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Dietary inflammatory index and brain disorders: a Large Prospective Cohort study

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There is emerging evidence that diet plays a key contributor to brain health, however, limited studies focused on the association of dietary inflammatory potential with brain disorders. This study aimed to examine the association of dietary inflammation with brain disorders in the UK biobank. The prospective cohort study used data from 2006 to 2010 from the UK Biobank, with the median follow-up duration for different outcomes ranging between 11.37 to 11.38. Dietary inflammatory index and Energy-adjusted dietary inflammatory index [DII and EDII] were assessed through plausible dietary recalls. Outcomes included brain disorders (all-cause dementia [ACD], Alzheimer's disease [AD], Parkinson's disease [PD], stroke, sleep disorder, anxiety and depression disorder) and brain magnetic resonance imaging measures. Cox proportional-hazard models, restricted cubic spline model [RCS], Ordinary least squares regressions, and structural equation models were used to estimate associations. Of 164,863 participants with available and plausible dietary recalls, 87,761 (53.2%) were female, the mean (SD) age was 58.97 (8.05) years, and the mean (SD) education years was 7.49 (2.97) years. Vegetables and fresh fruits show significant anti-inflammatory properties, while low-fiber bread and animal fats show pro-inflammatory properties. The nonlinear associations of DII and EDII scores with ACD, AD, sleep disorder, stroke, anxiety, and depression were observed. Multivariable-adjusted HRs for participants in highest DII score VS lowest DII score were 1.165 (95% CI 1.038–1.307) for ACD, 1.172 (95% CI 1.064–1.291) for sleep disorder, 1.110 (95% CI 1.029–1.197) for stroke, 1.184 (95% CI 1.111–1.261) for anxiety, and 1.136 (95% CI 1.057–1.221) for depression. Similar results were observed with regard to EDII score. Compared with the lowest EDII score group, the highest group showed a higher risk of anxiety, depression, sleep disorder, stroke and dementia. Results from sensitivity analyses and multivariable analyses were similar to the main results. Pro-inflammatory diets were associated with a higher risk of brain disorders. Our findings suggest a potential means of diet to lower risk of anxiety, depression, sleep disorder, stroke, and dementia.

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INTRODUCTION

With an increase in the aging population worldwide, brain disorders, the disturbance of brain health characterized by structural damage or/and functional impairment in the brain, are being increasingly recognized as the leading cause of disabilities and death [1, 2]. According to the World Health Organization (WHO), the incidence and prevalence of brain diseases account for one-third of all diseases in developed countries [2]. Primordial prevention (i.e., the prevention of risk factor onset) is increasingly recognized as a complementary strategy for the prevention of brain disorders [3].

Inflammation has been widely suggested as a contributor to aging and brain disorders, such as depression, anxiety disorders, and dementia [4–6]. Diet has been identified as a strong preventive measure. Substantial evidence suggested that diet, including foods, nutrients, and non-nutrient food components can modulate inflammation status [7, 8]. The dietary inflammatory index [DII], which provides the base for new lines of investigation of dietary pattern and human health, is correlated with select inflammatory markers, including IL-1β, IL-4, IL-6, IL-10, TNF-α, and CRP, and consists of the intake of various parameters [9]. The Energy-adjusted Dietary Inflammatory Indes [EDII] score calculated based on DII score and adjusting for energy expenditures per 1000 kcal. The advantage of the EDII over the original DII is that it accounts for inter-individual differences in energy intake [10]. So far, there have been a number of studies on the impact of DII on myocardial infarction [11], diabetic mellitus [12], and mortality [13]. However, a limited number of studies have examined the role of inflammatory diet in the acquisition of brain disorders.

Therefore, using data on reported measures of dietary habits from the UK biobank cohort, we derived dietary scores for DII and EDII and conducted a large prospective cohort study to identify the associations between DII and EDII scores and the risk for brain disorders, explore the potential mechanisms contributing to the associations (Fig. 1 and sFig. 1).

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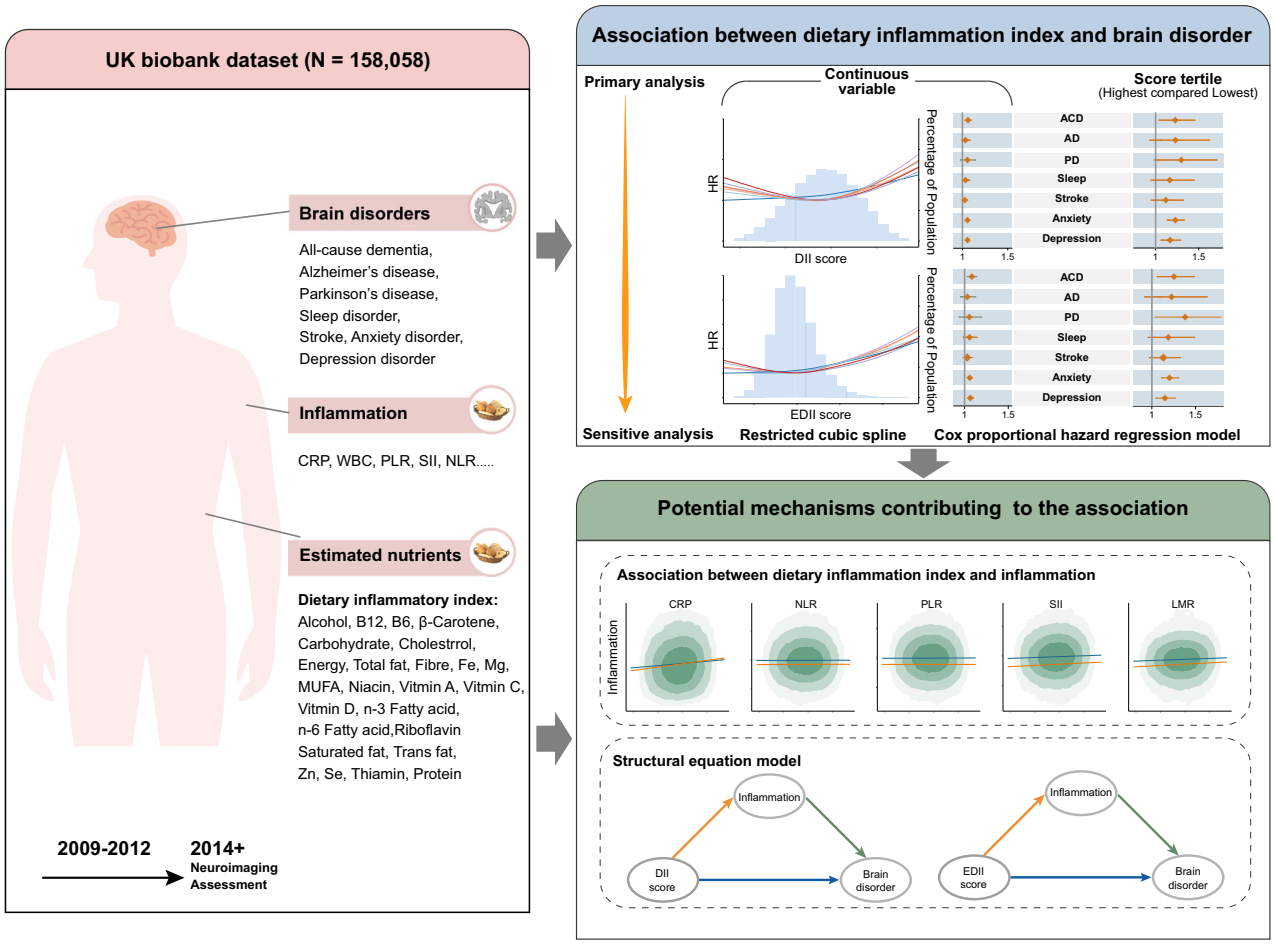

Fig. 1 Study workflow. Left, the data used in the study from UK Biobank including dietary assessments, brain disorders, and inflammation. Top right, associations of DII and EDII scores with brain disorders. Bottom right, potential mechanisms contributing to the associations of dietary inflammatory potential with brain disorders. Abbreviations: DII Dietary inflammatory index, EDII Energy-adjusted dietary inflammatory index, DTI Diffusion tensor imaging, CI Confidence interval.

METHODS

Participants

Individuals from UKB were included in the present study. The UKB is a national prospective cohort enrolling participants aged 40–69 years from 22 assessment centers across England, Scotland, and Wales between 2006 and 2010 [14, 15]. The database is linked to national health datasets, including primary care, hospital inpatient, death, and cancer registration data. All study participants provided written informed consent. This study utilized the UK Biobank Resource under application number 19,542. Dietary under-reporters (Energy intake: Estimated energy requirements [EI: EER] <95% CI EI: EER) and over-reporter (EI: EER >95% CI EI: EER) were excluded in the current study [16].

Dietary inflammatory index

Individuals' DII scores were estimated by using the dietary intake data from WebQ [17] (sMethods 1) to measure their dietary inflammatory potential, with a higher score indicating a pro-inflammatory diet and a lower score indicating an anti-inflammatory diet. Participants' exposure to each food parameter was expressed as a Z score relative to the standard global mean. The standardized dietary intake estimates were converted to centered percentiles for each DII component, multiplied by the corresponding component-specific inflammatory effect scores, and then summed to obtain the overall score for each individual (sTable 1). The EDII scores were calculated by adjusting for energy expenditures per 1000 kcal. To facilitate further analysis, the DII and EDII scores were evenly divided into tertiles, ensuring a balanced classification of dietary inflammatory potential across the study population.

Covariables assessment and ascertainment of brain disorders outcomes

Detailed information on sociodemographic and lifestyle factors was collected by a self-administered touchscreen questionnaire and interview, and physical measurements and biological samples were collected using standardized procedures. Further information on the covariates used in this study can be found in sMethods 2.

The following clinical outcomes were studied: (1) neurological disease, including ACD, AD, PD, sleep disorder, and stroke; (2) psychiatric disorders, including anxiety and depression disorders. The brain disorders were ascertained and classified according to the corresponding three-character ICD codes (sTable 2), obtained through hospital admissions and death registries linked to the UK biobank. The case ascertainment in the UK Biobank cohort is also described in sMethods 3.

Inflammation markers

Inflammation markers, including neutrophils, monocytes, platelets, lymphocytes and the concentration of CRP, were collected from blood count and biochemistry (category 100081&17518). Additionally, we calculated NLR (neutrophils/lymphocytes), platelet-to-lymphocyteratio (PLR) (platelets/lymphocytes), SII (neutrophils × platelets/lymphocytes) and lymphocyte-to-monocyte ratio (LMR) (lymphocytes/monocytes). The processing and analysis step of blood sample can be found in the UKB data sources (https://biobank.ndph.ox.ac.uk/showcase/label.cgi?id=100080).

Statistical analyses

Baseline characteristics of participants were presented as mean (SD) for continuous variables or percentages for categorical variables. Comparisons

were performed using t tests for continuous variables and χ 2 test for categorical variables. The reduced rank regression [RRR] constructs uncorrelated linear combinations of food groups that explain the maximize variation in the DII and EDII score, which were selected as intermediate variation. After adjusting for age, sex, race or ethnicity, Townsend Index of deprivation, education, BMI, smoking status, and physical activity, we used restricted cubic splines [RCS] fitted for Cox proportional hazards with 3 knots at the 10th, 50th, 90th percents of DII and EDII to evaluate the nonlinear associations and built multivariable Cox proportional hazards regression models to estimate hazard ratios [HRs] of brain disorder across continuous DII and EDII scores and three-level score categories. Linear trend tests were performed for increasing three-level categories of DII and EDII by treating the means of the three-level categories as continuous variables. FDR correction was applied to obtain FDR-corrected *P* for the analyses of DII and EDII score with brain disorders and proportional hazards of the associations were tested using Schoenfeld's residuals without indicating a violation of the model assumptions.

The structural equation models [SEM] were used to investigate the association of diet with brain disorders mediated by inflammation. The latent variable of brain disorders was measured in the model using ACD, anxiety, and depression, adjusting for the same set of covariables as in the Cox proportional hazards model.

Several sensitivity analyses were performed to ensure the reported results were robust. A sensitivity analyses with more covariates, including the history of hypertension, hyperlipidemia, and hyperglycemia, were performed. With the total number of follow-ups increasing from 1 visit to 5 visits, the average follow-up time and the number of brain disorders events showed a significantly reduced (sFig. 2). Therefore, the RCS and Cox proportional hazards models were repeated only among participants who complete 2+ online dietary assessments to investigate potential bias in relation to random variation in individual intakes as sensitive analysis.

RESULTS

Characteristics of the Study population

A total of 164,863 of the 502,411 UK biobank participants had available dietary recalls at baseline, including covariates relevant to this cohort study. The baseline characteristics of the study participants according to the tertiles of the DII score and EDII score were shown in Table 1 and sTable 4. The mean (SD) age of the participants was 58.97 (8.05) years, 53.2% were female, 95.9% were white, and the mean (SD) education years was 7.49 (2.97). Depending on the endpoint being investigated, the size of participants cohorts varied upon prevalent disease exclusion. Among them, the study included 2154 participants with incident ACD, 963 with AD, 1110 with PD, 2922 with sleep disorder, 4804 with stroke, 6959 with anxiety, and 5298 with depression (sTable 5).

Both DII and EDII scores were normally distributed across the study population, with ranges from −6.5 to 5.5 and from −4.5 to 7 points, respectively. Dietary inflammatory potential was characterized by positive loadings for low-fiber bread and butter, other

Table 1. Baseline characteristics across dietary inflammatory index among UK biobank participants.

Characteristic	Participants, No. (%)				
	Total (*N* = 164863)	DII score Tertiles			
		Q1 (*N* = 54,955)	Q2 (*N* = 54,954)	Q3 (*N* = 54,954)	*P* value
Age (mean (SD))	58.97 (8.05)	59.93 (7.89)	59.12 (7.98)	57.87 (8.16)	<0.001
Sex					
Male	77,102 (46.8)	27,551 (50.1)	26,093 (47.4)	23,458 (42.8)	<0.001
Female	87,761 (53.2)	27,484 (49.9)	28,905 (52.6)	31,372 (57.2)	
Ethnic					
Others	6755 (4.1)	1777 (3.2)	1833 (3.3)	3145 (5.8)	<0.001
White	157,606 (95.9)	53,083 (96.8)	53,013 (96.7)	51,510 (94.2)	
Townsend (mean (SD))	−1.64 (2.84)	−1.78 (2.76)	−1.76 (2.77)	−1.38 (2.97)	<0.001
Education (mean (SD))	7.49 (2.97)	7.65 (2.90)	7.61 (2.92)	7.21 (3.07)	<0.001
Smoking					
Never	94,316 (57.2)	31,770 (57.7)	31,731 (57.7)	30,815 (56.2)	<0.001
Former	58,373 (35.4)	20,218 (36.7)	19,673 (35.8)	18,482 (33.7)	
Current	12,174 (7.4)	3047 (5.5)	3594 (6.5)	5533 (10.1)	
PAL					
None or light	30,890 (18.7)	7638 (13.9)	10,373 (18.9)	12,879 (23.5)	<0.001
Moderate	87,946 (53.3)	29,476 (53.6)	29,963 (54.5)	28,507 (52.0)	
Vigorous	46,027 (27.9)	17,921 (32.6)	14,662 (26.7)	13,444 (24.5)	
BMI group					
Underweight	816 (0.5)	271 (0.5)	271 (0.5)	274 (0.5)	<0.001
Normal	61,902 (37.5)	21,754 (39.5)	20,891 (38.0)	19,257 (35.1)	
Overweight	69,326 (42.1)	23,017 (41.8)	23,219 (42.2)	23,090 (42.1)	
Obesity	32,819 (19.9)	9993 (18.2)	10,617 (19.3)	12,209 (22.3)	
Hypertension history, yes	88,344 (53.6)	30,482 (55.4)	29,424 (53.5)	28,438 (51.9)	<0.001
Dementia family history, yes	21,070 (12.8)	7442 (13.5)	7069 (12.9)	6559 (12.0)	<0.001
Diabetes history, yes	1300 (0.8)	442 (0.8)	426 (0.8)	432 (0.8)	0.781
DII score (mean (SD))	−0.45 (1.77)	−2.43 (0.89)	−0.41 (0.47)	1.51 (0.82)	<0.001

Q tertiles, *BMI* body mass index, *PAL* physical activity level, *SD* standard deviation, *DII* dietary inflammatory index.

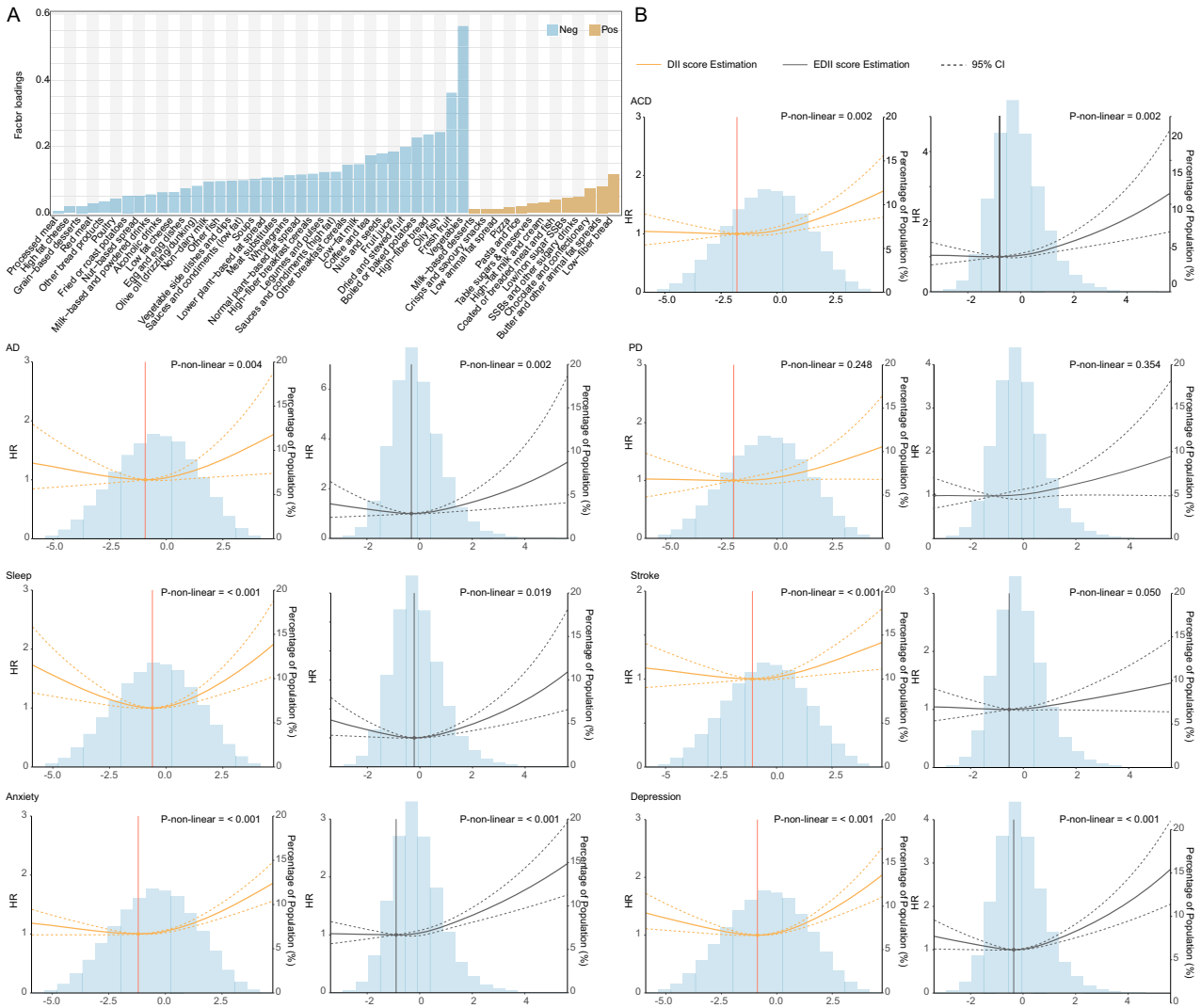

Fig. 2 Factor loadings for food groups in dietary inflammatory potential and hazard ratios for brain disorders as a function of types of DII and EDII scores on a continuous scale. A Factor Loadings for Food Groups in dietary inflammatory potential. **B** Results were derived from RCS regression models adjusted for age and sex, race and ethnicity, educational levels, and lifestyle factors including body mass index, smoking status, physical activity. Solid lines represent hazard ratios and dotted line represent corresponding 95% CIs, using restricted cubic splines with knots at the 5th, 50th, and 95th percentiles and with median DII and EDII score as reference. The density plots indicate the distribution of the population. Values in bold indicate findings that have remained significant after adjusting for multiple comparisons. Abbreviations: DII Dietary inflammatory index, EDII Energy-adjusted dietary inflammatory index, ACD all-cause dementia, AD Alzheimer's disease, PD Parkinson's disease, RCS restricted cubic splines.

animal fat and negative loadings for vegetables, fruit, oily fish, and high-fiber bread (Fig. 2A and sTable 6). This suggests that vegetables, fruit, fish oil, and high-fiber foods have anti-inflammatory effects, while low-fiber bread and animal fats have pro-inflammatory effects. Compared with the lowest DII score or EDII score, those in the highest DII or EDII score tended to be younger, female, had lower education and income, were likely to smoke, less likely to be white and exercise and have a higher BMI.

Association of DII and EDII score with brain disorders

The RCS analyses identified evidence of nonlinear associations between DII and EDII scores with ACD, AD, sleep disorder, stroke, anxiety, and depression (Fig. 2B). In multivariable-adjusted models, we found a positive association for each deviation increase in DII score with risk of ACD (hazard ratio [HR], 1.039 [95% CI 1.011–1.068], corrected $P = 0.009$), sleep disorder (HR, 1.036 [95% CI 1.013–1.060], corrected $P = 0.004$), stroke (HR, 1.020 [95% CI 1.002–1.038], corrected $P = 0.044$), anxiety (HR, 1.039 [95% CI 1.024–1.054], corrected $P < 0.001$), depression (HR, 1.036 [95% CI 1.019–1.054], corrected $P < 0.001$) and EDII score with risk of ACD (HR, 1.090 [95% CI 1.031–1.154], corrected $P = 0.002$), sleep disorder (HR, 1.079 [95% CI 1.036–1.123], corrected $P < 0.001$), anxiety (HR, 1.042 [95% CI 1.024–1.061], corrected $P < 0.001$), and depression (HR, 1.036 [95% CI 1.014–1.058], corrected $P < 0.001$) (Fig. 3 and sTable 7).

Furthermore, participants with the highest DII score compared with the lowest DII score had a higher risk of ACD by 16.5% (95% CI 1.038–1.307), sleep disorder by 17.2% (95% CI 1.064–1.291), stroke by 11.0% (95% CI 1.029–1.197), anxiety by 18.4% (95% 1.111–1.261), depression by 13.6% (95% CI 1.057–1.221). Similarly, the significantly higher risk of ACD (HR, 1.177 [95% CI 1.048 − 1.321]), PD (HR, 1.176 [95% CI 1.006–1.375]), sleep disorder (HR, 1.166 [95% CI 1.058–1.286]), stroke (HR, 1.106 [95% CI 1.025–1.192]), anxiety (HR, 1.177 [95% CI 1.105–1.253), and depression (HR, 1.131 [95% CI 1.052–1.215]) were observed among those with higher EDII score tertiles (Fig. 3). Tests for

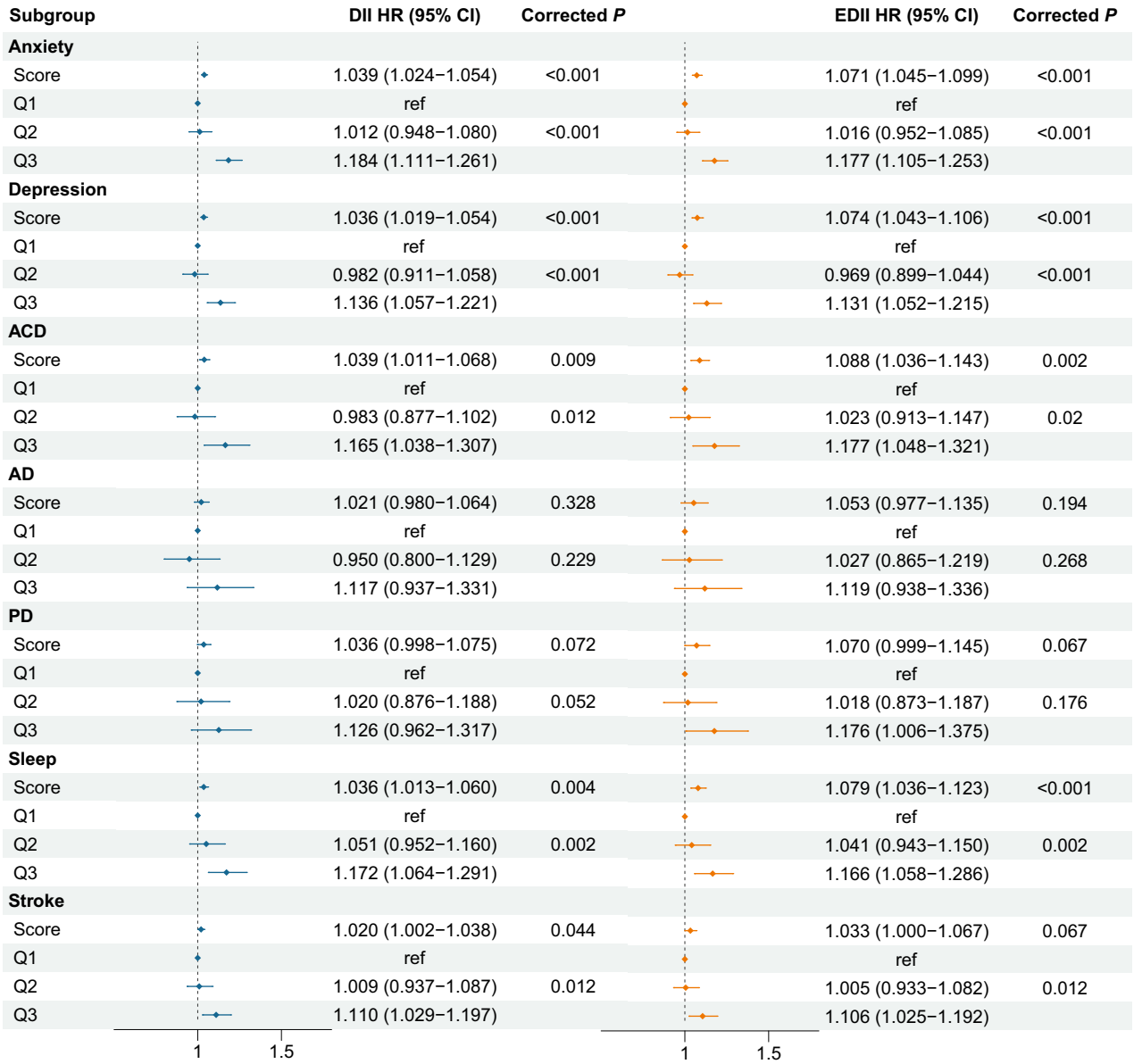

Fig. 3 Hazard ratios and 95%CIs for brain disorders across DII and EDII continuous scores and tertiles. The blue forest plot represents the Cox regression model results for the DII score, while the orange forest plot represents the Cox regression model results for the EDII score. Results were derived from Cox regression models adjusted for age and sex, race and ethnicity, educational levels, and lifestyle factors including body mass index, smoking status, physical activity. Corrected *P*: [a]FDR corrected *P* for DII and EDII continuous scores; [b]FDR corrected *P* for trend. Abbreviations: DII Dietary inflammatory index, EDII Energy-adjusted dietary inflammatory index, ACD all-cause dementia, AD Alzheimer's disease, PD Parkinson's disease.

linear trend suggested a linear relationship of DII with ACD (corrected $P = 0.012$ for trend), sleep disorder (corrected $P = 0.002$ for trend), stroke (corrected $P = 0.012$ for trend), anxiety (corrected $P < 0.001$ for trend), depression (corrected $P = 0.014$ for trend) and EDII with ACD (corrected $P = 0.02$ for trend), sleep disorder (corrected $P = 0.002$ for trend), stroke (corrected $P = 0.012$ for trend), anxiety (corrected $P < 0.001$ for trend), depression (corrected $P = 0.014$ for trend).

Sensitivity analysis

In sensitivity analysis, HRs for incident brain disorders (including ACD, 1.167 (1.038–1.313); sleep disorder, 1.154 (1.044–1.274); stroke, 1.104 (1.022–1.193); anxiety, 1.184 (1.110–1.264); depression, 1.201 (1.066–1.352)) were still statistically significant after further adjusting for the baseline presence of comorbidities (sTable 8). When participants with completed 2 + 24-h online dietary assessment were included, results from Cox proportional hazards regression analyses on endpoints remained similar. ACD, sleep disorder, stroke and anxiety were associated with higher DII scores, although the associations of dietary inflammatory potential with PD and depression were no longer significant (sTable 8). After further excluding individuals with a follow-up period of less than 5 years, we observed that ACD, anxiety, and depression remained significantly associated with higher DII and EDII scores (sTable 9).

Association of inflammation with DII, EDII score and brain disorders

To further investigate the association of DII and EDII score with inflammation, we evaluated the relationship between DII and EDII with blood count and biochemistry in a subsample of 167,010

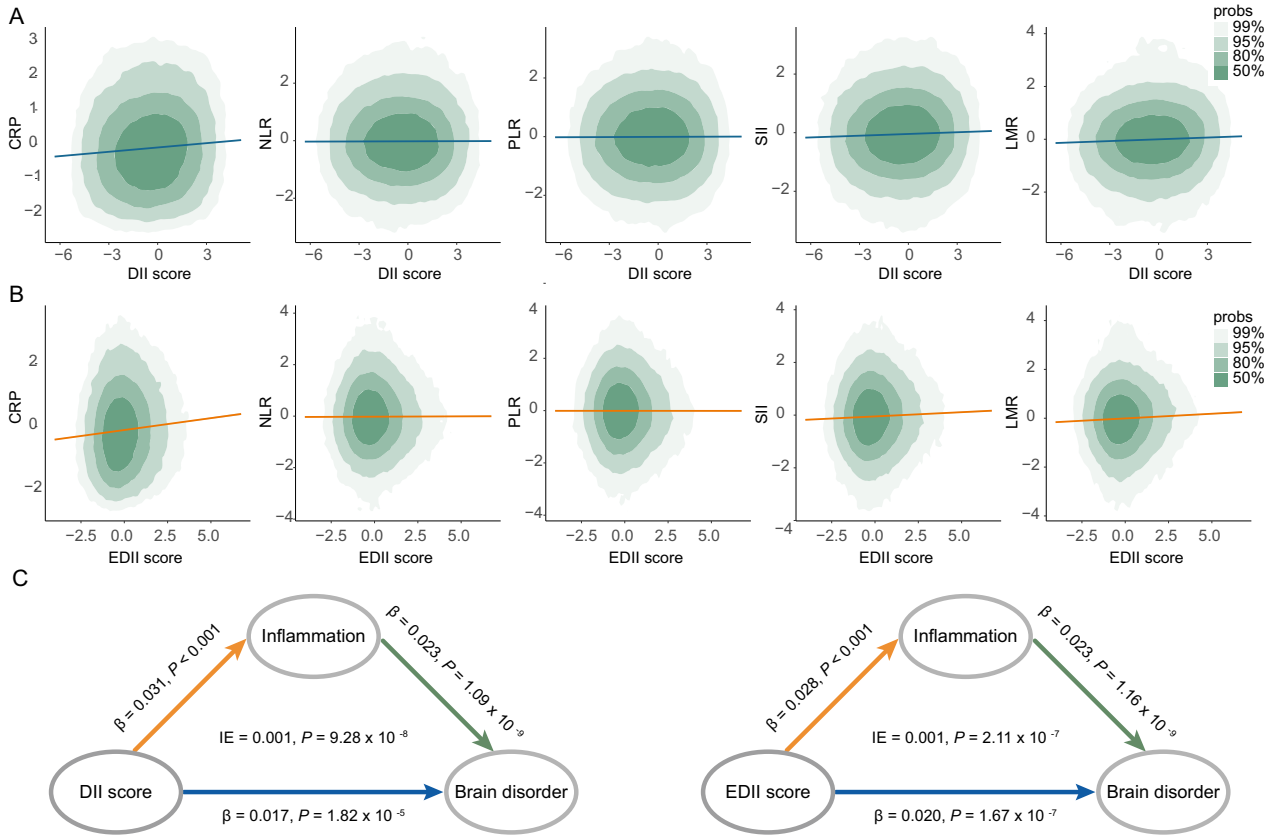

Fig. 4 Associations of DII and EDII scores with inflammation and structure equation model. All models used age as the underlying time variable and were adjusted for sex, body mass index, race and ethnicity, physical activity level, smoking status, education level. **A** Associations of DII scores with inflammation markers. **B** Associations of EDII scores with inflammation markers. **C** Structural equation model. Latent variables including brain disorders and brain structures were estimated in the model. Abbreviations: DII Dietary inflammatory index, EDII Energy-adjusted dietary inflammatory index, ACD all-cause dementia, AD Alzheimer's disease, PD Parkinson's disease.

participants with available data. The most significant inflammation markers associated with DII and EDII scores included the concentration of CRP, WBC, Neutrophil, SII, and Lymphocyte (Fig. 4A, B, sTable 10). In addition, CRP, WBC, Neutrophil, NLR, SII have been associated with a variety of neuropsychiatric diseases, especially dementia, anxiety and depression.

Structural equation model

Confirmatory factor analysis was performed to examine the latent variables in the structural equation model including brain disorders. The results demonstrated that depression symptoms and anxiety symptoms were the main components of brain disorders' latent variable. The results demonstrated that DII and EDII scores were associated with inflammation, and inflammation was associated with brain disorders. The indirect pathway of the effect of DII and EDII scores on brain disorders via inflammation (DII: indirect effect [IE] = 0.001; EDII: IE = 0.001). (Fig. 4C, sTable 11).

DISCUSSION

In this cohort study, the prospective analyses of UK biobank data provide a comprehensive assessment of dietary inflammatory potential with risk of brain disorders and brain structures. Several findings are particularly noteworthy: (1) participants in the highest tertiles of DII and EDII scores exhibited the greatest risk for incident ACD, sleep disorder, stroke, anxiety, and depression; (2) DII and EDII scores were significantly associated with inflammation; (3) the inflammation was a significant mediator for the relationship of dietary inflammatory potential with brain structures and brain disorders.

In recent years, the role of dietary inflammatory potential in leading to human aging has garnered much interest [18], and their associations with brain disorders [19], including depression [20, 21], cardiovascular disease [22], dementia [23], and intermediate risk factors for brain disorders, including obesity [24–26], diabetes [12, 26], hypertension [26–28]. Recent studies have shown that the proinflammatory diet was positively associated with an increased risk of depression [29–31], stroke [22, 32, 33], and dementia [23, 34]. Importantly, we observed the association of DII/EDII scores with anxiety disorder and PD in this large-scale, population-based study. One possible reason for no associations of dietary inflammatory potential with PD in sensitivity analyses is that the number of case participants and the length of the follow-up period were insufficient. Our finding highlights that certain food components, such as fruits, vegetables, fish oils, and high-fiber breads, exhibit substantial anti-inflammatory effects. Conversely, animal fats and low-fiber breads appear to promote inflammation. This evidence aligns with the extensive body of research underscoring the anti-inflammatory benefits of fruits and vegetables and the pro-inflammatory characteristics of animal fats [35, 36]. Such findings are consistent with the growing body of literature exploring the intricate links between dietary patterns and inflammation [37, 38]. Despite the relationship between an inflammatory diet and brain disorders has not been extensively studied, our findings were in agreement with studies that have reported associations between existing dietary patterns, including the Mediterranean dietary pattern and Western dietary pattern, and brain disorders outcomes in older individuals. Adherence to the Mediterranean dietary pattern, which was inversely associated with inflammation, reduced the risk of depression [39, 40], anxiety

[39], stroke [41, 42], PD [43–45], dementia [46], higher cognition function [47]. However, the Western dietary pattern, which has been shown to induce inflammatory responses [48–50], increased the risk of brain disorders [21, 51, 52]. Overall, It is increasingly apparent that anti-inflammatory dietary pattern, such as the Mediterranean dietary pattern-characterized by higher intakes of fruit, vegetables, and whole grains, is associated with lower risk of a diverse range of neurological and neuropsychiatric conditions.

Several mechanisms may underlie the associations between diet quality and the risk of brain disorders. First, one interpretation of those associations seen in our study may be related to systemic inflammation caused by inflammatory diet. Increasing levels of circulating proinflammatory cytokines have been associated with neurodegenerative and psychiatric disorders [53–57]. Second, proinflammatory diet may result in metabolic imbalances that lead to type 2 diabetic mellitus [58], unfavorable lipoproteins [59], and metabolic syndrome [25, 59], all of those may increase the risk of brain disorders. Third, dietary pattern may change the intestinal microbiome composition and that microbiome composition influence the pathogenesis of neurodegenerative and psychiatric disorders [60–62]. Forth, some nutrients, such as choline, reduced the pathogenesis of neurodegenerative and psychiatric disorders by inhibiting inflammation. A diet supplemented with choline lead to a decrease inflammation, resulting in a decrease in AD pathology [63]. Further insight into the association between dietary inflammatory potential and brain structure comes from the primary discoveries under the associations of dietary inflammatory potential with brain disorders. Previous findings showed that a higher score of an inflammation-related nutrient pattern was associated with smaller total brain volume [TBV] and total gray matter volume [TGMV] [64, 65]. In addition, results from previous studies investigating associations of dietary patterns with cortical thickness and hippocampal volume support our study, finding either positive associations with Mediterranean dietary patterns or a negative association with the Western dietary pattern [66–69]. Our results indicated that adherence to an anti-inflammatory diet such as the Mediterranean dietary pattern may lead to healthy aging in older adults.

Strengths and limitations

The strengths of this cohort study include a large sample size, a prospective design with long-term follow-up, long-term and repeated measures of diet, and observed associations between dietary inflammatory potential and brain health. However, our study has several important limitations. First, dietary intake information was based on self-reported, which may introduce measuring errors. Second, the calculation of DII and EDII scores is limited by the lack of complete information on several dietary nutrients. Third, 39.7% of participants had only one 24-h recall and may be prone to measurement error owing to its limited ability to fully capture individuals' variation in diet. Finally, although we adjusted for a broad range of relevant potential confounders, the possibility of residual confounding influencing our results remains.

CONCLUSIONS

In conclusion, pro-inflammatory diets were associated with higher risk of brain disorders, such as ACD, PD, stroke, anxiety, and depression, and some brain regions. Inflammation was a significant mediator for the relationship of dietary inflammatory potential with brain structures and brain disorders. Our study indicated a shift toward food intake that emphasizes anti-inflammatory diet to improve health. However, further studies are needed to clarify the risk of brain disorders in relation to a pro-inflammatory diet among more racially diverse populations.

AVAILABILITY OF DATA AND MATERIALS

The main data used in this study were accessed from the publicly available UK Biobank Resource under application number 19,542, which cannot be shared with other investigators. The dataset supporting the conclusions of this article is available in the UK Biobank (https://biobank.ndph.ox.ac.uk/showcase/index.cgi) upon application.

CODE AVAILABILITY

All data management and analyses were performed using R version 4.0.1 using the data. table package version 1.14.0, the dplyr package version 1.0.2, the Mice package, and the car package version 3.0.10. Figures were plotted using ggplot2 version 3.2.1. Additionally, stringr package version 1.4.0 and fst package version 0.9.4 were used for data management. Scripts used to perform the analyses are available at https://github.com/yanfu-a/Diet_inflammation.

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AUTHOR CONTRIBUTIONS

Dr Yu and Cheng had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: Yu. Acquisition, analysis, or interpretation of data: All authors. Drafting of the manuscript: Fu, Chen. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Fu, Chen. Obtained funding: Yu. Administrative, technical, or material support: Ou, Wang, Gao. Supervision: Yu, Cheng, Feng.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The UK Biobank study received approval from the National Health Service (NHS) North West Multicenter Research Ethics Committee. All participants were informed of consent via electronic signature prior to participation in the study. Analysis was performed under application number 19542 and the study complied with the Declaration of Helsinki.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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