymphocyte, and monocyte counts were measured in units of\(10^3) cells/μL. The formulas for calculating SII and SIRI are as follows:

$$\mathrm{SII} = \frac{\mathrm{platelet} \times \mathrm{neutrophil}}{\mathrm{lymphocyte}}$$

$$\mathrm{SIRI} = \frac{\mathrm{monocyte} \times \mathrm{neutrophil}}{\mathrm{lymphocyte}}$$

To minimize the impact of individual variability on the conclusions, this study included the following covariates:

1) Demographic information, including age, gender, education level, ethnicity, and poverty-income ratio (PIR);
2) Lifestyle factors: alcohol consumption and smoking;
3) Anthropometric data: body mass index (BMI);
4) Disease information: cardiovascular disease and diabetes.

Anthropometric data were collected by NHANES-trained health technicians following standardized protocols at Mobile Examination Centers (MECs). Height was measured using a fixed stadiometer with an accuracy to the nearest millimeter, while weight was measured using calibrated digital scales accurate to 0.1 kg, with participants wearing standardized examination gowns.

Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Based on the World Health Organization classification criteria, this study categorized BMI into four groups: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obesity (≥30.0 kg/m^2). In the

analysis, BMI was included as a categorical variable (bmistra) to account for its potential nonlinear relationship with COPD risk.

This study constructed three levels of adjusted models: Model 1: adjusted for CDAI and demographic factors (ethnicity, gender, age, BMI); Model 2: additionally adjusted for lifestyle factors (alcohol consumption, smoking) and disease status (cardiovascular disease, diabetes); Model 3: further adjusted for education level and PIR.

Analytical Methods

To investigate the associations between SII, SIRI, and COPD risk, we employed logistic regression within a generalized linear model (GLM) framework. Inflammatory indices (SII, SIRI) were analyzed both as continuous variables and as ordinal categorical variables based on quartiles (Q1-Q4). Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). For all multivariable models, multicollinearity was assessed using the variance inflation factor (VIF); all variables had a VIF < 10, indicating no severe multicollinearity (see Supplementary Table 1). Model goodness-of-fit was evaluated and compared using the likelihood ratio test and the Akaike Information Criterion (AIC).

To test the robustness of the primary findings, we conducted sensitivity analyses: (1) using models with different covariate adjustment sets; and (2) exploring potential non-linear relationships by treating SII and SIRI as continuous variables in generalized additive models. Furthermore, to examine the potential modifying effect of dietary anti-inflammatory potential, we performed stratified analysis by median CDAI ("Low CDAI" vs. "High CDAI" groups) and formally tested for interaction by including product terms (SII×CDAI and SIRI×CDAI) in the fully adjusted model. All analyses were performed using RStudio, with a statistical significance level of α=0.05.

Data Processing and Handling of Missing Data

This study was based on data from the National Health and Nutrition Examination Survey (NHANES). A tiered strategy was employed to handle missing data, aiming to maximize the use of available information while ensuring data quality. For key categorical covariates (eg., education level, poverty-income ratio, BMI category, drinking status), records with missing values were excluded from the final analysis (complete case analysis). For the primary exposure variables—the Systemic Immune-Inflammation Index (SII) and Systemic Inflammation Response Index (SIRI)—sporadic missing values in the original blood cell counts (<0.5% of samples) were imputed using the median of the overall study population. Diagnosis of Chronic Obstructive Pulmonary Disease (COPD) was strictly based on pulmonary function data; participants were excluded only if valid test results were entirely unavailable. All analyses were conducted on the final sample with complete data on these key variables.

Results

The baseline characteristics of the overall population, COPD patients, and non-COPD participants are presented in Table 1. The mean age of the study participants was 46.65 ± 16.21 years, with 53.64% being male. The mean SII and SIRI were 530.95 ± 432.90 and 1.13 ± 0.76, respectively. Baseline analysis results indicated significant interactions between the COPD population and the non-COPD population across all variables except alcohol consumption, cardiovascular disease, PIR, and CDAI, suggesting substantial differences between the two groups. Regarding inflammatory markers, the median SII in the COPD group was 492.80 (IQR: 363.14–700.00), which was higher than that in the non-COPD group (466.00, IQR: 338.24–634.86) ($p < 0.01$). The median SIRI was 1.12 (IQR: 0.80–1.67) versus 0.97 (IQR: 0.67–1.34) ($p < 0.01$).

As shown in Table 2, in the fully adjusted model (Model 3), each 1 IQR increase in the SII level was associated with an odds ratio (OR) of 1.28 (95% CI: 1.12–1.47) for COPD. All three adjusted models demonstrated a statistically significant association between SII and the risk of COPD ($p < 0.01$). Compared to the group with the lowest SII (Q1), the prevalence of COPD in the other groups increased by 1.01%, 1.43%, and 3.53%, respectively. As presented in Table 2, in the fully adjusted model (Model 3), each 1 IQR increase in the SIRI level was associated with an OR of 1.45 (95% CI: 1.26–1.67) for COPD. Similarly, all three adjusted models indicated a statistically significant association between SIRI and the risk of COPD ($p < 0.01$) (Table 3). Compared to the group with the lowest SIRI (Q1), the prevalence of COPD in the other groups increased by 1.54%, 4.08%, and 7.42%, respectively.

Table 1 Descriptive Analysis of Baseline Characteristics of Study Participants (2007–2012)

	Overall Population (N=8601)	Non-COPD (N=7720)	COPD (N=881)	p-value for Intergroup Differences
Age (Mean ± SD)	46.65 ± 16.21	45.07 ± 15.73	61.09 ± 13.08	<0.01
Gender (Male, %)	53.64	52.10	67.20	<0.01
BMI (Mean ± SD)	29.13 ± 6.77	29.24 ± 6.83	28.10 ± 6.00	<0.01
Ethnicity (%)				<0.01
Mexican American	15.08	16.14	5.79	
Other Hispanic	10.03	10.41	6.81	
Non-Hispanic White	46.94	45.10	62.30	
Non-Hispanic Black	20.51	20.54	20.20	
Other Races	7.44	7.81	4.20	
Education Level (%)				<0.01
Less than 9th Grade	7.65	7.38	9.99	
9–11th Grade (Including incomplete 12th)	14.16	11.86	16.80	
High School Graduate	22.17	21.53	27.81	
Some College or Technical School	30.69	31.32	25.20	
College Graduate or Above	25.28	25.85	20.20	
Other	0.05	0.05	0.00	
Alcohol Consumption (Days/Year, Mean ± SD)	5.10 ± 33.97	4.90 ± 34.01	6.86 ± 33.56	0.10
Smoking (Yes, %)	47.89	44.78	75.14	<0.01
Cardiovascular Disease (Yes, %)	2.65	2.14	7.15	<0.01
Diabetes (Yes, %)	10.27	9.59	16.23	<0.01
PIR (Mean ± SD)	2.68 ± 1.67	2.69 ± 1.67	2.60 ± 1.65	0.11
SII (Mean ± SD)	530.95 ± 432.90	526.05 ± 441.73	574.15 ± 342.59	<0.01
SII, median [IQR]	466.00 [339.47, 637.95]	466.00 [338.24, 634.86]	492.80 [363.14, 700.00]	
SIRI (Mean ± SD)	1.13 ± 0.76	1.11 ± 0.74	1.36 ± 0.91	<0.01
SIRI, median [IQR]	0.97 [0.68, 1.37]	0.97 [0.67, 1.34]	1.12 [0.80, 1.67]	
CDAI (Mean ± SD)	0.01 ± 3.33	0.02 ± 3.33	−0.04 ± 3.27	0.63
CDAI, median [IQR]	−0.54 [−2.25, 1.56]	−0.55 [−2.25, 1.56]	−0.46 [−2.22, 1.59]	

Notes: Statistical tests: Continuous variables are presented as mean ± SD and compared using the independent samples *t*-test (or Mann–Whitney *U*-test as appropriate); categorical variables are presented as n (%) and compared using the chi-square test. P-values for intergroup differences are shown in the last column.

Table 2 Change in COPD Risk per 1 IQR Increase in SII

	OR (95% CI)	p-value
Model 1	1.32 (1.16, 1.51)	<0.01
Model 2	1.28 (1.12, 1.46)	<0.01
Model 3	1.28 (1.12, 1.47)	<0.01

Notes: Model 1: dependent variables include CDAI, ethnicity, gender, age, and BMI; Model 2: fixed-effect dependent variables include those in Model 1 plus alcohol consumption, smoking, cardiovascular disease, and diabetes; Model 3: fixed-effect dependent variables include those in Model 2 plus education level and PIR. Odds ratios (ORs) and p-values were derived from multivariable logistic regression analysis.

Results from the generalized additive model demonstrated that each 1 IQR increase in SII significantly raised the risk of COPD to 1.04 (95% CI: 1.00–1.08), while each 1 IQR increase in SIRI significantly raised the risk to 1.16 (95% CI: 1.09–1.23), indicating stable and reliable findings (Figure 1).

After including the CDAI interaction term in the fully adjusted model, the p-values for the interaction terms between CDAI and both SII and SIRI were less than 0.01. Subgroup analysis revealed that among individuals with low CDAI levels, those with higher SII had a significantly increased risk of COPD, with an OR of 1.24 (95% CI: 1.01–1.52)

Table 3 Change in COPD Risk per 1 IQR Increase in SIR

	OR (95% CI)	p-value
Model 1	1.51 (1.32, 1.74)	<0.01
Model 2	1.45 (1.26, 1.67)	<0.01
Model 3	1.45 (1.26, 1.67)	<0.01

Notes: Model 1: dependent variables include CDAI, ethnicity, gender, age, and BMI; Model 2: fixed-effect dependent variables include those in Model 1 plus alcohol consumption, smoking, cardiovascular disease, and diabetes; Model 3: fixed-effect dependent variables include those in Model 2 plus education level and PIR. Odds ratios (ORs) and p-values were derived from multivariable logistic regression analysis.

compared to the lower SII group; however, this risk difference was not significant in the high CDAI group. Similarly, among individuals with low CDAI levels, the higher SIRI group exhibited an OR of 1.34 (95% CI: 1.09–1.64) for COPD risk, whereas no significant association between SIRI and COPD risk was observed in the high CDAI group (CDAI ≥ median).

Discussion

The third-level adjusted model in this study revealed that the significant positive associations between SII and SIRI and COPD risk remained stable after sequentially adjusting for demographic, lifestyle, and socioeconomic factors. This indicates that the association between systemic inflammation levels and COPD is independent of traditional risk factors (such as smoking and age), suggesting that inflammation itself may be an independent risk signal. Interaction models demonstrated that CDAI significantly modulated the relationship between SII/SIRI and COPD risk. Specifically, among individuals with lower CDAI scores, the adverse health effects of elevated inflammation levels were amplified, whereas in those with higher CDAI scores, this association was weakened or even became non-significant. This strongly suggests that an antioxidant-rich dietary pattern may serve as a modifiable lifestyle factor capable of buffering lung health risks associated with systemic inflammation. To test for potential non-linearity in the associations, we conducted sensitivity analyses using generalized additive models (GAM). The results indicated a monotonic positive relationship between SII/SIRI and COPD risk, consistent with the findings from the primary logistic regression analyses. This further supports the rationale for treating inflammation indicators as continuous or categorical variables and confirms the robustness of the

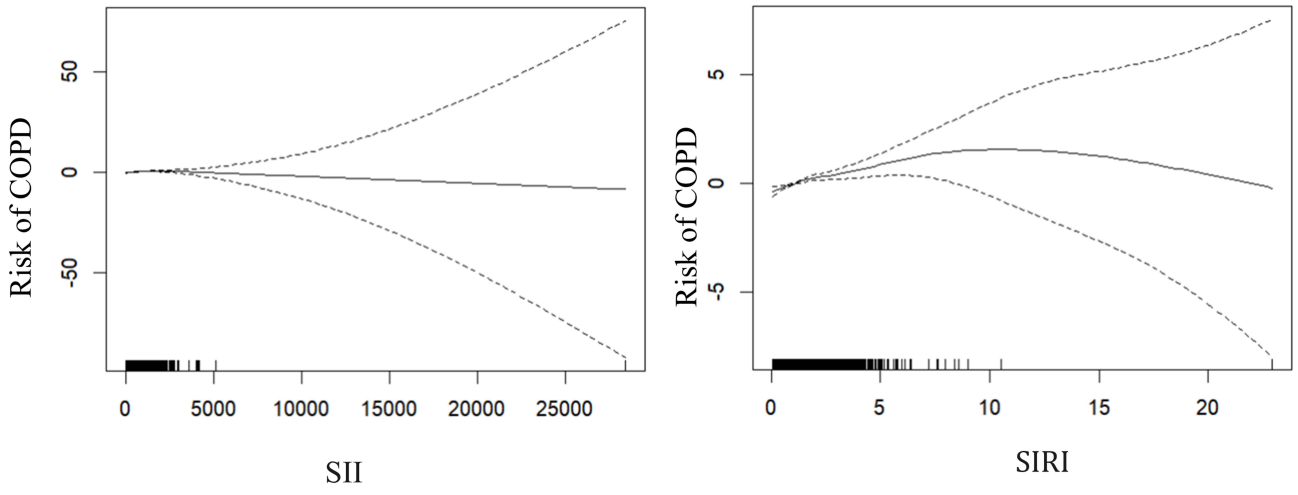

Figure 1 Non-linear association between SII and SIRI and risk of COPD prevalence.

main conclusions. This study adds to the inflammatory theory of COPD by demonstrating that easily obtainable systemic inflammation indices (SII and SIRI) are independently associated with disease risk, thereby extending the evidence beyond localized airway inflammation to the systemic circulation. Substantial evidence indicates that localized airway inflammation plays a critical role in the development and progression of COPD. Barnes (2016) found that the inflammatory response in the airways of COPD patients is more pronounced than in smokers without COPD, and this inflammatory pattern exhibits persistent characteristics.[27] Additionally, the number of macrophages in bronchoalveolar lavage fluid and sputum of COPD patients is 5–10 times higher than in healthy individuals. These activated macrophages drive the inflammatory cascade by releasing pro-inflammatory factors such as IL-8 and TNF-α.[28] Airway inflammation in COPD exhibits heterogeneity: although most patients exhibit neutrophilic inflammation, 20%–40% of patients show type 2 inflammation, characterized by eosinophilia.[29,30] While airway inflammation is widely recognized as a core driver of COPD progression, the role of systemic inflammation in COPD remains controversial. A cohort study by Ye et al (2023) demonstrated that elevated SII is associated with an increased risk of COPD and further contributes to higher all-cause mortality risk.[31] However, a prospective cohort study by Ellingsen et al (2024) reported that while SII and SIRI were associated with exacerbation risk in unadjusted analysis, these associations did not remain significant for predicting future acute exacerbations after multivariable adjustment.[32] The results of this study suggest that COPD is not only related to localized airway inflammation but may also be influenced by systemic inflammatory status, providing insights into strategies for modulating inflammation levels and reducing COPD risk through anti-inflammatory dietary interventions.

Evidence suggests that dietary patterns rich in antioxidants are significantly associated with a reduced risk of COPD and can improve inflammatory status.[33,34] Similarly, Zhao et al (2025) reported that a higher CDAI was associated with a lower risk of all-cause mortality in patients with COPD.[22] The CDAI employed in this study provides an integrative framework for quantifying the anti-inflammatory potential of the diet.[21] The six dietary antioxidants encompassed by the CDAI—vitamin A, C, E, carotenoids, selenium, and zinc—are abundantly present in foods such as vegetables, fruits, and whole grains. Through synergistic interactions, these nutrients help mitigate oxidative stress and downstream inflammatory responses, with their protective effects having been validated in multiple observational studies.[35] Consequently, the present study found that a higher CDAI can buffer the adverse impact of systemic inflammation (SII/SIRI) on the risk of COPD, thereby providing direct evidence from a nutritional epidemiology perspective for the strategy of "modulating inflammation through dietary pattern interventions to prevent chronic diseases".

The present study identified that a higher CDAI, which characterizes a diet rich in antioxidants, may buffer the adverse effects of systemic inflammation on COPD risk. This offers direct evidence for dietary guidance in COPD patients and high-risk populations. We recommend adhering to a predominantly plant-based dietary pattern with established anti-inflammatory potential, such as the Mediterranean diet or the DASH diet. Specifically, individuals should be encouraged to consume ample amounts of a variety of colorful fruits and vegetables (providing carotenoids and vitamin C), nuts, whole grains, legumes, and fish rich in ω-3 fatty acids. Simultaneously, intake of red meat, processed foods, refined carbohydrates, and sugar-sweetened beverages should be limited to reduce the consumption of pro-inflammatory compounds, such as advanced glycation end products. This dietary pattern may not only influence the progression of COPD by lowering systemic inflammation but also help improve the risk of comorbidities, such as cardiovascular disease.

This study further explored the interaction between CDAI and systemic inflammation markers (SII and SIRI). The primary analysis revealed that elevated SII and SIRI were significantly positively associated with the risk of COPD in the overall population (SII-OR = 1.28; SIRI-OR = 1.45). Subgroup analysis indicated that among individuals with low CDAI levels, elevated SII and SIRI were significantly positively associated with the risk of COPD (SII-OR = 1.24, 95% CI: 1.01–1.52; SIRI-OR = 1.34, 95% CI: 1.09–1.64). This finding aligns with the conclusion of a study based on a Chinese population,[31] which similarly reported that higher SII levels were significantly correlated with an increased risk of COPD. Furthermore, that study suggested that SII may serve as a biomarker for prognosis in COPD patients. However, this association was significantly attenuated in the group with higher CDAI (≥ median). The explanation for this potential mechanism is as follows. Studies have indicated that nutritional supplementation therapy not only improves malnutrition in COPD patients but also delays COPD progression and reduces inflammation levels.[36] Additionally, individuals with

higher CDAI levels may have better health literacy and are more likely to adopt proactive self-management behaviors, synergistically enhancing the protective effects of their diet.[37] This highlights the complex interplay between dietary patterns, socioeconomic factors, and health behaviors, suggesting that future COPD prevention and control strategies should adopt multidimensional interventions.

This study has several limitations. First, its cross-sectional design precludes causal inference. Second, key variables were primarily obtained via questionnaires and are subject to recall bias. Although a wide range of covariates were adjusted for, the analysis did not account for air pollution exposure—a known risk factor for COPD. Furthermore, due to limitations in the NHANES dataset, calibration for baseline pulmonary function was not possible. These unmeasured confounding factors may influence the estimates. Third, COPD was defined using a fixed spirometric ratio (FEV1/FVC < 0.7). While commonly used, the potential evolution of clinical diagnostic criteria during the study period may have introduced minor inconsistencies in case identification over time. Fourth, the cross-sectional design is susceptible to survivor bias, as the most severely ill individuals may have been excluded, potentially leading to an underestimation of risk associations. Finally, the CDAI was calculated based on a single 24-hour dietary recall, which may not perfectly reflect long-term dietary habits.

The findings are based on a nationally representative US sample, and their generalizability to other populations should be interpreted with caution. Future prospective cohort studies are needed to verify the causal nature of these associations, and randomized controlled trials are warranted to test the efficacy of dietary interventions aimed at reducing inflammation for COPD prevention. Additionally, integrating more precise environmental exposure data and molecular biomarkers would help elucidate the underlying mechanisms.

Conclusion

This study demonstrates that systemic inflammatory indices derived from routine blood tests (SII and SIRI) are independently associated with the risk of COPD, and that an antioxidant-rich dietary pattern (characterized by a higher CDAI) can significantly mitigate this risk. These findings provide epidemiological support for the inflammatory theory of COPD and suggest potential value in integrating systemic inflammation management and the promotion of anti-inflammatory diets (such as the Mediterranean diet) into comprehensive COPD prevention and control strategies in both clinical and public health practice. SII and SIRI may serve as simple tools for identifying high-risk individuals, and targeted nutritional interventions could offer a novel avenue for COPD prevention and management. Future prospective studies are needed to verify the causality of these associations and to explore targeted prevention strategies based on inflammatory indicators and dietary patterns.

Data Sharing Statement

The data used to support the findings of this study are included within the article.

Ethics Statement

This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The analysis utilized publicly available, de-identified data from the National Health and Nutrition Examination Survey (NHANES). Since this research involves the secondary analysis of existing data from a legally established database, it meets the exemption criteria stipulated in Article 32 (1) and (2) of the "Measures for Ethical Review of Life Science and Medical Research Involving Human Subjects" (issued on February 18, 2023). The exemption status of this study has been reviewed and confirmed by the Ethics Committee of the First People's Hospital of Lianyungang.

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Disclosure

The authors have no conflicts of interest to declare for this work.

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