Association between vegetables and fruits consumption and depressive symptoms in a middle-aged Chinese population
An observational study
Hai-Ying Cheng, BAa, Yun-Xia Shi, BAa, Feng-Na Yu, BAa, Huan-Zong Zhao, BAa, Jian-Hua Zhang, MDa, Mei Song, BAa,e

Abstract
There is scarce evidence regarding the association between the consumption of vegetables and fruits and depressive symptoms in Chinese population. The purpose of this study was to ascertain the influence of vegetables and fruits consumption on depressive symptoms in a middle-aged Chinese population. This study comprised 1676 Chinese adults aged between 45 and 59 years, who participated in a Health Survey at the time of periodic checkup in the city of Linyi, Shandong Province, China. Dietary intake was assessed using a semi-quantitative food frequency questionnaire (FFQ). Depressive symptoms were assessed using the Center for Epidemiological Studies Depression (CES-D) scale. Log-binomial regression analysis was used to evaluate the association between the consumption of vegetables and fruits and depressive symptoms. A total of 53 participants (3.2%) were classified as having depressive symptoms. After adjustment for confounding variables, participants in the highest quartile of the fruits consumption and vegetables consumption had lower prevalence ratio (PR) for depressive symptoms (PR = 0.76; 95% confidence interval [CI]: 0.603–0.974, P = .042; PR = 0.77; 95% CI: 0.612–0.977, P = .045) than those in the lowest quartile. Moreover, those in the highest quartile of total vegetables and fruits consumption had also a lower PR of depressive symptoms (PR = 0.67; 95% CI: 0.503–0.806, P = .037) than did those in the lowest quartile. Our findings indicate that higher consumption of vegetables and fruits is significantly associated with a lower risk of depressive symptoms. Further prospective studies are needed to confirm these findings.

Abbreviations: ANOVA = analysis of variance, BMI = body mass index, CES-D = Center for Epidemiologic Studies Depression scale, CI = confidence interval, CVD = cardiovascular disease, FFQ = food frequency questionnaire, FPG = fasting plasma glucose, IPAQ = international physical activity questionnaire, OGTT = oral glucose tolerance test, OR = odds ratio, WHO = World Health Organization.

Keywords: depressive symptoms, diet, epidemiology, middle-aged Chinese population, vegetables and fruits

1. Introduction
Depression represents a major public health concern, affecting approximately 350 million people worldwide.1 According to the statistics from World Health Organization, it accounts for 4.3% of the global burden of disease and will be the second leading cause of disease burden by the year 2020.2,3 A previous observational study reported that the incidence of depression in elderly Chinese was from 4% to 26.5%, and it has become a substantial burden.4 It is well-known that depression is a multifactorial disease that may be associated with some factors, including environmental, genetic, physiological, and dietary factors.5

Among the dietary factors, fruits and vegetables consumption, which are rich in antioxidants and anti-inflammatory components, was hypothesized to play an important role in the development of depression.6,7 A considerable number of epidemiological studies in recent years have been conducted to investigate the associations between the consumption of fruits and vegetables and risk of depressive symptoms.8–10 However, findings from these studies have yielded controversial results. Some studies have shown an inverse association between fruits and vegetables intake and depressive symptoms,6,10 but other studies found no significant associations.7–9 To the best of our knowledge, only 2 studies have investigated the association between fruit and vegetables consumption and depressive symptoms in older Taiwanese.7,8 and 1 study reported the consumption of vegetables but number of fruits was associated with lower depressive symptoms in Chinese adults aged ≥65 years.9 Furthermore, no studies published data have
examined the association of vegetables and fruits consumption with depressive symptoms in a middle-aged Chinese population. We, therefore, conducted this study to clarify the association between the consumption of vegetables and fruits and the risk of depressive symptoms in a middle-aged Chinese population, using the data from Linyi Nutrition and Health Survey.

2. Subjects and methods

2.1. Study population

The present study was performed in the city of Linyi, Shandong Province, China from May 2016 to June 2017, as reported previously.[11] Shandong province is located in the East coast of China with a population of 99 million, and Linyi is a prefecture-level city of Shandong, with approximately 10.43 million inhabitants. The study sample was taken from 3 areas (Lanshan, Luozhuang, and Hedong) and 9 countries (Junan, Qishui, Tancheng, Pinyi, Lanling, Mengyin, Linshu, Feixian, and Yinan) by a stratified cluster random-sampling method. A total of 1865 participants (835 men and 1030 women), aged between 45 and 59 years, were recruited when attending their health examinations at the Medical Center for Physical Examination, Linyi People’s Hospital, where the study participants were face-to-face interviewed by well-trained dieticians using written questionnaire. We excluded 84 participants with the missing or incomplete information on fruits and vegetables consumption in their questionnaires, 13 participants with a total energy intake of >3000kcal/d, and 92 participants with missing information for any of the variables used in the main analysis. Ultimately, a total of 1676 participants (786 men and 890 women) were included for the analysis of the association between the consumption of vegetables and fruits and depressive symptoms. Written informed consent was provided from all participants, and the study protocol was approved by the Institutional Review and Ethics Committee of Linyi People’s Hospital, and was performed in accordance with the principles described in the Declaration of Helsinki, reference DC 2016/067 in September 2016.

2.2. Assessment of fruits and vegetables intake

Diet was evaluated by well-trained dieticians using a semi-quantitative food frequency questionnaire (FFQ). For fruits and vegetables intake, participants were asked to recall their average frequency of consumption over the past 12 months and the estimated portion size, using local weight units (1 Liang = 50 g). Besides, the frequency of each food item was classified as follows: never or occasionally, 1 to 3 times/mo, 1 to 2 times/wk, 3 to 4 times/wk, 5 to 6 times/wk, 1 time/d, 2 times/d, and 3 times/d. Then, the selected frequency category for each food item was converted to g/d and used in the further analysis.

2.3. Assessment of other variables

Information on the level of physical activity was obtained by using a self-reported questionnaire and expressed as metabolic equivalents in hours per week (MET-h/wk). Detail data have been described elsewhere.[12] Moreover, information on smoking status was collected and categorized into never, former, and current smokers. The education level was classified as follows: primary school or below (<high school), middle and high school (high school), college or above (>high school). Total energy intake was estimated through the semi-quantitative FFQ, expressed in kilocalorie per day (kcal/d).

2.4. Definition of terms

The Center for Epidemiologic Studies Depression scale (CES-D) is a short self-report scale designed to measure depressive symptoms in the general population. Participants were asked to score the frequency of occurrence of specific symptoms over the last week on a 4-point scale (0, “less than 1 day”; 1, “1–2 days”; 2, “3–4 days”; and 3, “5–7 days”). Depressive symptoms were defined as a CES-D scale score ≥16.[13] Hypertension was defined as a systolic pressure of 140mmHg or higher and/or a diastolic pressure of 90mmHg or higher.[14] Diabetes was defined by fasting plasma glucose (FPG) ≥7.0mmol/L or at least 2 separate occasions, or an oral glucose tolerance test (OGTT) with a value ≥11.1mmol/L, and/or use of hypoglycaemic medication (e.g., insulin or oral hypoglycaemic drug).[15] History of cardiovascular disease (CVD) was defined as previous ischemic heart disease and/or cerebrovascular accidents. Family history of premature CVD was defined as any prior diagnosis of CVD in first-degree female relatives, aged <65 years, or first-degree male relatives aged <55 years.[16]

2.5. Statistical analyses

All statistical analyses were performed with the SPSS statistical software, version 23.0 (SPSS Inc, Chicago, IL). Data were checked for normality using histograms and logarithmic transformation was applied whenever appropriate. The data for continuous variables were generally reported as the mean ± SD, and the data for categorical variables were reported as sum (percentages). The chi-square test was used to assess the difference for categorical variables, while the analysis of variance (ANOVA) was used to describe mean differences for continuous variables. After adjustment for confounding variables, log-binomial regression analysis was carried out to identify the association between the consumption of fruits and vegetables and the risk of depressive symptom. In our analyses, Model 1 was unadjusted. Model 2 was adjusted for sex (male/female), age (years), smoking status (never, former, and current), education level (<high school, high school, >high school), economic income (continuous), body mass index (BMI) (continuous), physical activity level (MET-h/wk), total energy intake (kcal/d). Model 3 was further adjusted for self-reported history of diabetes (yes/no), hypertension (yes/no), CVD (yes/no), and self-reported history of depression (yes/no). Two-tailed P-values <.05 were considered as statistically significant.

3. Results

The characteristics of the study participants according to depressive symptoms are shown in Table 1. In this population, the overall prevalence of depressive symptoms was 3.2%, with men was 1.8% and women was 4.4%. Age (54.7±7.60 vs 52.1±5.80, P<.001) and the proportion of women (73.6% vs 52.4%, P= .002) were significantly higher in participants with depressive symptoms than in those without depressive symptoms. Participants without depressive symptoms had significantly higher energy intake (1810.5±295.2 vs 1609.3±256.0, P<.001) and...
### Table 1
Characteristics of the study participants according to depressive symptoms.

| Variables                      | Yes | No  | Significance |
|-------------------------------|-----|-----|--------------|
| Number of participants        | 53  | 1623|              |
| Age, y                        | 54.7±7.60 | 52.1±5.80 | *P* < .001 |
| BMI, kg/m²                    | 23.06±2.91 | 23.75±2.80 | 0.098 |
| Energy intake, kcal           | 1609.3±256.0 | 1810.5±205.2 | *P* < .001 |
| Gender                        | 9.220|     |              |
| Male                          | 14 (26.4) | 772 (47.6) |
| Female                        | 39 (73.6) | 851 (52.4) |
| Smoking status (%)            | 5.450|     | *P* = .057  |
| Never smoker                  | 37 (69.8) | 1318 (81.2) |
| Former smoker                 | 11 (20.8) | 237 (14.6) |
| Current smoker                | 5 (9.4) | 68 (4.2) |
| Education (%)                 | 16.394|     | *P* < .001  |
| <High school                  | 31 (58.5) | 519 (32.0) |
| High school                   | 12 (22.6) | 628 (38.7) |
| >High school                  | 10 (18.9) | 476 (29.3) |
| Monthly income per person (%) | 0.354|     | *P* = .838  |
| ≤3000 (RMB)                   | 15 (28.3) | 419 (25.8) |
| 3000–5000 (RMB)               | 26 (49.1) | 782 (48.2) |
| >5000 (RMB)                   | 12 (22.6) | 422 (26.3) |
| Diabetes (%)                  | 23.7 |     |              |
| Hypertension (%)              | 12 (22.6) | 331 (20.4) |
| CVD (%)                       | 5 (9.4) | 188 (11.6) |
| Categorical variables are presented as sum and percentages, and continuous variables are presented as mean±SD. BMI=body mass index, CVD=cardiovascular disease. *P* values for continuous variables (analysis of variance) and for categorical variables (chi-square test). *P* < .05 was considered statistically significant.

### Table 2
Characteristics of the study participants according to quartiles of total fruits and vegetables intake.

| Quartiles of total fruits and vegetables consumption | Q1 (n=419) | Q2 (n=419) | Q3 (n=419) | Q4 (n=419) | P-trend |
|-----------------------------------------------------|------------|------------|------------|------------|---------|
| g/d (median)                                        | 32.3       | 34.8       | 40.2       | 447.6      | .032    |
| Age, y                                               | 49.5±6.3   | 51.8±6.1   | 50.5±5.9   | 54.8±6.7   |         |
| Gender (%)                                           | 316.2      | 316.2      |            |            | <.001   |
| Male                                                 | 243 (58.0) | 213 (50.8) | 195 (46.5) | 169 (40.3) |
| Female                                               | 176 (42.0) | 206 (49.2) | 224 (53.5) | 250 (59.7) |
| BMI, kg/m²                                           | 26.34±5.31 | 25.47±4.56 | 25.74±4.91 | 24.52±4.01 | .011    |
| Education (%)                                        | 181.8      | 181.8      |            |            | <.001   |
| <High school                                         | 89 (21.2)  | 92 (22.0)  | 123 (29.4) | 92 (21.9)  |
| High school                                          | 180 (43.0) | 159 (37.9) | 134 (32.0) | 139 (33.2) |
| >High school                                         | 150 (35.8) | 168 (40.1) | 162 (38.6) | 188 (44.9) |
| Carbohydrate intake, g                               | 219.3±46.1 | 240.2±45.4 | 245.9±49.7 | 261.9±56.4 | <.001   |
| Protein intake, g                                    | 56.8±9.0   | 57.7±10.2  | 58.0±10.5  | 60.5±11.4  | .038    |
| Fat intake, g                                        | 52.7±12.9  | 48.4±11.3  | 50.2±16.5  | 48.6±13.3  | .008    |
| Total fiber intake, g                                | 39.6±16.3  | 42.6±15.7  | 40.4±16.7  | 45.8±18.4  | <.001   |
| Energy intake, kcal/d                                | 1598.6±280.2 | 1614.5±287.0 | 1671.3±305.8 | 1802.4±349.5 | <.001   |
| Physical activity, MET/h/wk                          | 490.8±272.7 | 478.1±205.5 | 500.3±283.7 | 516.7±337.4 | .315    |
| Hypertension (%)                                     | 77 (18.3)  | 71 (16.9)  | 72 (17.1)  | 56 (13.4)  | <.001   |
| Diabetes (%)                                         | 34 (8.1)   | 32 (7.6)   | 27 (6.4)   | 22 (5.3)   | <.001   |
| CVD (%)                                              | 39 (9.3)   | 38 (9.1)   | 35 (8.4)   | 25 (6.0)   | <.001   |

Categorical variables are presented as sum and percentages, and continuous variables are presented as mean±SD. BMI=body mass index, CVD=cardiovascular disease. *P* values for continuous variables (analysis of variance) and for categorical variables (chi-square test). *P* < .05 was considered statistically significant.

In the present study, our findings demonstrated that higher consumption of vegetables and fruits was significantly associated with a decreased risk of depressive symptoms after controlling for potential confounders. Limited epidemiological studies have reported the association of vegetables and fruits consumption with depressive symptoms in Chinese population. To the authors’ knowledge, this is the first study in China investigating the

education level (29.3% vs 18.9%, *P* < .001) than those with depressive symptoms.

The characteristics of the study participants according to quartiles of total fruits and vegetables intake are shown in Table 2. Compared with participants in the lowest quartile, those in the highest quartile of total fruits and vegetables intake were more likely to be older (*P* = .032), women (*P* < .001), and had lower prevalence of hypertension (*P* < .001), diabetes (*P* < .001) and CVD (*P* < .001), lower BMI (*P* = .011) and fat intake (*P* = .008), and higher education level (*P* < .001), carbohydrate (*P* < .001) and protein intake (*P* = .038), total fiber intake (*P* < .001) and energy intake (*P* < .001). Besides, there was no significant difference in the physical activity (*P* = .315).

The relations between consumption of vegetables and fruits and the risk of depressive symptoms using log-binomial regression were presented in Table 3. After adjustment for confounding variables, participants in the highest quartile of the fruits consumption and vegetables consumption had lower PR for depressive symptoms (PR = 0.76; 95% CI: 0.603–0.974, *P* = .042; PR = 0.77; 95% CI: 0.612–0.977, *P* = .045) than those in the lowest quartile. Moreover, those in the highest quartile of total vegetables and fruits consumption had also a lower PR for depressive symptoms (PR = 0.67; 95% CI: 0.503–0.806, *P* = .037) than did those in the lowest quartile.

### 4. Discussion

In the present study, our findings demonstrated that higher consumption of vegetables and fruits was significantly associated with a decreased risk of depressive symptoms after controlling for potential confounders. Limited epidemiological studies have reported the association of vegetables and fruits consumption with depressive symptoms in Chinese population. To the authors’ knowledge, this is the first study in China investigating the...
association between the consumption of vegetables and fruits and the risk of depressive symptoms in a middle-aged population.

In our analyses, higher intake of vegetables and fruits was significantly associated with a decreased risk of depressive symptoms. Our findings are line with results from a previous study, showing an inverse relationship between consumption of fruits and/or vegetables and depressive symptoms.[17] Similarly, recent a meta-analysis conducted by Liu et al[18] also reported that consumption of vegetables and fruits are inversely related to the risk of depression. There are several possible explanations for the inverse association between the consumption of vegetables and fruits and depressive symptoms. First, the apparently protective effect of vegetables and fruits against depressive symptoms might be related to their high content of antioxidant substances, that is, vitamin C, vitamin E, and other carotenoids compounds. It is well-known that vitamin E and C, having antioxidant properties, can reduce the oxidative stress, which is thought to contribute to the incidence of depression.[19] Besides, antioxidants such as carotenoids, vitamin C, and vitamin E, which play a key role in the endothelial cell signaling cascades, could dampen the detrimental effects of oxidative stress on mental health.[20,21] Second, green vegetables contain a variety of folate and magnesium, which are important in the prevention of depression.[22,23] Chi et al[27] reported that folate is involved in the metabolism of monoamines such as serotonin in the brain. Studies also found that magnesium consumption could decrease the level of C-reactive protein, which is a marker of low-grade inflammation.[23] Third, higher intakes of vegetables and fruits can increase the amount of dietary fiber. Previous studies have found that high intake of dietary fiber may influence gut microbiota, which might also be associated with better mental and cognitive health.[24,25] Finally, most of the mentioned nutrients in vegetables and fruits may reduce inflammation, thereby reducing the risk of depression.[16,27]

4.1. Strengths and limitations

This study has some strengths and limitations. First, to the best of our knowledge, this is the first study reporting the topic of vegetables and fruits consumption and risk of depressive symptom in a middle-aged Chinese population. Second, information on the consumption of vegetables and fruits was collected by trained dieticians using a semi-quantitative FFQ. This FFQ enabled us to capture more reliable information on vegetables and fruits consumption of individuals in the last year. Third, we also have controlled for several potential known confounding factors for reliability in our analyses. However, there are also several potential limitations to this study. First, given the cross-sectional nature of this study, it could evaluate the only association and not causality. Thus, further studies are needed to confirm our findings. Second, the use of an FFQ to measure the consumption of vegetables and fruits may introduce some degree of measurement error. Third, although some confounding factors have been adjusted for in the multivariable adjusted model, we cannot eliminate the potential effect of other unmeasured factors, such as cultural factors. Fourth, in this study, we observed a significant association between higher intake of vegetables and fruits and depressive symptoms. But, the directionality of the associations was uncertain. Because participants with major depressive disease care less of their self, they may change their dietary habits and food choices, either eating less healthier food or having lower energy intake.[28]

Finally, the study participants were recruited in the city of Linyi and not a random sample of the general population. Therefore, our results could not be generalizable to other populations.

5. Conclusions

In conclusion, we found that higher consumption of vegetables and fruits was significantly associated with a lower risk of depressive symptoms. Our findings reinforce the importance of diet in the progression of depressive symptoms, and also provide further evidence for the hypothesis that higher intake of vegetables and fruits was protectively associated with depressive symptoms. However, further prospective studies are urgently required to clarify whether a true causal association exists between consumption of vegetables and fruits and risk of depressive symptoms.

Acknowledgments

The authors thank all participants from the Department of Burns and Orthopedics, Linyi People’s Hospital for their assistance and support. We also acknowledge the Medical Center for Physical Examination, Linyi People’s Hospital for their important contributions to collection of data in the present study.

Author contributions

The authors’ contributions are as follow: Mei Song conceived and developed the idea for the paper and revised the manuscript; Hai-Ying Cheng contributed to data collection and wrote draft; Yun-Xia Shi and Feng-Na Yu contributed to data analysis and interpretation of the data. Huan-Zong Zhao and Jian-Hua Zhang conducted research. All authors read and approved the final manuscript.

Conceptualization: Huan-Zong Zhao, Mei Song.
Data curation: Yun-Xia Shi, Feng-Na Yu, Jian-Hua Zhang.
Formal analysis: Yun-Xia Shi, Feng-Na Yu.  
Investigation: Jian-Hua Zhang.  
Methodology: Huan-Zong Zhao.  
Supervision: Huan-Zong Zhao.  
Writing – original draft: Hai-Ying Cheng.  
Writing – review & editing: Mei Song.  

References
[1] Vermeulen E, Stronks K, Visser M, et al. The association between dietary patterns derived by reduced rank regression and depressive symptoms over time: the Invecchiare in Chianti (InCHIANTI) study. Br J Nutr 2016;115:2145–53.  
[2] World Health Organization. Mental health action plan: 2013-2020. Available at: http://apps.who.int/iris/bitstream/10665/89966/1/9789241506021_eng.pdf?ua=1. Accessed June 3, 2013.  
[3] Lin PY, Huang SY, Su KP. A meta-analytic review of polyunsaturated fatty acid compositions in patients with depression. Biol Psychiatry 2010;68:140–7.  
[4] Gao S, Jin Y, Unverzagt FW, et al. Correlates of depressive symptoms in an elderly Chinese population. Int J Geriatr Psychiatry 2006;21:1036–43.  
[5] Palazidou E. The neurobiology of depression. Br Med Bull 2012;101:127–45.  
[6] Mihrshahi S, Dobson AJ, Mishra GD. Fruit and vegetable consumption prevalence and incidence of depressive symptoms in mid-age women: results from the Australian longitudinal study on women’s health. Eur J Clin Nutr 2013;67:585–91.  
[7] Chi SH, Wang JY, Tsai AC. Combined association of leisure-time physical activity and fruit and vegetable consumption with depressive symptoms in older Taiwanese: results of a national cohort study. Geriatr Gerontol Int 2016;16:244–51.  
[8] Tsai AC, Chang TL, Chou SH. Frequent consumption of vegetables predicts lower risk of depression in older Taiwanese - results of a prospective population-based study. Public Health Nutr 2012;15:1087–92.  
[9] Woo J, Lynn H, Lau WY, et al. Nutrient intake and psychological health in an elderly Chinese population. Int J Geriatr Psychiatry 2006;21:1036–43.  
[10] Gangwisch JE, Hale I, 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;102:454–63.  
[11] Yu FN, Hu NQ, Huang XL, et al. Dietary patterns derived by factor analysis are associated with cognitive function among a middle-aged and elderly Chinese population. Psychiatry Res 2018;269:640–5.  
[12] Wang CJ, Yang TF, Wang GS, et al. Association between dietary patterns and depressive symptoms among middle-aged adults in China in 2016-2017. Psychiatry Res 2017;260:123–9.  
[13] Radloff L. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1977;1:385–401.  
[14] Zhang J, Zhang K, Shi H, et al. A cross-sectional study to evaluate the associations between hypertension and osteoporosis in Chinese postmenopausal women. Int J Clin Exp Med 2015;8:21194–200.  
[15] Villegas R, Yang G, Gao YT, et al. Dietary patterns are associated with lower incidence of type 2 diabetes in middle-aged women: the Shanghai Women’s Health Study. Int J Epidemiol 2010;39:889–99.  
[16] Mirmiran P, Bahadoran Z, Vakili AZ, et al. Western dietary pattern increases risk of cardiovascular disease in Iranian adults: a prospective population-based study. Appl Physiol Nutr Metab 2017;42:326–32.  
[17] Wolnitzek I, Gáceres-DelAgua JA, Maguña JL, et al. Fruits and vegetables consumption and depressive symptoms: a population-based study in Peru. PLoS One 2017;12:e0186379.  
[18] Liu X, Yan Y, Li F, et al. Fruit and vegetable consumption and the risk of depression: a meta-analysis. Nutrition 2016;32:296–302.  
[19] Baharzadeh E, Siaffi F, Qorbani M, et al. Fruits and vegetables intake and its subgroups are related to depression: a cross-sectional study from a developing country. Ann Gen Psychiatry 2018;17:46.  
[20] Khanzode SD, Dakhale GN, Khanzode SS, et al. Oxidative damage and major depression: the potential antioxidant action of selective serotonin re-uptake inhibitors. Redox Rep 2003;8:365–70.  
[21] Maes M, De Vos N, Pirol R, et al. Lower serum vitamin E concentrations in major depression. Another marker of lowered antioxidant defenses in that illness. J Affect Disord 2000;58:241–6.  
[22] Skarupski KA, Tangney C, Li H, et al. Longitudinal association of vitamin B-6, folate, and vitamin B-12 with depressive symptoms among older adults over time. Am J Clin Nutr 2010;92:330–5.  
[23] McMartin SE, Jacka FN, Colman I. The association between fruit and vegetable consumption and mental health disorders: evidence from five waves of a national survey of Canadians. Prev Med 2013;56:235–30.  
[24] Miki T, Eguchi M, Kurotani K, et al. Dietary fiber intake and depressive symptoms in Japanese employees: the Furukawa Nutrition and Health Study. Nutrition 2016;32:584–9.  
[25] Calvani R, Picca A, Lo Monaco MR, et al. Of microbes and minds: a narrative review on the second brain aging. Front Med (Lausanne) 2016;3:91.  
[26] Rooney C, McKinley MC, Woodside JV. The potential role of fruit and vegetables in aspects of psychological well-being: a review of the literature and future directions. Pro Nutr Soc 2013;72:420–32.  
[27] Black CN, Bot M, Scheffer PG, et al. Is depression associated with increased oxidative stress? A systematic review and meta-analysis. Psychoneuroendocrinology 2015;51:164–75.  
[28] Lai JS, Hiles S, Bisquera A, et al. A systematic review and meta-analysis of dietary patterns and depression in community dwelling adults. Am J Clin Nutr 2014;99:181–97.