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# Associations of anti-inflammatory diet with cognitive impairment, physical dysfunction, depressive symptoms, and Multimorbidity in Chinese elderly: a national community-based study

Deng Huang[1], Pan Ding[2], Rongxiu Ding[3*†] and Chao Lin[4*†]

## Abstract

**Objective** The health effects of anti-inflammatory diets have been less studied in the Chinese elderly. We aimed to investigate the association of an anti-inflammatory diet on cognitive function, physical function, depressive status, and multimorbidity.

**Methods** A total of 11,123 participants aged 65 years and older from the 2017–2019 Chinese Longitudinal Healthy Longevity Survey (CLHLS) were included in this cross-sectional study. The anti-inflammatory diet was assessed by asking about the frequency of food consumption at around age 60. We used logistic regression to explore the associations of the anti-inflammatory diet with cognitive impairment, physical dysfunction, depressive symptoms, multimorbidity, and restricted cubic spline to determine whether the relationships were nonlinear. Results were expressed using odds ratios (ORs) and 95% confidence intervals (CIs).

**Results** The prevalence of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity in the Chinese elderly were 20.73%, 24.95%, 16.13%, and 16.11%, respectively. The restricted cubic spline showed significant negative linear associations between the anti-inflammatory diet and cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity. After multivariate adjustment, compared with the high-frequency anti-inflammatory diet (Q4), the low-frequency group (Q1) had higher odds of cognitive impairment (OR = 1.41, 95%CI: 1.21–1.64), physical dysfunction (OR = 1.23, 95%CI: 1.06–1.42), depressive symptoms (OR = 1.19, 95%CI: 1.01–1.40), and multimorbidity (OR = 1.33, 95%CI: 1.12–1.58).

†Rongxiu Ding and Chao Lin contributed equally to this work and share the last authorship.

*Correspondence:
Rongxiu Ding
dingrx527@163.com
Chao Lin
wfylinchao@163.com

Full list of author information is available at the end of the article

**Conclusions** Regular anti-inflammatory diets may have potential benefits in protecting against cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity, and rational dietary modification may be an effective strategy for preventing aging-related health problems in older adults.

**Keywords** Anti-inflammatory diet, Cognitive impairment, Physical dysfunction, Depressive symptoms, Multimorbidity

## Introduction

Population aging has become a global social trend, and the World Health Organization predicts that the proportion of people aged 60 and over will reach 22% in 2050 [1]. According to the 2023 National Aging Development Bulletin, China's population aged 60 and over has reached 21.1%, and the population aged 65 and over has reached 15.4% [2], making the aging trend facing China even more severe. As the aging process accelerates, the public health challenges posed by aging are becoming more pressing. Aging is a universal, multifaceted process associated with increased rates of cognitive [3], physical [4], and psychological [5] morbidity. However, most previous studies have tended to focus on a single disease in the older population, ignoring those with two or more chronic diseases at the same time. The prevalence of multimorbidity in the elderly population has been reported in the past literature to be 15–43% [6]. Individuals with coexisting multimorbidities are more likely to die prematurely, increase the frequency of medical visits, and prolong hospitalization than older adults with a single disease [7]. Patients with multimorbidity consume more healthcare resources while reducing an individual's quality of life [8]. To decrease the prevalence and incidence of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity in older adults, further research on their potential protective factors is needed to inform prevention strategies.

In this context, dietary patterns have emerged as an essential and easily modifiable factor with the potential to mitigate adverse health outcomes and promote healthy aging [9]. While some studies did not find a protective role for anti-inflammatory diets in health outcomes, the majority of opinions insisted on the role of anti-inflammatory diets in combating the aging process and reducing chronic disease [10]. Among these, anti-inflammatory diets [11] have gained increasing attention due to their capacity to reduce systemic inflammation—a key contributor to aging and chronic disease progression [12]. Pro-inflammatory mediators (e.g., cytokines [13] and reactive oxygen species [14]) are implicated in neurodegeneration, physical disability, mood disorders, and the clustering of multiple comorbidities. Notably, anti-inflammatory diets characterized by foods rich in DHA and EPA [15], lecithin [16], isoflavones [17], allicin [18], omega-3 and omega-6 fatty acids [19], beta-glucan [20], and polyphenols [21] have been shown to modulate inflammatory pathways and provide protective effects against these adverse consequences. However, evidence on the effectiveness of such dietary patterns in non-Western populations, particularly among older adults in China, remains scarce.

The purpose of our study was to assess the association between anti-inflammatory diet frequency and health outcomes in Chinese older adults using data from the 7th wave of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The objectives of our study included: (1) to assess the prevalence of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity; (2) to investigate the dose-response relationship and the extent of associations between anti-inflammatory diets and cognitive functioning, physical functioning, depressive status, and multimorbidity in older adults.

## Methods

### Study design and participants

The CLHLS is a nationwide cohort study of people aged 65 and older, widely recognized by scholars for its openness and ongoingness [22]. Originally conducted in 1998 and followed up every 2–4 years, the CLHLS utilizes a disproportionate and targeted sampling method to recruit participants in 22 provinces across China, covering 85% of the Chinese population [23]. The survey data were collected face-to-face in a household setting by highly trained public health physicians and community workers [24], covering general demographic characteristics, lifestyle, and health status. More detailed descriptions of the CLHLS design are available in other topics [24–26].

Using data from the 7th wave (2017–2019) of the CLHLS ($n = 15{,}874$), we applied the following exclusion criteria: participants younger than 65 or older than 105 ($n = 500$), those with missing data on anti-inflammatory dietary variables ($n = 2{,}873$), those lacking information on cognitive functioning, activities of daily living, and depressive status ($n = 847$), and those with missing data for the majority of covariates ($n = 531$). After these exclusions, a total of 11,123 participants were included in the final analysis (Fig. 1). The CLHLS was approved by the research ethics committee of Peking University (IRB00001052-13074) and obtained informed consent from all participants.

### Assessment of anti-inflammatory diet

The anti-inflammatory diet was measured by 10 items in the Food Frequency Questionnaire (FFQ) [27, 28]:

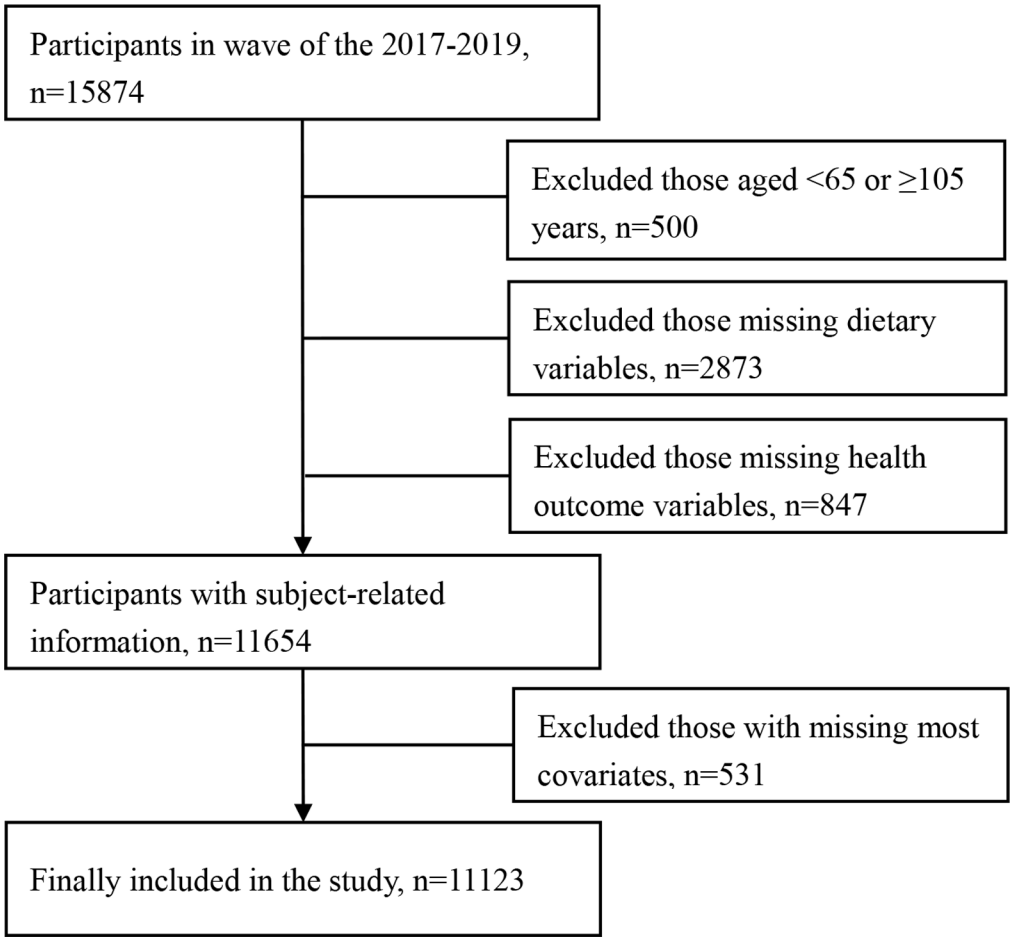


**Fig. 1** Flow chart of the study population

fisheries products, eggs, soybean products, garlic, dairy products, nuts, mushrooms, multivitamin supplements, medicinal plants, and tea. Each item asked about the frequency of consumption at around age 60: "rarely or never," "not monthly, but sometimes," "not weekly, but at least once a month," "not daily, but at least once a week," and "almost every day," scored 0–4 points [29] (total score 40). In addition, by investigating dietary patterns in middle and old age, as well as health status in old age, it may be possible to partially avoid the lag effect caused by the reversal of cause and effect.

#### Assessment of cognitive function, physical function, depressive status, and multimorbidity

Cognitive function was assessed by a 25-item Chinese version of the Mini-Mental State Examination (CMMSE) [30]. The scale covers the dimensions of orientation, naming, attention, computation and graphic reproduction, memory, language, comprehension, and self-coordination [23]. Previous studies have confirmed that cognitive functioning is affected by education level [31], and when the education level is illiterate /primary school /Middle school or above, CMMSE scores below 18 /20 /24 are cognitively impaired, while the others are cognitively normal [32].

Physical function was assessed on a 6-item Katz Activity of Daily Living (ADL) scale [33]. Impairment of daily activities was determined when more than one of bathing, dressing, toileting, indoor transferring, continence, and feeding required assistance [34, 35].

Depressive status was measured on a 10-item Center for Epidemiological Studies Depression Scale (CES-D-10) [36]. Assessment questions covered mood, anxiety, loneliness, and adverse sleep, and responses were categorized into four frequency levels (never or rarely, sometimes, often, and always) with a corresponding score (0–3) assigned to each response [23]. Depressive symptoms were recognized when scores exceeded 10, otherwise, they were considered normal [23, 37].

Participants were defined as multimorbidity when they had two or more types of cognitive impairment, physical dysfunction, and depressive symptoms at the same time [8, 38, 39].

### Assessment of covariates

Based on previous research experience [8, 23, 32] and descriptive directed acyclic graph (Figure S1), we included general demographic characteristic variables: sex (male, female), age (< 80, < 90, ≥90), residence (city, town, rural), economic status (good, general, poor), widowed (yes, no); lifestyle behavior variables: sleep duration (< 7 h, 7–8 h, > 8 h), drinking status (current, former, never), smoking status (current, former, never); and health factors: body type (underweight, normal, overweight, obese), and chronic disease (yes, no).

Current marital status was obtained by asking: married ($n = 4{,}979$), divorced ($n = 32$), widowed ($n = 6{,}024$), and never married ($n = 88$). Since the older age group has the highest proportion of widows (54.16%), we used widowed (yes or no) to assess confounding effects. Drinking status was assessed by two questions [40]: "Do you currently drink alcohol" and "Have you ever drank in the past", both of which were answered "yes" or "no". We categorized participants' drinking status into three groups: current, former, and never. Smoking status was also assessed by two questions [40]: "Do you currently smoke" and "Have you ever smoked in the past", both of which were answered "yes" or "no". We categorized smoking status into three groups: current, former, and never. Body mass index (BMI) was calculated from weight (kg) and height squared ($m^2$) and is usually categorized into four categories according to Chinese standards [32]: underweight (< 18.5 kg/$m^2$), normal weight (18.5–23.9 kg/$m^2$), overweight (24–27.9 kg/$m^2$) and obese (≥ 28 kg/$m^2$). Chronic diseases were defined as those common to Chinese adults [41]: hypertension, diabetes, heart disease, stroke, cardiovascular disease, bronchitis, emphysema, asthma or pneumonia, cancer, and rheumatism. Participants were identified as having a chronic disease by self-reporting one of these diseases.

### Statistical analysis

In describing the baseline characteristics of the populations in the different anti-inflammatory diet groups, the Chi-Square test was used when comparing unordered categorical data, and the Kruskal-Wallis test was used when comparing ordinal data. We used restricted cubic spline to assess trends in the association of the anti-inflammatory diet with cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity, respectively. Additionally, after quartile grouping the anti-inflammatory diet, we analyzed its association with cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity using logistic regression. Results were described by the odds ratios (ORs) and 95% confidence intervals (CIs). We adjusted for sex, age, residence, economic status, widowed, sleep duration, drinking status, smoking status, and body type in multivariate adjustment models. *P* for trend was obtained by analyzing the anti-inflammatory diet variable as continuous data.

To assess potential effect heterogeneity across population subgroups, we performed stratified analyses for sex, age, sleep duration, drinking status, smoking status, and body type. *P* for interaction was obtained by comparing likelihood ratios with and without multiplicative interaction terms. Meanwhile, we conducted several sensitivity analyses. Firstly, we included chronic diseases as indicators of multimorbidity. Second, to decrease recall bias, we excluded older adults over 90 years of age. Third, to decrease the influence of patients with severe cognitive impairment on the results, we excluded participants with CMMSE scores below 10. Finally, recognizing the clinical complexity of multimorbidity patterns, we performed exploratory analyses categorizing multimorbidity conditions into four clinically meaningful clusters: cognitive impairment combined with physical dysfunction, cognitive impairment combined with depressive symptoms, physical dysfunction combined with depressive symptoms, and cognitive impairment and physical dysfunction combined with depressive symptoms. All results were analyzed using SPSS version 26, Empowerstats (X & Y Solutions, inc. Boston MA), and R software version 4.4.3. Tests were two-sided with the statistical significance set as $P < 0.05$.

## Results

Of the 11,123 participants recruited, general demographic characteristics showed that 55.16% were female, 36.10% were ≥ 90 years of age, 42.26% resided in rural areas, 47.85% were illiterate, 70.09% had a general economy, and 54.16% were widowed. Lifestyle factors showed 37.03% of those who slept 7–8 h, 73.74% never drank and 69.89% never smoked. Health factors showed that 50.48% were normal body type, and 40.36% suffered from chronic diseases (Table 1).

### Basic characteristics of participants according to the anti-inflammatory diet

In the quartile grouping results for the anti-inflammatory diet, compared to the low anti-inflammatory diet group (Q1 and Q2), the high anti-inflammatory diet group (Q3 and Q4) had lower proportions of being female, illiterate, widowed, and chronic disease; additionally, higher proportions of being < 80 years old, living in city, having rich economic, sleeping for 7–8 h, currently drinking and smoking, being overweight or obese (all $P < 0.001$; Table 1).

### Association of anti-inflammatory diet with health outcomes

Health outcomes showed the prevalence of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity were 20.73%, 24.95%, 16.13%,

**Table 1** Basic characteristics of participants by anti-inflammatory diet ($n = 11,123$)

| Variables | Anti-inflammatory diet | | | | | $\chi^2$ / H | *P* |
|---|---|---|---|---|---|---|---|
| | Total ($n = 11123$) | Q1 ($n = 2703$) | Q2 ($n = 2670$) | Q3 ($n = 2553$) | Q4 ($n = 3197$) | | |
| **Female**, ***n*(%)** | 6135 (55.16) | 1698 (62.82) | 1579 (59.14) | 1372 (53.74) | 1486 (46.48) | 180.63 | **< 0.001** |
| **Age**, **years**, ***n*(%)** | | | | | | 289.63 | **< 0.001** |
| < 80 | 4291 (38.58) | 749 (27.71) | 965 (36.14) | 1051 (41.17) | 1526 (47.73) | | |
| < 90 | 2816 (25.32) | 728 (26.93) | 684 (25.62) | 645 (25.26) | 759 (23.74) | | |
| ≥ 90 | 4016 (36.10) | 1226 (45.36) | 1021 (38.24) | 857 (33.57) | 912 (28.53) | | |
| **Residenc**, ***n*(%)** | | | | | | 2142.84 | **< 0.001** |
| City | 2769 (24.89) | 159 (5.88) | 324 (12.13) | 593 (23.23) | 1693 (52.96) | | |
| Town | 3653 (32.85) | 1023 (37.85) | 987 (36.97) | 886 (34.70) | 757 (23.67) | | |
| Rural | 4701 (42.26) | 1521 (56.27) | 1359 (50.90) | 1074 (42.07) | 747 (23.37) | | |
| **Education**, ***n*(%)** | | | | | | 1736.81 | **< 0.001** |
| Illiterate | 5322 (47.85) | 1779 (65.82) | 1517 (56.82) | 1232 (48.26) | 794 (24.84) | | |
| Primary school | 3622 (32.56) | 745 (27.56) | 882 (33.03) | 907 (35.53) | 1088 (34.03) | | |
| Middle school or above | 2179 (19.59) | 179 (6.62) | 271 (10.15) | 414 (16.21) | 1315 (41.13) | | |
| **Economic status**, ***n*(%)** | | | | | | 389.08 | **< 0.001** |
| Rich | 2220 (19.96) | 369 (13.65) | 424 (15.88) | 539 (21.11) | 888 (27.78) | | |
| General | 7796 (70.09) | 1896 (70.14) | 1930 (72.28) | 1826 (71.53) | 2144 (67.06) | | |
| Poor | 1107 (9.95) | 438 (16.21) | 316 (11.84) | 188 (7.36) | 165 (5.16) | | |
| **Widowed**, ***n*(%)** | 6024 (54.16) | 1738 (64.30) | 1525 (57.12) | 1365 (53.47) | 1396 (43.67) | 263.62 | **< 0.001** |
| **Sleep duration**, **h**, ***n*(%)** | | | | | | 73.69 | **< 0.001** |
| < 7 | 4077 (36.65) | 1070 (39.59) | 969 (36.29) | 888 (34.78) | 1150 (35.97) | | |
| 7–8 | 4118 (37.03) | 872 (32.26) | 957 (35.84) | 955 (37.41) | 1334 (41.73) | | |
| > 8 | 2928 (26.32) | 761 (28.15) | 744 (27.87) | 710 (27.81) | 713 (22.30) | | |
| **Drinking status**, ***n*(%)** | | | | | | 94.09 | **< 0.001** |
| Current | 1618 (14.55) | 288 (10.65) | 388 (14.53) | 371 (14.53) | 571 (17.86) | | |
| Former | 1303 (11.71) | 258 (9.54) | 300 (11.24) | 334 (13.08) | 411 (12.86) | | |
| Never | 8202 (73.74) | 2157 (79.81) | 1982 (74.23) | 1848 (72.39) | 2215 (69.28) | | |
| **Smoking status**, ***n*(%)** | | | | | | 90.87 | **< 0.001** |
| Current | 1669 (15.01) | 344 (12.73) | 410 (15.36) | 391 (15.32) | 524 (16.39) | | |
| Former | 1680 (15.10) | 326 (12.06) | 345 (12.92) | 414 (16.21) | 595 (18.61) | | |
| Never | 7774 (69.89) | 2033 (75.21) | 1915 (71.72) | 1748 (68.47) | 2078 (65.00) | | |
| **Body type**, ***n*(%)** | | | | | | 256.95 | **< 0.001** |
| Underweight | 1967 (17.68) | 626 (23.16) | 518 (19.39) | 411 (16.09) | 412 (12.89) | | |
| Normal | 5615 (50.48) | 1456 (53.86) | 1376 (51.54) | 1268 (49.67) | 1515 (47.39) | | |
| Overweight | 2666 (23.97) | 473 (17.50) | 587 (21.99) | 629 (24.64) | 977 (30.56) | | |
| Obese | 875 (7.87) | 148 (5.48) | 189 (7.08) | 245 (9.60) | 293 (9.16) | | |
| **Chronic disease**, ***n*(%)** | 4489 (40.36) | 1295 (47.95) | 1179 (44.16) | 1028 (40.27) | 987 (30.87) | 200.17 | **< 0.001** |

Note: Anti-inflammatory diet was divided into four groups using quartiles (Q1 0–7, Q2 8–12, Q3 13–17, Q4 18–40)

The Chi-square test was used for comparing unordered categorical data and the Kruskal-Wallis test was used for ordinal data, and bold values indicated statistical significance $P < 0.05$

and 16.11%, respectively (Table 2). In the crude model, compared with those on a high-anti-inflammatory diet (Q4), those on a low-anti-inflammatory diet (Q1) had 88% higher odds of cognitive impairment (OR = 1.88, 95%CI 1.65–2.13, *P* for trend < 0.001), 35% higher odds of physical dysfunction (OR = 1.35, 95%CI 1.20–1.52, *P* for trend < 0.001), 69% higher odds of depressive symptoms (OR = 1.69, 95%CI 1.47–1.95, *P* for trend < 0.001), and 79% higher odds of multimorbidity (OR = 1.79, 95%CI 1.55–2.06, *P* for trend < 0.001). After multivariable adjustment, the odds of health outcomes were reduced: compared with those on a high-anti-inflammatory diet (Q4), those on a low-anti-inflammatory diet (Q1) had 41% higher odds of cognitive impairment (OR 1.41, 95%CI 1.21–1.64, *P* for trend < 0.001), 23% higher odds of physical dysfunction (OR = 1.23, 95%CI 1.06–1.42, *P* for trend = 0.006), and 19% higher odds of depressive symptoms (OR = 1.19, 95%CI 1.01–1.40, *P* for trend = 0.025), and 33% higher odds of multimorbidity (OR = 1.33, 95%CI 1.12–1.58, *P* for trend = 0.002) (Table 2).

We used multivariate-adjusted restricted cubic spline to assess the association of the anti-inflammatory diet with cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity. Figure 2 showed

**Table 2** Association of anti-inflammatory diet with health outcomes

| Health Outcomes | *n* (%) | Anti-inflammatory diet, OR (95%CI) | | | | *P* for trend |
|---|---|---|---|---|---|---|
| | | Q1 (*n* = 2703) | Q2 (*n* = 2670) | Q3 (*n* = 2553) | Q4 (*n* = 3197) | |
| **Crude moedl** | | | | | | |
| Cognitive impairment | 2306 (20.73) | **1.88 (1.65–2.13)** | **1.41 (1.23–1.61)** | **1.34 (1.17–1.54)** | 1.00 (Reference) | < 0.001 |
| Physical dysfunction | 2775 (24.95) | **1.35 (1.20–1.52)** | **1.19 (1.06–1.35)** | 1.12 (0.99–1.26) | 1.00 (Reference) | < 0.001 |
| Depressive symptoms | 1794 (16.13) | **1.69 (1.47–1.95)** | **1.33 (1.15–1.54)** | **1.17 (1.01–1.36)** | 1.00 (Reference) | < 0.001 |
| Multimorbidity | 1792 (16.11) | **1.79 (1.55–2.06)** | **1.39 (1.20–1.61)** | **1.25 (1.08–1.45)** | 1.00 (Reference) | < 0.001 |
| **Adjusted model** | | | | | | |
| [a] Cognitive impairment | 2306 (20.73) | **1.41 (1.21–1.64)** | **1.19 (1.02–1.38)** | 1.18 (0.99–1.36) | 1.00 (Reference) | < 0.001 |
| [b] Physical dysfunction | 2775 (24.95) | **1.23 (1.06–1.42)** | **1.15 (1.01–1.32)** | 1.08 (0.94–1.24) | 1.00 (Reference) | 0.006 |
| [b] Depressive symptoms | 1794 (16.13) | **1.19 (1.01–1.40)** | 1.07 (0.91–1.26) | 1.06 (0.90–1.24) | 1.00 (Reference) | 0.025 |
| [b] Multimorbidity | 1792 (16.11) | **1.33 (1.12–1.58)** | **1.28 (1.08–1.51)** | 1.05 (0.89–1.25) | 1.00 (Reference) | 0.002 |

Note: Anti-inflammatory diet was divided into four groups using quartiles (Q1 0–7, Q2 8–12, Q3 13–17, Q4 18–40)

[a] Adjusted for sex (male, female), age (< 80, < 90, ≥90), residence (city, town, rural), economic status (good, general, poor), widowed (yes, no), sleep duration (< 7 h, 7–8 h, > 8 h), drinking status (current, former, never), smoking status (current, former, never), body type (underweight, normal, overweight, obese)

[b] Further adjusted for education (illiterate, primary school, middle school or above)

Bold values indicated statistical significance $P < 0.05$

that the anti-inflammatory diet was negatively and linearly associated with cognitive impairment ($P$ for overall < 0.001, $P$ for nonlinear = 0.266), physical dysfunction ($P$ for overall = 0.001, $P$ for nonlinear = 0.222), depressive symptoms ($P$ for overall < 0.001, $P$ for nonlinear = 0.229), and multimorbidity ($P$ for overall < 0.001, $P$ for nonlinear = 0.541).

### Stratification and sensitivity analysis

In stratified analyses, the associations between anti-inflammatory diet and health outcomes did not observe heterogeneity in the stratification of sex, age, sleep duration, drinking status, smoking status, and body type, with $P$ for interaction > 0.05 (Fig. 3). In sensitivity analyses, we found the association between the anti-inflammatory diet and multimorbidity to be robust after including chronic disease as an indicator of multimorbidity. Robust associations were still obtained after excluding participants older than 90 years and participants with CMMSE scores below 10, respectively (Table S1). After categorizing multimorbidity into four groups (cognitive impairment combined with physical dysfunction, cognitive impairment combined with depressive symptoms, physical dysfunction combined with depressive symptoms, and cognitive impairment and physical dysfunction combined with depressive symptoms; prevalence 11.61%, 5.62%, 6.17%, and 3.64%, respectively; Fig. 4), we found a significant association between a low-frequency anti-inflammatory diet (Q1) and each of the multimorbidity subgroups (ORs: 1.49, 1.47, 1.35, 1.46, respectively; Table 3).

## Discussion

### Main findings

Based on data from the 7th wave of the Chinese Longitudinal Healthy Longevity Survey, we found that the prevalence rates of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity in the Chinese elderly population were 20.73%, 24.95%, 16.13%, and 16.11%, respectively. The restricted cubic spline showed significant negative linear associations between anti-inflammatory diet and cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity, i.e., the lower the intake of anti-inflammatory diet, the worse the health outcomes (compared with the highest frequency of anti-inflammatory diet group (Q4), the lowest frequency of anti-inflammatory diet group (Q1) increased the odds of adverse health outcomes by 41%, 23%, 19%, and 33%, respectively).

### Comparison with other studies

Our findings were consistent with those of many existing studies [42–44], suggesting that prevention of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity in the elderly population from improved dietary patterns is promising. In terms of cognitive function, a review covering 32 studies showed that the Mediterranean diet (high consumption of fish, vegetables, fruits, nuts, and olive oil), a typical anti-inflammatory dietary pattern, was effective in slowing cognitive decline in older adults [10]. A randomized clinical trial conducted in Spain found that intervention with olive oil and nuts in the Mediterranean diet significantly improved cognitive function in older adults ($\beta$ = -0.38) [45], particularly in memory and executive function. Furthermore, other research has pointed out that anti-inflammatory diets may play a key role in the prevention of Alzheimer's disease and other cognitive disorders by reducing the level of inflammation in the brain [46, 47]. Nonetheless, some studies failed to find a significant association between anti-inflammatory diets and cognitive function, which was usually related to small sample sizes or lack of adequate adjustment for confounders

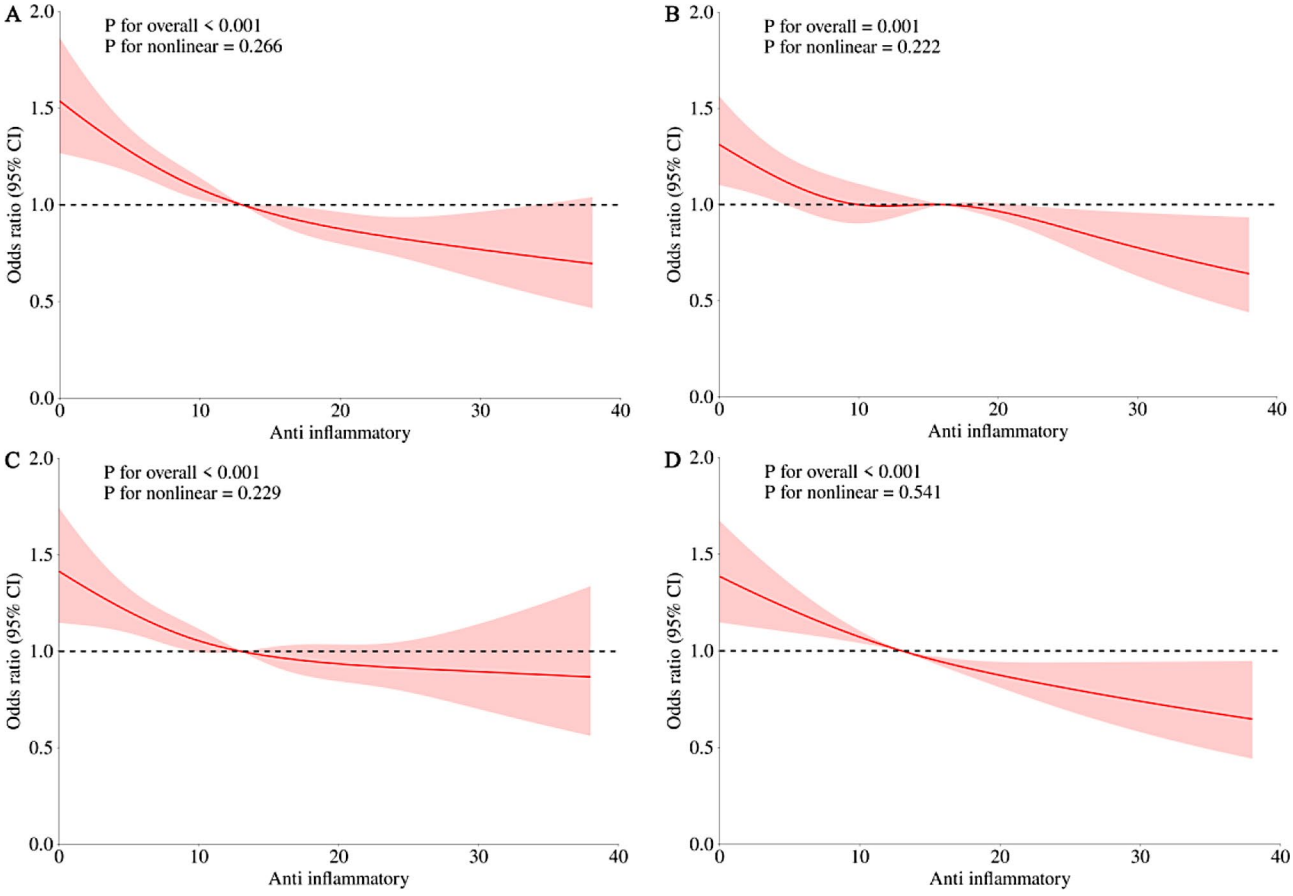


**Fig. 2** Restricted Cubic Spline for the association between anti-inflammatory diet and health outcomes. Note: (**A**) Anti-inflammatory diet with cognitive impairment, (**B**) Anti-inflammatory diet with physical dysfunction, (**C**) Anti-inflammatory diet with depressive symptoms, (**D**) Anti-inflammatory diet with multimorbidity. A was adjusted for sex (male, female), age (< 80, < 90, ≥90), residence (city, town, rural), economic status (good, general, poor), widowed (yes, no), sleep duration (< 7 h, 7–8 h, > 8 h), drinking status (current, former, never), smoking status (current, former, never), body type (underweight, normal, overweight, obese). **B**, **C**, and **D** were further adjusted for education (illiterate, primary school, middle school or above)

[48–50]. Therefore, while most studies support the benefits of anti-inflammatory diets on cognitive health, there is a need to further explore the impact of other potential factors such as cultural differences, dietary traditions, or lifestyles for inconsistent results. Our results further suggested that the high anti-inflammatory diet group showed a negative dose-response trend with lower impaired daily activities (i.e., the higher the diet score, the lower the odds of impairment). Even though there were fewer previous studies on physical functioning, they largely support our view. Evidence from prospective studies in the Chicago ($n = 809$) [9], Boston ($n = 1502$) [51], and Washington ($n = 1696$) [44] areas showed a negative linear association between an anti-inflammatory diet and physical dysfunction (*HR*: 0.75–0.92), which may be related to the fact that anti-inflammatory diets (Mediterranean, Dietary Approaches to Stop Hypertension and Healthy Eating Indices) reduce chronic inflammation in the body and slow aging-related functional decline and dyskinesia. Similarly, the benefits of the anti-inflammatory diet in psychological health, especially depressive symptoms, have been widely supported. A British longitudinal study by Arshad et al. showed that higher adherence to the Mediterranean diet reduced recurrent depressive symptoms by 26% [52]. A meta-analysis by Staudacher et al. observed that strict adherence to diets with a low inflammatory index was negatively associated with the risk of depressive symptoms [53]. These findings were consistent with our results, the reasons for which may include the fact that diets rich in anti-inflammatory components (e.g., polyphenols, vitamins, and dietary fiber) modulate the inflammatory process, modulate the gut microbiome and the function of the hypothalamic-pituitary-adrenal axis, and reduce oxidative stress and neurotransmitter release [53].

In our study, the low anti-inflammatory diet was associated with higher odds of multimorbidity, including co-morbidities of cognitive impairment, physical dysfunction, and depressive symptoms. Previous research on cognitive-physical-psychological co-morbidity was

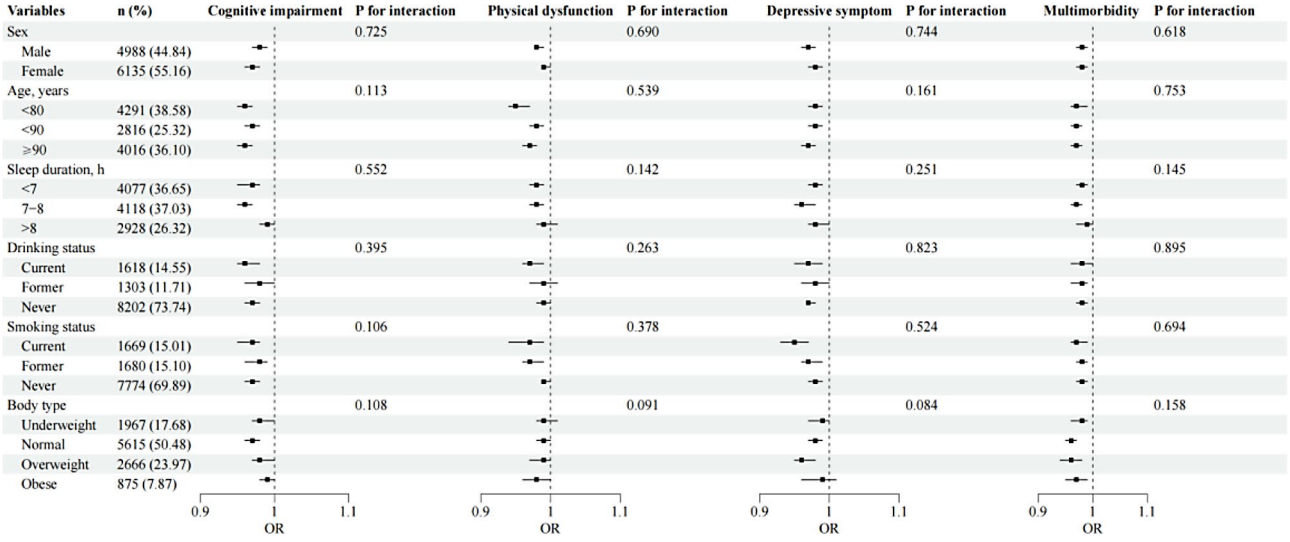


**Fig. 3** Association between anti-inflammatory diet and health outcomes, stratification analyses. Adjusted for sex (male, female), age (< 80, < 90, ≥90), residence (city, town, rural), economic status (good, general, poor), widowed (yes, no), sleep duration (< 7 h, 7–8 h, > 8 h), drinking status (current, former, never), smoking status (current, former, never), body type (underweight, normal, overweight, obese). Further adjustment of education (illiterate, primary school, middle school or above) in the analysis of anti-inflammatory diets with depressive symptoms, physical dysfunction and multimorbidity. Except for the factor itself

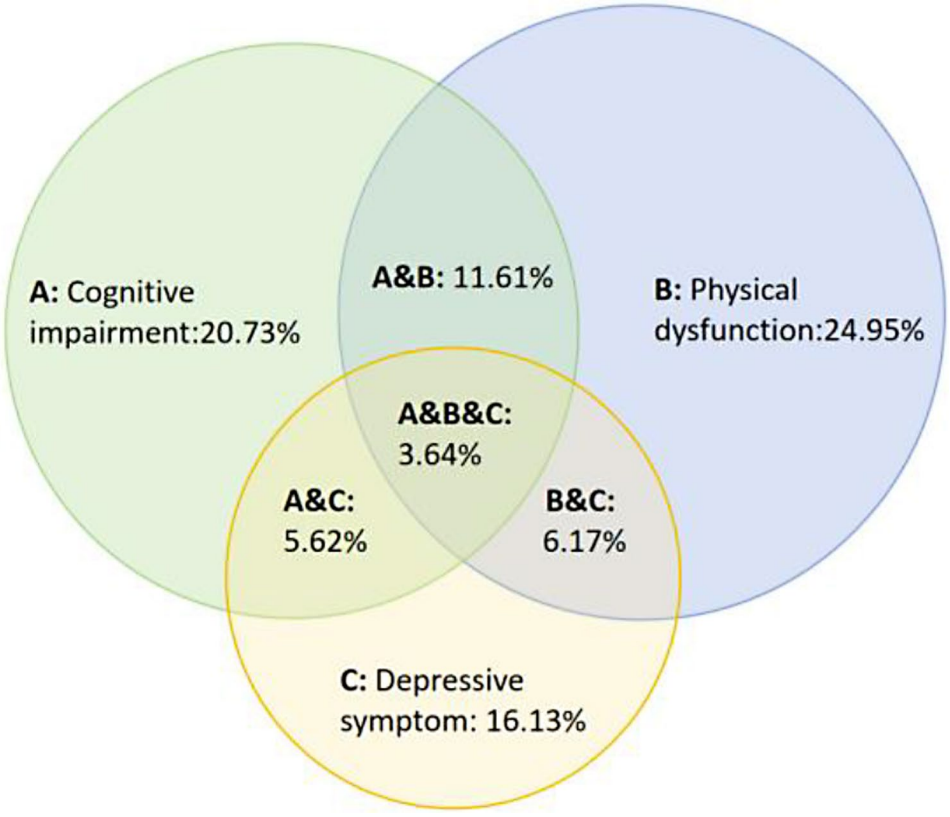


**Fig. 4** Venn diagrams for different health outcomes

relatively sparse, but several studies have suggested that an anti-inflammatory diet may help reduce brain damage, including cardiovascular and cognitive damage [54, 55]. A large cohort study from UK Biobank ($n = 102424$, median follow-up 10.23 years) showed that a low-inflammatory diet was associated with a lower and slower cumulative risk of multiple morbidities (especially in participants aged > 60 years; *HR*: 0.84) and that a low-inflammatory

**Table 3** Association of anti-inflammatory diet with types of multimorbidity

| Multimorbidity | *n* (%) | Anti-inflammatory diet, OR (95%CI) | | | |
|---|---|---|---|---|---|
| | | Q1 (*n* = 2703) | Q2 (*n* = 2670) | Q3 (*n* = 2553) | Q4 (*n* = 3197) |
| Cognitive impairment & Physical dysfunction | 1291 (11.61) | **1.49 (1.24–1.80)** | **1.45 (1.22–1.75)** | 1.11 (0.92–1.35) | 1.00 (Reference) |
| Cognitive impairment & Depressive symptoms | 625 (5.62) | **1.47 (1.12–1.91)** | 1.25 (0.95–1.62) | 1.11 (0.84–1.46) | 1.00 (Reference) |
| Physical dysfunction & Depressive symptoms | 686 (6.17) | **1.35 (1.04–1.74)** | **1.31 (1.04–1.70)** | 1.24 (0.96–1.60) | 1.00 (Reference) |
| Cognitive impairment & Physical dysfunction & Depressive symptoms | 405 (3.64) | **1.46 (1.07–2.04)** | **1.39 (1.02–1.89)** | 1.20 (0.86–1.66) | 1.00 (Reference) |

Note: Adjusted for sex (male, female), age (< 80, < 90, ≥90), residence (city, town, rural), education (illiterate, primary school, middle school or above), economic status (good, general, poor), widowed (yes, no), sleep duration (< 7 h, 7–8 h, > 8 h), drinking status (current, former, never), smoking status (current, former, never), body type (underweight, normal, overweight, obese). Bold values indicated statistical significance $P < 0.05$

diet al.so prolonged the survival of chronically unwell people (0.81 years) [56]. Age-related chronic and low-grade inflammation involves not only cellular senescence and aging of the immune system [57], but is also a marker of multimorbidity and mortality risk. Combined with the results of previous studies [56, 58], adherence to an anti-inflammatory diet in older adults may promote health and prolong life.

### Potential mechanisms

The observed associations between an anti-inflammatory diet and improved health outcomes—reduced odds of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity—can be explained through several biological and psychosocial pathways. Firstly, an anti-inflammatory diet is rich in nutrients such as omega-3 fatty acids, polyphenols, and vitamins that inhibit the production of pro-inflammatory cytokines (e.g. IL-1β, IL-6, TNF-α, CRP) [13]. The reduction in systemic inflammation relieves neuroinflammation, improves cognitive function, and prevents inflammation-induced muscle atrophy and physical dysfunction. Secondly, substances such as protein and dietary fiber in anti-inflammatory diets improve gut microbial composition and increase beneficial bacteria (e.g., Bifidobacteria and Lactobacillus), which enhance neurotransmitter production (e.g., 5-hydroxytryptophan, which is critical for mood regulation and cognitive performance) while reducing intestinal permeability and systemic inflammation [11]. Thirdly, antioxidants found in anti-inflammatory diets (e.g., green tea polyphenols and vitamin E) neutralize reactive oxygen species (ROS), reduce activation of pro-inflammatory pathways, and improve mitochondrial function, markers of oxidative stress, and body antioxidant effects [14]. Fourth, an anti-inflammatory diet helps to modulate HPA axis activity, lower cortisol levels, increase stress resistance, and promote mental health [59].

### Strengths and limitations

Our study reinforces the evidence from previous research while adding to the understanding of anti-inflammatory diets in the context of aging populations. By focusing on the Chinese elderly, we also address a significant gap in the literature, as most existing studies have been conducted in Western populations. This cultural and dietary diversity enhances the generalizability of our findings and highlights the universal applicability of anti-inflammatory dietary patterns in promoting health and longevity. Furthermore, our study expands on previous work by integrating multiple health domains—cognitive function, physical function, and depressive status—into a single framework, allowing for a comprehensive understanding of the role of diet in aging.

Despite the large sample size and data from a broad group of Chinese older adults, this study still had some limitations. Firstly, this study utilized a cross-sectional design, and although we adjusted for multiple confounding variables through rigorous statistical control, future longitudinal studies are needed to validate these associations. Second, although we used the Food Frequency Questionnaire (FFQ) to measure participants' intake of an anti-inflammatory dietary pattern around the age of 60 years, self-reported dietary data may be subject to some degree of recall bias, particularly in the cognitively impaired older adult population, whose memory and reporting accuracy may be compromised. Third, as only 10 anti-inflammatory dietary factors were included in the CLHLS questionnaire, this limited our assessment of other dietary factors such as vegetables and fruits. In the future, we will measure the health effects of anti-inflammatory diets using a more comprehensive dietary assessment approach. Fourth, although we considered a wide range of factors affecting diet and health, these variables were collected along with the outcome variables, and information on covariates around age 60 could not be obtained. In addition, due to the limitations of the CLHLS questionnaire, other possible confounding variables (e.g., genetic factors and changes in health behaviors) have not been fully considered. Finally, the participants in this study were Chinese adults aged 65 years or older, and it is impossible to generalize the findings to other regions and other age groups.

## Conclusions

We found that people who followed a low anti-inflammatory diet had higher odds of cognitive impairment, physical dysfunction, depressive symptoms, and multimorbidity compared with those who followed a high anti-inflammatory diet. Our study provided new evidence for the promotion of anti-inflammatory diets as an intervention to improve the health of the elderly population, especially in the context of an aging society, where rational dietary modifications may be an effective strategy for the prevention of aging-related health problems in older adults. Future studies need to further explore the mechanisms of action of anti-inflammatory diets and their effects in different populations to optimize dietary intervention programs and promote public health policies.

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-23013-7.

Supplementary Material 1

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**Author contributions**
Design, D.H. and R.D.; Conduct/data collection, C.L. and P.D.; Data analysis, D.H. and R.D.; Drafted manuscript, D.H., C.L., P.D., and R.D.; Revised manuscript, C.L., P.D. All authors have read and agreed to the published version of the manuscript.

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**Data availability**
All data used in this study were accessed from the publicly available Chinese Longitudinal Healthy Longevity Survey (https://opendata.pku.edu.cn/dataverse/CHADS).

## Declarations

**Institutional review board statement**
The CLHLS was approved by the research ethics committee of Peking University (IRB00001052-13074).

**Informed consent**
Informed consent was obtained from all subjects involved in the study.

**Competing interests**
The authors declare no competing interests.

**Author details**
[1]Department of Quality Management, Wenzhou People's Hospital, Wenzhou, Zhejiang, China
[2]School of Mental Health, Wenzhou Medical University, Wenzhou, Zhejiang, China
[3]School and Hospital of Stomatology, Wenzhou Medical University, Wenzhou, Zhejiang, China
[4]Department of Clinical Laboratory, Key Laboratory of Clinical Laboratory Diagnosis and Translational Research of Zhejiang Province, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang, China

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## Publisher's note