The association of dietary macronutrient quality indices with depression and anxiety symptoms and quality of life in Iranian adults: The LipoKAP study

Parisa Hajihashemi[1], Fahimeh Haghighatdoost[2*], Noushin Mohammadifard[3*], Maryam Maghroun[4], Firouzeh Sajjadi[3], Farid Najafi[5], Hossein Farshidi[6], Masoud Lotfizadeh[7], Tooba Kazemi[8], Simin Karimi[3], Hamidreza Roohafza[9], Mohammadreza Sabri[10], Cesar de Oliveira[11], Erika Aparecida Silveira[11,12], Nizal Sarrafzadegan[3]

[1] *Isfahan Gastroenterology and Hepatology Research Center, Isfahan University of Medical Sciences, Isfahan, Iran*

[2] *Hypertension Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran*

[3] *Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran*

[4] *Heart Failure Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran*

[5]*Research Center for Environmental determinants of Health, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran*

[6] *Hormozgan Cardiovascular Research Center, Hormozgan University of Medical Sciences, Bandarabbas, Iran*

[7] *Social Determinants of Health Research Center, Shahrekord University of Medical Sciences, Shahrekord, Iran*

[8] *Birjand Cardiovascular Research Center, Birjand University of Medical Sciences, Birjand, Iran*

[9] *Cardiac Rehabilitation Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran*

[10] *Prdiatric Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran*

[11] *Department of Epidemiology & Public Health, Institute of Epidemiology & Health Care, University College London, UK*

[12] *Postgraduate Program in Health Sciences, Faculty of Medicine, Federal University of Goiás, Brazil*

Running title: Dietary quality, mental health, and quality of life

Number of words: 3,383

Number of figures: 0

Number of Tables: 4

Keywords: Carbohydrate quality; Fat quality; Protein quality; Anxiety; Depression; Quality of life.

Fahimeh Haghighatdoost and Noushin Mohammadifard are the corresponding authors.

Corresponding Author: Noushin Mohammadifard, PhD; or Fahimeh Haghighatdoost, PhD

Corresponding Address: Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
Tel: +98 313 6115307
Fax: +98 313 6115307
Email: nmohammadifard@gmail.com or f_haghighatdoost@yahoo.com

Funding: This study has been approved by the International Atherosclerosis Society (IAS) and funded by Pfizer (grant number 11531879).

ABSTRACT

Background: Macronutrients' quality may impact differently on mental health and quality of life (QOL). This study aimed to investigate the potential relationship between the carbohydrate quality index (CQI), fat quality index (FQI), protein quality index (PQI), the affective mental health disorder symptoms and QOL among Iranian adults.

Methods: The LipoKAP is a cross-sectional study, conducted with 2,456 adults in Iran**.** A validated food frequency questionnaire was used to evaluate usual dietary intakes. A validated Iranian version of the Hospital Anxiety and Depression Scale was used to assess the severity of anxiety and depression. QOL was assessed by EQ-5D.

Result: In the fully adjusted model, participants in the highest tertile of CQI had lower QOL than those in the lowest tertile (OR= 1.35; 95% CI: 1.06, 1.73). Individuals in the top tertile of FQI (OR= 0.71; 95% CI: 0.55, 0.91) and PQI (OR = 0.78; 95% CI: 0.60;1.01) were less likely to report lower QOL than those in the bottom tertile. An inverse association was found between PQI and depressive symptoms (OR = 0.72, 95% CI: 0.55, 0.95), but not for CQI and FQI.

Limitations: The cross-sectional design of the study and the use of a memory-based dietary tool may limit the generalizability of our findings.

Conclusion: Higher PQI was associated with lower risk of depressive symptoms and having a low-quality life. Although CQI and FQI were not related to depressive and anxiety symptoms, higher values of FQI were associated with better QOL, while CQI showed an inverse association.

Keywords: Carbohydrate quality; Fat quality; Protein quality; Anxiety; Depression; Quality of life.

Introduction

Mental disorders, including depression and anxiety, are considerably disabling disorders that affect one's quality of life (QOL) in both high- and middle-low-income countries (1,2). Over the last years, they have been considered the leading cause of disease burden worldwide (1,3). Diet, as a modifiable risk factor, may play a contributory role in the etiology of mood disorders (13–15). For instance, existent evidence has shown that the Mediterranean diet may have a protective effect on depression and improve QOL (14,16,17). In contrast, the Western diet, rich in animal protein, total fat, saturated fat, refined sugars and food additives has been shown to have adverse effects on mental health and QOL (14). In addition, the beneficial association of marine n-3 long chain polyunsaturated fatty acids, olive oil, dietary fiber, whole grains, fruit and vegetables with depression risk has been reported in previous studies (15,18). It is well accepted that beside macronutrients amount, their type and quality may have diverse effects on health status (1,7) (19).

Considering various dietary components simultaneously is a better approach to predict diet-disease relationship due to potential interactions between them. For example, for carbohydrates, the amount of fiber and whole grains may affect the association between dietary glycemic index (GI) and health outcomes. Therefore, the carbohydrate quality index (CQI), fat quality index (FQI) and protein quality index (PQI), which assess several features (20), may be a more comprehensive and complimentary indicator for better evaluation of macronutrients quality. However, recent studies have mostly focused on the associations of specific features of macronutrients in relation to depression, anxiety and QOL (21), while evidence examining the overall quality of macronutrients is scarce. For example, various studies have studied separately dietary GI, GL and fiber intake as the indicators of carbohydrate quality, leading to conflicting findings (22–26). Similarly, different types of fatty acids have individually been investigated and despite a potential favorable association between polyunsaturated fatty acids

(PUFA), monounsaturated fatty acids (MUFA) and mood disorders, saturated fatty acids (SFA) and trans fatty acids (TFA) were adversely related to mental health (27–32). Nevertheless, it is important to highlight that each food contains different types of fatty acids and none of them is consumed alone. Concerning protein types, there is even more paucity with the existing evidence demonstrating that total protein intake, particularly plant protein, might reduce the risk of depressive symptoms (33,34).

Nutritional transition and the rising tendency in Western diets amongst low and middle-income countries have been accompanied by a considerable increase in the prevalence of mental health disorders and QOL (35). Macronutrients' quality may play a key role in mood disorders (36) and consequently QOL (21). Indeed, low quality diets contain lower amounts of various dietary compounds and nutrients associated with mental health (37,38). Furthermore, to the best of our knowledge, this is the first study to examine the association between different macronutrients' quality indexes (CQI, FQI and PQI), depression and anxiety symptoms and QOL. Therefore, the aim of this cross-sectional study is to investigate the association of the CQI, FQI and PQI with depression and anxiety symptoms and QOL in Iranian adults.

Materials and methods

Study population: This cross-sectional study was conducted in the framework of the Knowledge And Practice Of dyslipidemia prevention, management, and control (LipoKAP) multicentric national study between February 2018 and July 2019 (39). The LipoKAP was performed in five different cities of Iran including Isfahan, Birjand, Bandar abbas, Kermanshah, and Shahrekord. In total, 2,456 adults aged 18 and older were recruited using stratified multistage random cluster sampling. The adequate sample size was calculated using the simple random method and then doubled due to different clusters. The final sample size for each area was estimated considering the population size in the different cities and the urban

and rural areas distribution of each city. Then, clusters were randomly selected from among available clusters in health care centers. Based on the distribution of population across different clusters, a specific sample size for each cluster was allocated and participants were randomly selected and invited by the interviewers. All interviewers were well trained and had participated in a 4-hour training session. The exclusion criteria were any systemic or dyslipidemia-related diseases, chronic kidney disease, liver disease, cancer, immune system disorders and under- or over-estimation of energy intake (< 800 or > 4200 Kcal/day). These exclusion criteria were applied to mitigate the reverse causality because of their potential confounding effect. The final analytical comprised of 2,033 eligible participants. All participants signed an informed written consent. This study was approved by the ethics committee of the Isfahan University of Medical Sciences (protocol number: IR.MUI.RC. 1395.4.077). Sociodemographic characteristics including age, gender, smoking and socioeconomic status (SES) were assessed by a self-administered questionnaire. Further detailed information on the study participants, study design (39) and the evaluation of socioeconomic status has been described elsewhere. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) and expressed as the metabolic equivalent (MET) hour/week (40).

Dietary assessment: The habitual dietary intake of participants over the preceding year was assessed using a validated 110-item, semi-quantitative food frequency questionnaire (FFQ) (41). Each food was examined based on a popular portion size and nine possible categories indicating the frequency of consumption, from never/seldom to more than 6 times/d, were provided for participants to indicate how they usually are accustomed to consuming each food item. According to the weight of each portion size and the frequency of consumption, the average intake of each food item (g/d) was estimated for all participants. Then, energy and

nutrients intakes were calculated by means of Nutritionist IV software which was adjusted for Iranian foods.

Carbohydrate quality index estimation: The CQI was defined by summing up the following four criteria: 1) dietary fiber intake (g/day) 2) ratio of solid carbohydrates to total carbohydrates 3) GI and 4) ratio of whole grains to total grains (whole grains, refined grains, and their products) (42). Accordingly, subjects were categorized into quintiles for each of these four dietary components and then received a value ranged from 1 to 5 according to the quintile where they located in. However, for GI the scoring was reversed and those in the fifth quintile received the lowest score, that is, one point and those in the first quintile received the highest score, that is, five. Finally, by summing up the scores of all of the four criteria, an overall CQI was calculated, ranging from 4 to 20 (43).

Dietary glycemic index, whole grains, fiber and solid carbohydrates: Total dietary GI was calculated by using the following formula: $\sum (GI_a \times \text{available carbohydrate}_a)/\text{total available carbohydrate}$, where available carbohydrate was calculated as total carbohydrate_a minus fiber_a (44). GI values for individual food items were obtained from international tables, the glycemic index of Iranian foods, and literature reviews (45,46). Glucose was used as the reference (GI for glucose= 100). The GIs of mixed meals were estimated based on the GIs of individual food components.

Dark breads [sangak, barbari] and whole meal biscuits was defined as whole grains and white bread was defined as refined grain.

Dietary fiber intake of participants was obtained using Nutritionist IV software modified for Iranian foods. Carbohydrate intake was classified according to its physical form in room temperature: solid carbohydrate intake included all carbohydrate containing solid foods and

liquid carbohydrate intake included sugar-sweetened beverages and fruit juice. Solid carbohydrates were obtained by subtracting the amount of liquid carbohydrate from total carbohydrate intake (47).

Fat quality index (FQI) estimation: To calculate the FQI, the ratio of unsaturated fatty acids (MUFA + PUFA) to saturated and trans fatty acids (SFA + trans-fatty acids) was computed (20).

Protein quality index (PQI) estimation: The PQI (20) was calculated using the following ratio: PQI = (seafood + poultry + pulses + nuts)/(red and processed meats + cheese).

Depression and anxiety symptoms and QOL assessment: A validated Iranian version of the Hospital Anxiety and Depression Scale (HADS) was used (48). This simple validated questionnaire includes 2 separate sections to assess severity of anxiety and depression. Each section includes 7 items with a 4-point rating scale. The final possible score ranged from 0 (the lowest degree of anxiety and depression) to 21 (the highest degree of anxiety or depression). Scores of ≤7 in each section were considered to be normal status (no depression or low anxiety), and scores of ≥8 were considered to represent the presence of depression or anxiety. A further analysis based on the cut-off point of 11 was also performed since values of 8 to 10 may just be suggestive of the presence of the respective state.

The contributors' QOL was assessed with the self-administered instrument EQ-5D (49). The EQ-5D includes five domains of health status: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Three distinct levels of severity presented for each domain as 1 (No problems), 2 (some problems) and 3 (extreme problems). Higher EQ-5D scores indicate poor QOL. In the present study, using the median QOL cut-off point, participants were classified into two groups: low (≤5) and high QOL (>5).

Statistical analysis

General characteristics of the participants were compared across the tertiles of dietary quality scores using analysis of variance (ANOVA) and Chi-square test for continuous and categorical variables, respectively. Continuous variables were reported as mean ± standard deviation (SD) and categorical variables were reported as percentage. Differences in age-, sex-, and energy-adjusted dietary intakes of participants were examined using analysis of covariance (ANCOVA). Mean scores of depression, anxiety and QOL were compared by ANOVA in the crude and ANCOVA in the adjusted model. Multiple logistic regression was applied to estimate odds ratio (OR and 95% confidence interval (CI) for depression and anxiety symptoms and having low QOL in crude and multivariable adjusted models. In the first adjusted model, the confounding effect of age, sex, and energy was controlled. Model 2 was additionally adjusted for education, marital status, physical activity level, and smoking. Further adjustment was made for fat quality, carbohydrate quality and protein quality when they were not independent variable. All confounders were regarded as covariates included in the statistical analysis. P trend was estimated by considering tertiles of dietary quality scores to be linear continuous variables in the logistic regression model. All statistical analyses were done by using the Statistical Package for Social Sciences (version 20; SPSS Inc.). $P < 0.05$ was considered significant in all statistical analyses.

Results

The general characteristics of the study participants are presented in **Table 1**. Compared with those in the highest tertile, participants in the lowest tertile of CQI had lower level of education. No other significant differences were observed across the tertiles of CQI. In terms of FQI score, those in the bottom tertile of FQI were older, more likely to be female, but less likely to be physically active, highly educated and had lower socioeconomic status. They also had higher

scores of depression, anxiety symptoms and QOL. In comparison with individuals in the highest tertile, participants who were in the lowest tertile of PQI were older, but less likely to be highly educated. The scores of depression and QOL were higher in the lowest tertile compared with the highest tertile of PQI. No other significant differences were found across categories of PQI.

Dietary intakes of participants across the tertiles of CQI, FQI and PQI are summarized in **Table 2**. A greater CQI was significantly associated with higher intakes of carbohydrates, proteins, fiber, whole-grain, fruits, nuts, and legumes. In contrast, dietary intakes of fat, cholesterol, refined grains, sweet drinks and fast foods were higher in the lowest tertile of CQI. In terms of FQI, those in the lowest tertile had higher intake of carbohydrate, fiber, cholesterol, fruits, dairy, meat and fast foods, while dietary intakes of fat, refined grains and fish and sea foods were higher in the top tertile of FQI.

Carbohydrate, proteins, cholesterol, refined grains, dairy, meat and fast foods were consumed in greater amounts by the individuals in the lowest tertile of PQI, whereas fat, fiber, fruits, legumes and fish and sea foods were consumed in fewer amounts by individuals in the lowest tertile of PQI.

Table 3 presents means and standard errors (SE) of depression, anxiety and QOL in crude and adjusted models across the tertiles of CQI, FQI and PQI. No significant association was found between CQI and any of the depression and anxiety symptoms either in the crude or adjusted model. Participants in the highest tertile of CQI had higher QOL in comparison with those in the lowest tertile in model II (tertile 3: 5.71±0.05 vs. tertile 1: 5.56±0.04; P=0.034) and model III (tertile 3: 5.71±0.05 vs. tertile 1: 5.56±0.04; P=0.034). However, after further control for the quality of dietary fat and protein, the significance disappeared. In terms of FQI, in the crude model, participants in the highest tertile had lower mean of depression compared with those in the lowest tertile of FQI (tertile 3: 3.97±0.13 vs. tertile 1: 4.92±0.14; P<0.0001) and anxiety

(tertile 3: 4.48±0.14 vs. tertile 1: 5.14±0.15; P=0.001). Controlling for possible confounders did not affect the association substantially. In the crude model, QOL was lower in individuals in the top tertile of FQI (tertile 3: 5.49±0.04 vs. tertile 1: 5.78±0.05; P<0.0001). However, adjustment for led to a null association. Regarding PQI, in the crude model, the mean of depression (tertile 3: 4.15±0.13 vs. tertile 1: 4.73±0.15; P=0.011), anxiety (tertile 3: 4.65±0.15 vs. tertile 1: 4.95±0.15; P=0.059) and QOL (tertile 3: 5.54±0.04 vs. tertile 1: 5.74±0.05; P=0.004) was lower in individuals in the highest tertile compared with those in the lowest tertile. However, after adjustment for potential confounders, these associations remained no longer significant.

Table 4 provides the odds ratios and their 95% confidence intervals for depression, anxiety symptoms and low-QOL in crude and multivariate-adjusted models across tertiles of CQI, FQI and PQI. In the crude model, participants in the highest tertile of CQI had 26% lower risk for depression than those in the lowest tertile (95% CI: 0.57, 0.98). However, after adjustment for potential confounders, this association became no longer significant (OR =0.79; 95% CI: 0.59, 1.05). The CQI was not pertinent to the risk of anxiety in any of the models. Using the cut-off point of 11 for depression and anxiety symptoms, results did not change considerably **(Supplementary Table 1)**. Nevertheless, in the fully adjusted model, those with the greatest CQI were at a higher risk for having a low QOL than those in the lowest CQI tertile (OR= 1.35; 95% CI: 1.06, 1.73).

Regarding FQI, a significant inverse association was observed between FQI and odds of depression (OR= 0.74; 95% CI: 0.56, 0.97) and anxiety (OR= 0.76; 95% CI: 0.59, 0.99) in the crude model. However, adjustment for potential confounders eliminated the significance for both depression (OR= 0.84; 95% CI: 0.63, 1.11) and anxiety (OR= 0.81; 95% CI: 0.61, 1.07). Nevertheless, the inverse association between FQI and odds of anxiety remained significant

when the cut-off point of 11 was used (in the fully adjusted model, OR in tertile 2= 0.63, 95% CI: 0.43, 0.92 and OR in T3= 0.57, 95% CI: 0.38, 0.84; P for trend= 0.004) **(Supplementary Table 1)**. In addition, in the crude model, individuals with higher FQI were less likely to have low-QOL (OR= 0.58; 95% CI: 0.47, 0.73), and this association remained significant in multivariate-adjusted model (OR= 0.71; 95% CI: 0.55, 0.91).

In terms of PQI, individuals in the top tertile of PQI were 28% less likely to have depression than those in the bottom tertile (95% CI: 0.55, 0.95). When lifestyle confounders were considered, the association remained significant (OR: 0.74; 95% CI: 0.56, 0.99). However, further adjustment for CQI and FQI disappeared the association (OR= 0.77; 95% CI: 0.56, 1.04). In the analysis based on the cut-off point of 11, the inverse association between PQI and depression remained significant even after adjustments for FQI and CQI (OR in T2= 0.87, 95% CI: 0.58, 1.29 and OR in T3= 0.60, 95% CI: 0.38, 0.98; P for trend= 0.036). No significant association was found between PQI and anxiety in different models even when the cut-off point of 11 was considered **(Supplementary Table 1)**. In the crude model, the risk of having low-QOL was 30% lower in those in the third tertile of PQI compared with those in the first tertile (95% CI: 0.57, 0.88). This association was independent of various lifestyle confounders (OR: 0.76; 95% CI: 0.59, 0.97) and tended to be lower after adjustment for CQI and FQI (OR: 0.78; 95% CI: 0.60, 1.01).

Discussion

This is the first study investigating the association of dietary macronutrients quality scores with depression and anxiety symptoms and QOL in a large sample of Iranian adults. This study showed that despite an inverse association between FQI and CQI and depression and anxiety symptoms in the unadjusted model, adjustment for potential confounders made this association no longer significant. However, PQI was inversely related to depression and this association remained significant even after adjustment for CQI and FQI. In terms of QOL, higher quality score of fat and protein were associated with better QOL, whereas greater CQI was associated with higher odds of having low-QOL.

In the current study, an inverse association was observed between PQI and depression symptoms. Depression, the most common mental disorder, is associated with lower QOL, and increased risk of stroke, cardiovascular disease (CVD), and some cancers (2,50). Therefore, preventive strategies including dietary modifications should be a priority in health care systems. Despite some research on the association of total and different sources of protein with depression (33,51), no previous investigation has been conducted examining PQI-depression association. Total protein intake might reduce the risk of depressive symptoms (33,51). In addition, an inverse association was suggested between plant protein and the prevalence of depressive symptoms in a cross-sectional study among Japanese male workers (33), while red and processed meat were directly linked to depression symptoms among Iranian males. In overweight or obese participants, higher white meat intake was associated with lower risk of psychological distress (52). In contrast, in the present study, we defined PQI using dividing proteins into healthy (seafood, poultry, pulses and nuts) and unhealthy (red and processed meats and dairy), regardless of protein sources (animal or plant). The inverse association of PQI with depression might be explained by several mechanisms. Protein and its constituent

amino acids are required for neurotransmitter synthesis and better nervous system function (53,54). For example, serotonin availability modulates mood and other components of depression (55,56). Previous evidence has indicated that tryptophan intake was inversely associated with mental disorders (55). Tyrosine is also a precursor of dopamine, which modulates symptoms of depression (57).

Regarding fat and carbohydrate's quality, earlier studies have mostly focused on a single component of fats or carbohydrates in relation to mental disorders (2) (22,23,25,28,30,31). These studies have suggested a positive association between the dietary GI or GL and depression (22,23,26). Recent studies have shown that omega-3 fatty acids, MUFA, and olive oil had protective effect on depression risk or anxiety symptoms (30,31). These findings might be affected by different components of CQI and FQI. Indeed, the diversity in the proportion and quality of macronutrients between various countries may result in inconsistent findings in epidemiologic studies. Refined carbohydrate, mainly white rice and bread, and n-6 PUFA, SFA and TFA make a substantial contribution to Iranians' diet (58). Diets rich in refined grains, n-6 PUFA, SFA and TFA induce free radical production and elevate oxidative stress and inflammation, which play a potential role in brain function and the etiology of depression (2) (13,32,59,60). In the current study, the null associations after adjustment for potential confounders indicate the relevance of other lifestyle factors as well as the quality of all dietary macronutrient. However, we further assessed the risk of depression and anxiety symptoms based on the cut-off point of 11 since a score of 8 to 10 for HADS may just be suggestive of the presence of the mood disorders while the cut-off point of 11 indicates probable presence of mood disorders. This analysis revealed that FQI may be protective against anxiety in the higher severities.

QOL is a measure of social wellbeing and life satisfaction of individuals in an area and is often classified as the five dimensions of physical wellbeing, material wellbeing, social wellbeing, emotional wellbeing, and development and activity (21,59). High consumption of vegetables, fruits, whole grains, legumes, seafood and low consumption of saturated fat, sweetened foods, refined grains and red and processed meat is associated with better QOL (21). The direct link between PQI and better QOL in the current study might be attributable to the stimulatory effect of essential amino acids on the synthesis of skeletal muscle, improving muscle mass and strength and bone health (61). In terms of FQI, TFA and SFA, may adversely affect QOL, while MUFA and PUFA are associated with better QOL (62). The reason for a positive association between CQI and QOL is not clear, and due to the cross-sectional design of this study, it might be caused by reverse-causality. On the other hand, people with some disabilities and low QOL may have changed their dietary intakes to feel healthier. Furthermore, while over 60% of Iranians' daily energy intake comes from carbohydrate, only a small proportion is received from whole-grain products (58). Therefore, they may not meet the appropriate proportion to exert their beneficial effects. The overall low score of CQI in our study compared with other studies may confirm this hypothesis. Moreover, the high intake of fiber in this study population suggests higher consumption of fruits and vegetables, which are important sources of fructose. High fructose intake increases levels of inflammatory cytokines, fasting glucose, insulin and consequently decreases QOL (63).

This study has several strengths, such as its large and representative sample of Iranian adults, using validated FFQ, filled by trained interviewers, considering various components for each macronutrient quality index and therefore considering potential interactions between them, and taking into account the wide range of potential confounders in statistical analyses. However, several limitations must be considered. The cross-sectional design of the study does not allow

us to infer casual relationships. Although all questionnaires were completed by interviewers, it is possible that respondents answer questions in a manner they seem psychologically healthy. In addition, since FFQs which is a memory-reliable tool, measurement errors are not inevitable.

In conclusion, higher PQI was associated with lower risk of depression and with having a high quality of life. Although CQI and FQI were not related to depression and anxiety symptoms, higher values of FQI were associated with better QOL, while CQI showed an inverse association.

Acknowledgment: We greatly appreciate the help from all staff in the five studied counties with their assistance in data collection and conducting intervention activities.

Funding: This study has been funded by Pfizer (grant number 11531879).

Conflict of interest: The authors declare that there are no conflicts of interest**.**

References

1. Murray C J, Lopez A D. Alternative projections of mortality and disability by cause 1990-2020: Global Burden of Disease Study. Lancet (London, England). 1997;349:1498–1504.
2. Kessler R C, Bromet E J. The epidemiology of depression across cultures. Annual review of public health. 2013;34:119–138.
3. Sayers J. The world health report 2001 — Mental health: new understanding, new hope. Bull World Health Organ. 2001;79:1085.
4. Rahe C, Unrath M, Berger K. Dietary patterns and the risk of depression in adults: a systematic review of observational studies. Eur J Nutr. 2014;53:997-1013.
5. Akbaraly TN, Brunner EJ, Ferrie JE, Marmot MG, Kivimaki M, Singh-Manoux A. Dietary pattern and depressive symptoms in middle age. Br J Psychiatry. 2009;195:408-413.
6. Northstone K, Joinson C, Emmett P. Dietary patterns and depressive symptoms in a UK cohort of men and women: a longitudinal study. Public Health Nutr. 2018;2:831-837.
7. Muñoz MA, Fíto M, Marrugat J, Covas MI, Schröder H; REGICOR and HERMES investigators. Adherence to the Mediterranean diet is associated with better mental and physical health. Br J Nutr. 2009;10:1821-1827.
8. Sofi F, Cesari F, Abbate R, Gensini GF, Casini A. Adherence to Mediterranean diet and health status: meta-analysis. BMJ. 2008;337:a1344.
9. Bodnar LM, Wisner KL. Nutrition and depression: implications for improving mental health among childbearing-aged women. Biol Psychiatry. 2005;58:679-685.
10. Shan Z, Rehm CD, Rogers G, et al. Trends in Dietary Carbohydrate, Protein, and Fat Intake and Diet Quality Among US Adults, 1999-2016. JAMA. 2019;322:1178-1187.
11. Minobe N, Murakami K, Kobayashi S, Suga H, Sasaki S; Three-generation Study of Women on Diets and Health Study Group. Higher dietary glycemic index, but not glycemic load, is associated with a lower prevalence of depressive symptoms in a cross-sectional study of young and middle-aged Japanese women. Eur J Nutr. 2018;57:2261-2273.
12. Haghighatdoost F, Azadbakht L, Keshteli AH, Feinle-Bisset C, Daghaghzadeh H, Afshar H, et al. Glycemic index, glycemic load, and common psychological disorders. Am J Clin Nutr. 2016;103:201-209.
13. Mwamburi DM, Liebson E, Folstein M, Bungay K, Tucker KL, Qiu WQ. Depression and glycemic intake in the homebound elderly. J Affect Disord. 2011;132:94-98.
14. Gangwisch JE, Hale L, Garcia L, et al. High glycemic index diet as a risk factor for depression: analyses from the Women's Health Initiative. Am J Clin Nutr. 2015;102:454-463.
15. Salari-Moghaddam A, Larijani B, Esmaillzadeh A. Review of earlier evidence on dietary glycemic index and load and depression needs further attention. Eur J Nutr. 2018;57:2341-2342.

16. Grosso G, Micek A, Marventano S, et al. Dietary n-3 PUFA, fish consumption and depression: A systematic review and meta-analysis of observational studies. J Affect Disord. 2016;205:269-281.

17. Thesing CS, Bot M, Milaneschi Y, Giltay EJ, Penninx BWJH. Omega-3 and omega-6 fatty acid levels in depressive and anxiety disorders. Psychoneuroendocrinology. 2018;87:53-62.

18. Kyrozis A, Psaltopoulou T, Stathopoulos P, Trichopoulos D, Vassilopoulos D, Trichopoulou A. Dietary lipids and geriatric depression scale score among elders: the EPIC-Greece cohort. J Psychiatr Res. 2009;43:763-769.

19. Wolfe AR, Ogbonna EM, Lim S, Li Y, Zhang J. Dietary linoleic and oleic fatty acids in relation to severe depressed mood: 10 years follow-up of a national cohort. Prog Neuropsychopharmacol Biol Psychiatry. 2009;33:972-977.

20. Deane KHO, Jimoh OF, Biswas P, et al. Omega-3 and polyunsaturated fat for prevention of depression and anxiety symptoms: systematic review and meta-analysis of randomised trials. Br J Psychiatry. 2021;218:135-142.

21. Sánchez-Villegas A, Verberne L, De Irala J, et al. Dietary fat intake and the risk of depression: the SUN Project. PLoS One. 2011;6:e16268.

22. Nanri A, Eguchi M, Kuwahara K, Kochi T, Kurotani K, Ito R, et al. Macronutrient intake and depressive symptoms among Japanese male workers: the Furukawa Nutrition and Health Study. Psychiatry Res. 2014;220:263-8.

23. Li Y, Zhang C, Li S, Zhang D. Association between dietary protein intake and the risk of depressive symptoms in adults. Br J Nutr. 2020;123:1290-1301.

24. López-Taboada I, González-Pardo H, Conejo NM. Western Diet: Implications for Brain Function and Behavior. Front Psychol. 2020;11:564413.

25. Sangsefidi ZS, Salehi-Abarghouei A, Sangsefidi ZS, Mirzaei M, Hosseinzadeh M. The relation between low carbohydrate diet score and psychological disorders among Iranian adults. Nutr Metab (Lond). 2021;18:16.

26. Govindaraju T, Sahle BW, McCaffrey TA, McNeil JJ, Owen AJ. Dietary Patterns and Quality of Life in Older Adults: A Systematic Review. Nutrients. 2018;10:971

27. Louie JC, Markovic TP, Ross GP, Foote D, Brand-Miller JC. Higher glycemic load diet is associated with poorer nutrient intake in women with gestational diabetes mellitus. Nutr Res. 2013;33:259-265.

28. Murakami K, Sasaki S. A low-glycemic index and -glycemic load diet is associated with not only higher intakes of micronutrients but also higher intakes of saturated fat and sodium in Japanese children and adolescents: the National Health and Nutrition Survey. Nutr Res. 2018;49:37-47.

29. Noushin Mohammadifar MM MT, Marjan Mansourian, Farid Najafi, Hossein Farshidi, Tooba Kazemi, Masoud Lotfizadeh, Ali Pourmoghaddas, Hassan Alikhasi, Jamshid Najafian, Masoumeh Sadeghi, Katayoun Rabiei, Hamidreza Roohafza, Mahammadreza Sabri. Rationale, Design and Initial Findings of Community Trial on the Improving the Iranian's Knowledge and Practice of Dyslipidemia Management, Prevention and Control.

30. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35:1381-1395.

31. Mohammadifard N, Khosravi AR, Esmaillzadeh A, et al. Validation of Simplified Tools for Assessment of Sodium Intake in Iranian Population: Rationale, Design and Initial Findings. Arch Iran Med. 2016;19:652-658.

32. Mohammadifard N, Haghighatdust F, Kelishadi R, Bahonar A, Dianatkhah M, Heidari H, Maghroun M, Dehghan M. Validity and reproducibility of a semi-quantitative food frequency questionnaire for Iranian adults. Nutr Diet. 2021;78(3):305-314.

33. Zazpe I, Sánchez-Taínta A, Santiago S, et al. Association between dietary carbohydrate intake quality and micronutrient intake adequacy in a Mediterranean cohort: the SUN (Seguimiento Universidad de Navarra) Project. Br J Nutr. 2014;111:2000-2009.

34. Wolever TM, Yang M, Zeng XY, Atkinson F, Brand-Miller JC. Food glycemic index, as given in glycemic index tables, is a significant determinant of glycemic responses elicited by composite breakfast meals. Am J Clin Nutr. 2006;83:1306-1312.

35. Atkinson FS, Foster-Powell K, Brand-Miller JC. International tables of glycemic index and glycemic load values: 2008. Diabetes Care. 2008;31:2281-2283.

36. Taleban F, EsmaeiliM. Glycemic index values of Iranian foods: a guideline for diabetic and hyperlipidemic patients. 1st edition. Tehran, Iran: National Nutrition and Food Technology Research Institute; 1999.

37. Santiago S, Zazpe I, Bes-Rastrollo M, Sánchez-Tainta A, Sayón-Orea C, de la, et al. Carbohydrate quality, weight change and incident obesity in a Mediterranean cohort: the SUN Project. Eur J Clin Nutr. 2015;69:297-302.

38. Santiago S, Zazpe I, Fernandez-Lazaro CI, de la O V, Bes-Rastrollo M, Martínez-González MÁ. Macronutrient Quality and All-Cause Mortality in the SUN Cohort. Nutrients. 2021;13:972.

39. Montazeri A, Vahdaninia M, Ebrahimi M, Jarvandi S. The Hospital Anxiety and Depression Scale (HADS): translation and validation study of the Iranian version. Health Qual Life Outcomes. 2003;1:14.

40. Saffari M, Pakpour AH, Naderi MK, Koenig HG, Baldacchino DR, Piper CN. Spiritual coping, religiosity and quality of life: a study on Muslim patients undergoing haemodialysis. Nephrology (Carlton). 2013;18:269-75.

41. Russ TC, Stamatakis E, Hamer M, Starr JM, Kivimäki M, Batty GD. Association between psychological distress and mortality: individual participant pooled analysis of 10 prospective cohort studies. BMJ. 2012;345:e4933.

42. Li Y, Zhang C, Li S, Zhang D. Association between dietary protein intake and the risk of depressive symptoms in adults. Br J Nutr. 2020;123:1290-1301.

43. Kazemi S, Keshteli AH, Saneei P, Afshar H, Esmaillzadeh A, Adibi P. Red and White Meat Intake in Relation to Mental Disorders in Iranian Adults. Front Nutr. 2021;8:710555.

44. Krishnan V, Nestler EJ. The molecular neurobiology of depression. Nature. 2008;455:894-902.

45. Rao TS, Asha MR, Ramesh BN, Rao KS. Understanding nutrition, depression and mental illnesses. Indian J Psychiatry. 2008;50:77-82.

46. Gostner JM, Geisler S, Stonig M, Mair L, Sperner-Unterweger B, Fuchs D. Tryptophan Metabolism and Related Pathways in Psychoneuroimmunology: The Impact of Nutrition and Lifestyle. Neuropsychobiology. 2020;79:89-99.

47. Wurtman RJ, Wurtman JJ. Brain serotonin, carbohydrate-craving, obesity and depression. Obes Res. 1995;3 Suppl 4:477S-480S.

48. Dailly E, Chenu F, Renard CE, Bourin M. Dopamine, depression and antidepressants. Fundam Clin Pharmacol. 2004;18:601-7.

49. Esmaillzadeh A, Azadbakht L. Food intake patterns may explain the high prevalence of cardiovascular risk factors among Iranian women. J Nutr. 2008;138:1469-75.

50. Kohler O, Krogh J, Mors O, Benros ME. Inflammation in Depression and the Potential for Anti-Inflammatory Treatment. Curr Neuropharmacol. 2016;14:732-42.

51. Liu T, Zhong S, Liao X, Chen J, He T, Lai S, Jia Y. A Meta-Analysis of Oxidative Stress Markers in Depression. PLoS One. 2015;10:e0138904.

52. Devries MC, Phillips SM. Supplemental protein in support of muscle mass and health: advantage whey. J Food Sci. 2015;80 Suppl 1:A8-A15.

53. Ruano C, Henriquez P, Bes-Rastrollo M, Ruiz-Canela M, del Burgo CL, Sánchez-Villegas A. Dietary fat intake and quality of life: the SUN project. Nutr J. 2011;10:121.

54. Majdi M, Imani H, Bazshahi E, Hosseini F, Djafarian K, Lesani A, et al. Habitual and meal-specific carbohydrate quality index and their relation to metabolic syndrome in a sample of Iranian adults. 2021.

Table 1- General characteristics of participants across tertiles of CQI, FQI and PQI[1].

	Tertiles of CQI				Tertiles of FQI				Tertiles of PQI			
	T1 (n=707)	**T2 (n=686)**	**T3 (n=645)**	**P-trend[2]**	**T1 (n=681)**	**T2 (n=681)**	**T3 (n=678)**	**P-trend[2]**	**T1 (n=682)**	**T2 (n=678)**	**T3 (n=682)**	**P-trend[2]**
Age (y)	39.50±0.51	38.51±0.57	39.81±0.58	0.224	41.20±0.57	38.78±0.54	37.76±0.54	<0.00 01	40.51±0.57	38.69±0.55	38.43±0.53	0.015
Physical activity	2974.77±157.94	3191.09±158.48	3343.89±150.89	0.244	2881.32±160.12	3125.01±148.62	3481.53±158.50	0.024	2988.24±165.19	3084.08±153.04	3420.53±148.69	0.120
Female (n (%))	372 (52.60)	356 (51.90)	333 (51.60)	0.931	385 (56.50)	356 (52.30)	322 (47.50)	0.004	353 (51.80)	341 (50.30)	369 (54.10)	0.365
Quality of life	5.59±0.04	5.62±0.04	5.67±0.04	0.440	5.78±0.05	5.59±0.04	5.49±0.04	<0.00 01	5.74±0.05	5.58±0.04	5.54±0.04	0.004
Depression	4.69±0.14	4.24±0.13	4.38±0.13	0.060	4.92±0.14	4.42±0.14	3.97±0.13	<0.00 01	4.73±0.15	4.43±0.13	4.15±0.13	0.011
Anxiety	4.68±0.15	4.67±0.14	4.74±0.14	0.947	5.14±0.15	4.46±0.14	4.48±0.14	0.001	4.95±0.15	4.47±0.14	4.65±0.15	0.059
Education level (n (%))				0.001				<0.00 01				<0.00 01
0-5 y	190 (26.90)	143 (20.80)	122 (18.90)		210 (30.90)	120 (17.60)	125 (18.40)		194 (28.40)	137 (20.10)	123 (18.10)	
6-12 y	331 (46.80)	309 (45.00)	298 (46.20)		299 (44.00)	317 (46.50)	322 (47.40)		291 (42.70)	324 (47.60)	324 (47.60)	
12-16 y	161 (22.80)	189 (27.60)	189 (29.30)		149 (21.90)	201 (29.50)	190 (28.00)		166 (24.30)	178 (26.20)	197 (29.00)	
>17 y	25 (3.50)	45 (6.60)	36 (5.60)		22 (3.20)	43 (6.30)	42 (6.20)		31 (4.50)	41 (6.00)	36 (5.30)	

Socioeconomic status				0.471				<0.0001				0.190
Low and middle	379 (53.6)	346 (50.4)	332 (51.5)		399 (58.6)	330 (48.5)	329 (48.5)		366 (53.7)	357 (52.6)	334 (49.0)	
High	328 (46.4)	340 (49.6)	313 (48.5)		282 (41.4)	351 (51.5)	349 (51.5)		316 (46.3)	321 (47.4)	348 (51.0)	
Current Smoker (n (%))	85 (12.00)	80 (11.60)	71 (11.00)	0.826	79 (11.60)	70 (10.30)	87 (12.80)	0.349	78 (11.40)	81 (11.90)	77 (11.30)	0.940

CQI: carbohydrate quality index; FQI: fat quality index; PQI: protein quality index.

[1]Values are mean (SE) for continuous variables and percentage for dichotomous variables.

[2]Derived from ANOVA for continuous and chi-square test for categorical variables.

Table 2- Dietary intakes of study participants across the tertiles of CQI, FQI and PQI[1].

	Tertiles of CQI				Tertiles of FQI				Tertiles of PQI			
	T1 (n=707)	**T2 (n=686)**	**T3 (n=645)**	**P-trend[2]**	**T1 (n=681)**	**T2 (n=681)**	**T3 (n=678)**	**P-trend[2]**	**T1 (n=682)**	**T2 (n=678)**	**T3 (n=682)**	**P-trend[2]**
Energy (kcal/d)	2083.31±27.59	2325.92±28.02	2497.56±28.89	<0.0001	2117.68±28.52	2299.61±28.40	2466.78±28.55	<0.0001	2100.14±28.07	2247.54±28.17	2537.63±28.08	<0.0001
Carbohydrate (g/day)	283.55±1.64	279.33±1.64	286.60±1.71	0.008	281.81±1.67	287.46±1.64	279.34±1.67	0.002	281.93±1.66	287.00±1.65	279.98±1.67	0.008
Protein (g/day)	90.96±0.64	95.09±0.64	98.13±0.66	<0.0001	97.64±0.64	96.14±0.64	89.90±0.65	<0.0001	95.32±0.65	97.63±0.64	90.87±0.65	<0.0001
Fat (g/day)	95.45±0.79	93.07±0.79	87.21±0.83	<0.0001	89.68±0.80	88.86±0.79	97.40±0.80	<0.0001	92.32±0.81	89.14±0.80	94.50±0.82	<0.0001
Fiber (g/day)	19.08±0.15	22.23±0.15	27.00±0.15	<0.0001	23.07±0.19	22.60±0.19	22.22±0.19	0.007	21.51±0.19	22.66±0.19	23.74±0.19	<0.0001
Cholesterol (g/day)	292.75±4.10	294.88±4.10	267.97±4.28	<0.0001	320.61±4.04	286.60±3.99	249.00±4.04	<0.0001	308.28±4.11	292.45±4.08	256.04±4.13	<0.0001
Whole grain(g/day)	19.96±2.67	74.16±2.67	182.95±2.79	<0.0001	84.43±3.72	94.07±3.67	90.60±3.73	0.178	91.80±3.71	96.53±3.69	80.86±3.74	0.010
Refined grain(g/day)	304.51±4.12	235.23±4.13	156.94±4.30	<0.0001	214.44±4.74	242.02±4.68	246.37±4.75	<0.0001	241.75±4.75	241.92±4.71	219.40±4.78	0.001

Fruits (g/day)	206.89±4.93	248.48±4.93	290.03±5.15	<0.0001	259.50±5.16	247.14±5.09	234.49±5.16	0.003	238.57±5.16	249.42±5.12	253.52±5.20	0.114
Nuts (g/day)	20.83±0.90	25.23±0.90	30.80±0.94	<0.0001	18.48±0.89	23.41±0.88	34.47±89.00	<0.0001	17.09±0.87	22.71±0.86	36.56±0.88	<0.0001
Legumes (g/day)	46.39±1.43	51.68±1.44	57.00±1.50	<0.0001	52.25±1.47	50.50±1.45	51.73±1.47	0.681	31.38±1.30	48.00±1.29	75.17±1.31	<0.0001
Dairy (g/day)	380.83±7.94	359.83±7.95	310.33±8.30	<0.0001	397.07±8.00	361.04±7.90	295.50±8.01	<0.0001	361.49±8.13	364.15±8.07	328.34±8.18	0.003
Fish & sea food (g/day)	15.12±0.60	16.04±0.60	15.04±0.62	0.423	13.85±0.60	15.22±0.60	17.14±0.60	0.001	11.88±0.59	14.95±0.59	19.39±0.60	<0.0001
Meat (g/day)	70.95±1.59	74.79±1.60	74.53±1.66	0.172	79.37±1.60	77.91±1.58	62.72±1.60	<0.0001	88.06±1.49	82.73±1.48	49.42±1.50	<0.0001
Sweet drinks (g/day)	41.80±1.96	42.48±1.96	24.11±2.04	<0.0001	37.48±2.01	35.17±2.00	36.53±2.02	0.715	39.81±2.01	34.61±2.00	34.77±2.04	0.119
Fast food (g/day)	13.67±0.74	16.88±0.75	9.86±0.78	<0.0001	14.68±0.76	14.13±0.75	11.77±.76	0.018	15.64±0.76	11.91±0.76	13.04±0.77	0.002

CQI: carbohydrate quality index; FQI: fat quality index; PQI: protein quality index.

[1] Values are age-, sex-, and energy-adjusted mean ± SE. Energy was adjusted for age and sex.

[2] Derived from ANCOVA.

Table 3- Mean of depression, anxiety and quality of life scores across tertiles of CQI, FQI and PQI[1].

	Tertiles of CQI				Tertiles of FQI				Tertiles of PQI			
	T1 (n=707)	**T2 (n=686)**	**T3 (n=645)**	**P-trend[2]**	**T1 (n=681)**	**T2 (n=681)**	**T3 (n=678)**	**P-trend[2]**	**T1 (n=682)**	**T2 (n=678)**	**T3 (n=682)**	**P-trend[2]**
Depression												
Crude model	4.69±0.14	4.24±0.13	4.38±0.13	0.060	4.92±0.14	4.42±0.14	3.97±0.13	<0.0001	4.73±0.15	4.43±0.13	4.15±0.13	0.011
Model I	4.63±0.13	4.26±0.13	4.44±0.14	0.149	4.77±0.13	4.52±0.13	4.05±0.14	0.001	4.70±0.14	4.48±0.13	4.15±0.14	0.020
Model II	4.61±0.13	4.27±0.13	4.45±0.14	0.194	4.74±0.13	4.51±0.13	4.09±0.13	0.003	4.65±0.13	4.51±0.13	4.17±0.13	0.041
Model III	4.66±0.13	4.27±0.13	4.39±0.14	0.118	4.81±0.14	4.43±0.13	4.09±0.14	0.001	4.59±0.14	4.51±0.13	4.25±0.14	0.215
Anxiety												
Crude model	4.68±0.15	4.67±0.14	4.74±0.15	0.947	5.14±0.15	4.46±0.14	4.48±0.14	0.001	4.95±0.15	4.47±0.14	4.65±0.15	0.059
Model I	4.65±0.14	4.70±0.14	4.74±0.15	0.904	5.04±0.14	4.57±0.14	4.48±0.14	0.130	4.98±0.14	4.54±0.14	4.57±0.14	0.052
Model II	4.65±0.14	4.70±0.14	4.75±0.15	0.874	5.00±0.14	4.55±0.14	4.54±0.14	0.035	4.93±0.14	4.57±0.14	4.59±0.14	0.130
Model III	4.71±0.14	4.69±0.14	4.69±0.15	0.993	5.08±0.14	4.47±0.14	4.54±0.14	0.005	4.90±0.15	4.56±0.14	4.62±0.15	0.210
Quality of life												
Crude model	5.59±0.04	5.62±0.04	5.67±0.04	0.440	5.78±0.05	5.59±0.04	5.49±0.04	<0.0001	5.74±0.05	5.58±0.04	5.54±0.04	0.004
Model I	5.56±0.04	5.64±0.04	5.71±0.04	0.034	5.69±0.04	5.64±0.04	5.57±0.04	0.135	5.70±0.04	5.62±0.04	5.57±0.04	0.092
Model II	5.56±0.04	5.64±0.04	5.71±0.04	0.034	5.69±0.04	5.63±0.04	5.57±0.04	0.131	5.69±0.40	5.62±0.40	5.58±0.40	0.195
Model III	5.57±0.04	5.64±0.04	5.69±0.04	0.112	5.71±0.04	5.61±0.04	5.57±0.04	0.630	5.69±0.04	5.62±0.04	5.58±0.40	0.224

CQI: carbohydrate quality index; FQI: fat quality index; PQI: protein quality index.

[1] Values are mean (SE).

[2] Derived from ANOVA in the crude and ANCOVA in the multivariable-adjusted models.

Model I: Adjusted for age, sex, and energy intake.

Model II: Adjusted for age, sex, energy intake, education, marital status, physical activity level, and smoking.

Model III: Additionally adjusted for education, marital status, physical activity level, and smoking, fat quality, carbohydrate quality and protein quality when they were not independent variable.

Table 4- Crude and multivariable-adjusted odds ratios and 95% CIs for anxiety, depression and quality of life across tertiles of CQI, FQI and PQI[1].

	Tertiles of CQI				Tertiles of FQI				Tertiles of PQI			
	T1 (n=707)	**T2 (n=686)**	**T3 (n=645)**	**P-trend**	**T1 (n=681)**	**T2 (n=681)**	**T3 (n=678)**	**P-trend**	**T1 (n=682)**	**T2 (n=678)**	**T3 (n=682)**	**P-trend[2]**
Depression												
Crude model	1	0.90 (0.70-1.17)	0.74 (0.57-0.98)	0.036	1	0.75 (0.58-0.98)	0.74 (0.56-0.97)	0.024	1	0.86 (0.67-1.12)	0.72 (0.55-0.95)	0.018
Model I	1	0.92 (0.70-1.20)	0.73 (0.55-0.98)	0.035	1	0.79 (0.60-1.03)	0.82 (0.62-1.08)	0.152	1	0.89 (0.68-1.17)	0.72 (0.54-0.96)	0.024
Model II	1	0.95 (0.73-1.25)	0.79 (0.59-1.06)	0.121	1	0.87 (0.66-1.14)	0.85 (0.64-1.12)	0.237	1	0.93 (0.71-1.22)	0.74 (0.56-0.99)	0.047
Model III	1	0.95 (0.72-1.24)	0.79 (0.59-1.05)	0.113	1	0.85 (0.64-1.13)	0.84 (0.63-1.11)	0.212	1	0.94 (0.71-1.24)	0.77 (0.56-1.04)	0.095
Anxiety												
Crude model	1	0.96 (0.75-1.25)	0.97 (0.75-1.26)	0.833	1	0.72 (0.55-0.93)	0.76 (0.59-0.99)	0.035	1	0.82 (0.63-1.07)	0.93 (0.72-1.20)	0.579
Model I	1	0.96 (0.74-1.25)	0.93 (0.71-1.22)	0.585	1	0.74 (0.56-0.96)	0.82 (0.63-1.08)	0.140	1	0.84 (0.64-1.10)	0.89 (0.68-1.16)	0.382
Model II	1	1.00 (0.77-1.31)	1.01 (0.76-1.33)	0.927	1	0.80 (0.61-1.05)	0.85 (0.65-1.11)	0.218	1	0.87 (0.66-1.14)	0.92 (0.70-1.21)	0.539
Model III	1	1.00 (0.76-1.31)	1.00 (0.76-1.32)	0.981	1	0.79 (0.60-1.03)	0.81 (0.61-1.07)	0.123	1	0.88 (0.67-1.16)	0.95 (0.71-1.28)	0.727
Quality of life												
Crude model	1	1.03 (0.83-1.29)	1.22 (0.97-1.52)	0.086	1	0.68 (0.55-0.85)	0.58 (0.47-0.73)	<0.0001	1	0.77 (0.62-0.96)	0.70 (0.57-0.88)	0.002

Model I	1	1.10 (0.87-1.40)	1.28 (1.01-1.63)	0.046	1	0.75 (0.59-0.95)	0.69 (0.55-0.88)	0.002	1	0.84 (0.66-1.06)	0.74 (0.58-0.94)	0.014
Model II	1	1.13 (0.89-1.44)	1.35 (1.06-1.72)	0.017	1	0.78 (0.62-0.99)	0.71 (0.55-0.90)	0.005	1	0.86 (0.68-1.09)	0.76 (0.59-0.97)	0.025
Model III	1	1.21 (0.88-1.43)	1.35 (1.06-1.73)	0.016	1	0.79 (0.63-1.01)	0.71 (0.55-0.91)	0.006	1	0.86 (0.68-1.10)	0.78 (0.60-1.01)	0.057

CQI: carbohydrate quality index; FQI: fat quality index; PQI: protein quality index.

[1] Derived from a Mantel-Haenszel extension chi-square test

Model I: Adjusted for age, sex, and energy intake.

Model II: Adjusted for age, sex, energy intake, education, marital status, physical activity level, and smoking.

Model III: Additionally adjusted for education, marital status, physical activity level, and smoking, fat quality, carbohydrate quality and protein quality when they were not independent variable.

Supplementary Table 1- Crude and multivariable-adjusted odds ratios and 95% CIs for anxiety and depression across tertiles of CQI, FQI and PQI[1] based on the cut-off point of 11 for HADS.

	Tertiles of CQI				Tertiles of FQI				Tertiles of PQI			
	T1 (n=707)	T2 (n=686)	T3 (n=645)	P-trend	T1 (n=681)	T2 (n=681)	T3 (n=678)	P-trend	T1 (n=682)	T2 (n=678)	T3 (n=682)	P-trend[2]
Depression												
Crude model	1	0.70 (0.48-1.04)	0.65 (0.43-0.97)	0.029	1	0.82 (0.56-1.21)	0.64 (0.42-0.96)	0.033	1	0.76 (0.52-1.11)	0.51 (0.34-0.78)	0.002
Model I	1	0.74 (0.49-1.09)	0.68 (0.55-1.03)	0.061	1	0.92 (0.62-1.36)	0.79 (0.52-1.21)	0.281	1	0.83 (0.56-1.22)	0.56 (0.36-0.87)	0.010
Model II	1	0.76 (0.51-1.14)	0.74 (0.48-1.14)	0.152	1	1.03 (0.69-1.55)	0.851 (0.53-1.25)	0.363	1	0.85 (0.57-1.26)	0.58 (0.37-0.90)	0.016
Model III	1	0.76 (0.50-1.13)	0.74 (0.48-1.14)	0.148	1	1.00 (0.67-1.51)	0.77 (0.50-1.20)	0.270	1	0.87 (0.58-1.29)	0.60 (0.38-0.96)	0.036
Anxiety												
Crude model	1	0.83 (0.58-1.19)	0.84 (0.58-1.21)	0.331	1	0.59 (0.41-0.85)	0.58 (0.40-0.83)	0.002	1	0.73 (0.51-1.06)	0.84 (0.59-1.20)	0.317
Model I	1	0.82 (0.57-1.18)	0.77 (0.83-1.13)	0.183	1	0.60 (0.41-0.86)	0.63 (0.43-0.92)	0.011	1	0.74 (0.51-1.09)	0.77 (0.53-1.12)	0.171
Model II	1	0.85 (0.58-1.23)	0.85 (0.57-1.25)	0.387	1	0.65 (0.44-0.95)	0.63 (0.43-0.92)	0.014	1	0.76 (0.52-1.12)	0.79 (0.53-1.15)	0.210
Model III	1	0.83 (0.57-1.21)	0.84 (0.57-1.24)	0.374	1	0.63 (0.43-0.92)	0.57 (0.38-0.84	0.004	1	0.80 (0.55-1.18)	0.88 (0.59-1.33)	0.529

CQI: carbohydrate quality index; FQI: fat quality index; PQI: protein quality index.

[1] Derived from a Mantel-Haenszel extension chi-square test

Model I: Adjusted for age, sex, and energy intake.

Model II: Adjusted for age, sex, energy intake, education, marital status, physical activity level, and smoking.

Model III: Additionally adjusted for education, marital status, physical activity level, and smoking, fat quality, carbohydrate quality and protein quality when they were not independent variable.