HHS Public Access

Author manuscript

Health Psychol. Author manuscript; available in PMC 2019 November 01.

Published in final edited form as:

Health Psychol. 2018 November ; 37(11): 1059–1066. doi:10.1037/hea0000646.

Association between Fruit and Vegetable Intake and Symptoms of Mental Health Conditions in Mexican-Americans

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Abstract

Objective: No studies have shown the effect of fruit and vegetable intake on mental disorders in Mexican-Americans for whom mental illness is an important health issue. This study measured the association of fruit and vegetable intake with the symptoms of cognitive impairment, the indication of increased risk of dementia, anxiety and depression in Mexican-Americans.

Methods: Participants were drawn from the Cameron County Hispanic Cohort (n=3,943), a randomly selected Mexican-American cohort in Texas on the US-Mexico border. Consumption of fruit and vegetable and symptoms of four mental disorders were assessed using reliable and validated instruments.

Results: Among 2,702 participants (mean age: 50 years; male: 34%) with available data, 213 had cognitive impairment, 61 had the indication of increased risk of dementia, 626 had depression, 196 had anxiety, and 787 (29.13%) had mental disorders (any symptoms of the above four disorders). Participants who met recommendations of 5 or more servings of fruits and vegetables per day were less likely to have anxiety (odds ratio [OR]=0.22; 95% CI: 0.08–0.65), cognitive impairment (OR=0.16; 95% CI: 0.05–0.46), and indication of increased risk of dementia (OR=0.16; 95% CI: 0.03–0.86), compared with those who did not meet recommendations, after adjusting for covariates. Every portion increment of total fruit and vegetable intake was significantly associated with the reduced odds of mental disorders by 11% and the odds of cognitive impairment by 32% with the adjustment of other covariates. No significant associations were found between fruit and vegetable intake and depression.

Conclusions: Fruit and vegetable intake was inversely associated with symptoms of cognitive impairment, the indication of increased risk of dementia, and anxiety in Mexican-Americans. Improving consumption of fruit and vegetable may be a convenient target for the mental disorder symptoms prevention and control among Mexican-Americans independent of other factors.

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Keywords

Fruit; vegetable; cognitive impairment; dementia; anxiety; depression; Mexican-Americans

INTRODUCTION

Dietary patterns characterized by a high intake of fruit and vegetable are associated with a lower risk of developing cardiovascular disease, hypertension (Wu et al., 2016), diabetes (Wang et al., 2016), and cancers (Ben et al., 2015; Fang et al., 2015). An intervention study showed that a healthy diet and active lifestyle including a vegan diet, fruit and vegetable juicing, nutritional supplements, regular exercise, and destressing techniques over 3 months may provide considerable benefits for participants with anxiety, depression, dementia or Alzheimer's disease (Null et al., 2017), although the intervention neither exclusively focused on diet nor excluded the effect of other interventions. A cross-sectional study of 296,121 Canadians reported that fruit and vegetable intake was significantly associated with lower odds of depression (odds ratio [OR]: 0.72; 95% CI: 0.71–0.75) for all five survey cycles between 2000 until 2009, and anxiety disorder during each survey cycle (all Ps < 0.05) (McMartin et al., 2013). One systematic review of 5 cohort studies showed that increased intake of vegetables is associated with a lower risk of dementia and slower rates of cognitive decline in older age (Loef et al., 2012), and another review also reported that chronic consumption of fruits, vegetables, and juices is beneficial for cognition in healthy older adults (Lamport et al., 2014). However, the authors for both articles only provided a review but did not conduct meta-analyses to quantitatively generate the pooled associations. Thus their reviews may not reflect the combined effects, especially as they did not specify the effect in different races/ethnicities. On the other hand, race/ethnicity may affect the association of fruit and vegetable consumption with depression and anxiety (Ellis et al., 2015). The prevalence of major mental health problems was different between Hispanic population and non-Hispanic white people, such as the prevalence of depression: 7.7% −15.2% in Mexicans versus 16–18% in US-born non-Hispanic white people (Alarcon et al., 2016; Aguilar-Gaxiola, 2008). The National Health and Nutrition Examination Survey showed that Mexican-Americans had less consumption of vegetables and fruits than non-Hispanic whites (1.26 vs.1.35 average total fruit and vegetable servings/day) (Rehm et al., 2016). However, no studies have shown the effect of fruit and vegetable intake on mental disorders in Mexican-Americans. The hypothesis of this study is that fruit and vegetable intake may be inversely associated with the symptoms of cognitive impairment, the indication of increased risk of dementia, anxiety, and depression in a randomly selected cohort of Mexican-American participants.

METHODS

Study Participants

This study was approved by the Committee for the Protection of Human Subjects of the UT Health, Houston and the Institutional Review Board of the University of the Texas Health Science Center, San Antonio. All study participants gave written informed consent. This cross-sectional analysis used data from the Cameron County Hispanic Cohort (CCHC), an

ongoing homogenous community-dwelling Mexican-American cohort study (Fisher-Hoch et al., 2010; Fisher-Hoch et al., 2012). Study participants were recruited from randomly selected tract/blocks according to the 2000 Census as described previously (Fisher-Hoch et al., 2010; Fisher-Hoch et al., 2012). At the baseline survey conducted between 2003 and 2016, 3,943 participants aged 18 years or older were recruited from their households in three predominantly Mexican-American cities along the Rio Grande Border with Mexico. All participants recruited between 2003 and 2012 were from Brownsville, TX.

All participants responded to a detailed baseline survey of demographic characteristics, lifestyle including diet, physical activity, family and medical history, and other exposures. Participants who had ever smoked at least 100 cigarettes in their entire life were defined as smokers. Participants who reported consuming alcohol were defined as drinkers. Participants were asked to fast for at least 10 hours overnight before a clinic visit at the Clinical Research Unit. Anthropometric measurements, including current weight and height, were also taken (Fisher-Hoch et al., 2010; Fisher-Hoch et al., 2012). Body mass index (BMI) was calculated as weight in kilograms divided by height squared in meters (kg/m^2) (Fisher-Hoch et al., 2010). Waist circumference (WC) was measured at the level of the umbilicus and hip circumference (HC) at the level of the maximum width of the buttocks with participants in a standing position and breathing normally, to the nearest 0.2 cm. Waist-to-Hip (WHR) ratio was calculated as waist circumference divided by hip circumference. The average of 3 blood pressures (BP) taken 5 minutes apart was used. Physical activity in a typical week according to intensity, frequency (times / week) and duration (minutes / time) was assessed using the International Physical Activity Questionnaire short-form (IPAQ)(Craig et al., 2003) in the early years of the cohort or the Godin Leisure-Time Exercise Questionnaire instruments (Gofin et al., 2015) in the later years of the cohort as reported previously (Reininger et al., 2015a). The metabolic equivalent adjusted minutes (MET adjusted minutes) of moderate and vigorous physical activity in the last week was calculated based on responses (USDHHS, 2008). The MET intensity of physical activity was classified as light intensity (< 3 METs), moderate intensity (3–6 METs), and vigorous intensity (>6 METs). Physical activity ≥ 600 MET adjusted minutes was considered meeting United States physical activity guidelines (USDHHS, 2008).

Mental Health Symptoms Examinations

In this study, mental health conditions/disorders referred to the symptoms of mental health conditions/disorders. Depression symptoms were assessed by the Centers for Epidemiologic Studies Scale in English or Spanish (Radloff, 1977). Total score of 16 or higher is considered a higher risk for depression. Anxiety was measured by the Zung's self-Rating Anxiety Scale and the anxiety scale score of less than 45 is considered within the normal range (Zung, 1971). Symptoms of cognitive function and the indication of increased risk of dementia were measured by the Mini Mental State Exam (MMSE) (Crum et al., 1993; Folstein et al., 1975). The MMSE scores less than 21 indicated increased odds of dementia and greater than 25 indicated decreased odds of dementia (Crum et al., 1993; Folstein et al., 1975). No participants in this analysis had MMSE scores ranged between 21 and 25. The MMSE scores within the range of 24–30 are interpreted as no cognitive impairment, 18–23

indicates mild cognitive impairment and 0–17 is considered severe cognitive impairment (Crum et al., 1993; Folstein et al., 1975).

Fruit and Vegetable Intake

Using the validated Two-item Dietary Questionnaire (Cappuccio et al., 2003; Reininger et al., 2015b), fruit and vegetable consumption was assessed by asking participants how many portions of fruit and vegetable they ate daily. A portion size was generally considered a 1/2 cup of fresh, frozen, or canned produce or a medium sized piece of produce (Reininger et al., 2015a). Consumption of five or more fruit and vegetable portions a day was considered meeting American Heart Association dietary guidelines (Krauss et al., 2000).

Laboratory Measurements

All participants provided a blood sample at baseline. After collection, samples were placed on ice and centrifuged within 30 minutes of collection. Following processing and aliquoting, all samples were stored at −80°C until laboratory analyses were conducted. Fasting lipid panel and fasting plasma glucose were performed by a local CLIA certified laboratory.

Definition of the Metabolic Health

Given the close positive relationship between metabolic health and mental disorders (Olvera et al., 2015; Kendzor et al., 2014) in our cohort, and other studies (Vancampfort et al., 2015), metabolic health was considered as a covariate in the analysis as an important factor. Metabolic health was defined as having ≥ 3 of the following metabolic abnormalities: WC ≥ 102 cm in men or ≥ 88 cm in women; systolic BP (SBP) ≥ 130 mmHg and/or diastolic BP (DBP) ≥ 85 mmHg or on antihypertensive medication; triglyceride ≥ 150 mg/dL; high-density lipoprotein cholesterol < 40 mg/dL in men or < 50 mg/dL in women; fasting glucose ≥ 100 mg/dL or on diabetes medication (Grundy et al., 2005; Wildman et al., 2008).

Statistical Analysis

Descriptive results and the models reported in this paper were adjusted for the probability sampling weights also taking into consideration clustering effects arising from the census block and household (Fisher-Hoch et al., 2010). Mental disorders include depression, anxiety, the indication of increased risk of dementia, and cognitive impairment in the analysis. Survey-weighted linear regression was used to obtain the t-test statistics to make comparisons for continuous data. Survey-weighted chi-square test was used to obtain the Rao-Scott F adjusted chi-square statistic to make comparisons for categorical data. Survey-weighted logistic regression modeling was performed to estimate the ORs for symptoms of mental disorders, anxiety, cognitive impairment, the indication of increased risk of dementia, or depression and their 95% CIs meeting recommendations of ≥ 5 servings of fruit and vegetables per day after adjusting for other covariates, respectively. The similar logistic regression modeling was also used to estimate the effect (ORs and their 95% CIs) of total portions of fruit and vegetable intake per day on the symptoms of above disorders. Analyses were adjusted for factors that could potentially confound the relationship between fruit and vegetable consumption and the symptoms of mental disorders based on the findings from our cohort (Olvera et al., 2015; Kendzor et al., 2014; Wilkinson et al., 2014) and other

studies (Jiang et al., 2017). Potential confounders in multivariable-adjusted survey-weighted logistic regression models included age, gender, BMI, cigarette smoking status, meeting physical activity guideline, metabolic health, per capita income and language used in the interview, and other mental disorders. The possible interaction terms such as income with fruit and vegetable intake, the language of the interview with fruit and vegetable intake, and other possible terms were also included in the model. Survey-weighted linear regression modeling was performed to estimate the regression coefficients for the logarithmical transformed continuous scores to measure the symptoms of anxiety, cognitive impairment, or depression and their standard errors for meeting recommendations of ≥ 5 servings of fruit and vegetables per day/total portions of fruit and vegetable intake per day after adjusting for other covariates, respectively. Log-transformation was conducted to normalize the distribution of the scores studied as appropriate.

Statistical analyses were carried out by using SAS version 9.3 (SAS Institute, Cary, NC). All statistical tests were based on 2-sided probability.

RESULTS

At the time of this study, a total of 3,943 individuals were enrolled in the CCHC, 3,220 from Brownsville, 396 participants from Harlingen and 327 participants from Laredo, Texas. Based on the availability of the data, 1,241 participants without data on mental disorders/ fruit and vegetable intake were excluded from the analyses. Of the remaining 2,702 participants, the mean age of this subset was 47.8 (standard error: 1.2) years; mean per capita annual income was 7,652 (1.1) US dollars; 34% were male. A total of 5.7% (n=153) of the participants met the minimum recommendation for ≥ 5 servings of fruit and vegetable. The percentage of participants eating 0, 1, 2, 3, and 4 portions of fruit and vegetables daily were 12.1%, 5.7%, 24%, 11.0% and 4.8%, respectively.

Seven hundred and eighty-seven participants of the cohort (29.13%) were found to have symptoms of cognitive impairment, the indication of increased risk of dementia, anxiety or depression, and 1,915 did not report any symptoms of mental disorders (Table 1). Among 787 participants with symptoms of mental disorders, 213 had cognitive impairment, 61 had the indication of increased risk of dementia, 626 had depression, and 196 had anxiety. The detailed frequency for participants with different symptoms of mental disorders or with two or more symptoms is shown in Table 2. Participants with mental disorders were more likely to be older, and less likely to meet the recommended guidelines for physical activity of more than 600 MET adjusted minutes per week or consume fruit and vegetables, although these associations were not statistically significant. Participants with mental disorders were less likely to be metabolically healthy ($P = 0.04$). Per capita annual household income in the participants with mental disorders was not significantly lower than those without mental disorders ($P = 0.05$). There was no statistically significant difference in gender, employment status, ever cigarette smoking status, ever alcohol drinking status, education, language used in the interview, BMI, and WHR between participants with and without mental disorders.

Participants who met recommendations of 5 or more servings of fruit and vegetable per day had a 58% decreased odds of symptoms of mental disorders (OR=0.42; 95% CI: 0.18–0.97)

after adjusting for age and gender compared with those who did not meet recommendations (Table 3). Multivariable-adjusted model showed that the inverse association between meeting fruit and vegetable intake recommendations and symptoms of mental disorders was borderline significant (OR=0.46; 95% CI: 0.20–1.03) after further adjusting for smoking, BMI, meeting physical activity guideline, metabolic health, per capita income and census tracts and blocks. Total portions of fruit and vegetable intake a day were significantly associated with a reduced odds of mental disorders after adjusting for age and gender; when daily total intake of fruit and vegetable increased 1 portion, the odds of mental disorders decreased 13% (OR=0.87; 95% CI: 0.77–0.99). The association did not materially change in the multivariable-adjusted model (OR=0.89; 95% CI: 0.79–0.99).

Compared to participants who did not meet recommendations of 5 or more servings of fruit and vegetable per day, participants who met recommendations had a 72% (OR=0.28; 95% CI: 0.11–0.68) decreased odds of anxiety after adjusting for age and gender (Table 3). Multivariable-adjusted model showed a 78% decreased odds of participants who met recommendations (OR=0.22; 95% CI: 0.08–0.65). Total portions of fruit and vegetable intake a day did not significantly reduce the odds of anxiety after adjusting for age and gender (OR=0.85; 95% CI: 0.71–1.01). The association did not change much in the multivariable-adjusted model (OR=0.89; 95% CI: 0.75–1.05). The multivariable-adjusted associations did not materially alter after further adjusting for depression.

Participants who met recommendations of 5 or more servings of fruit and vegetable per day had an 85% decreased odds of cognitive impairment (OR=0.15; 95% CI: 0.05–0.40) after adjusting for age and gender compared with those who did not meet recommendations (Table 3). Multivariable-adjusted model still presented the significant inverse association between meeting fruit and vegetable intake recommendations and cognitive impairment (OR=0.16; 95% CI: 0.05–0.46) after further adjusting for other covariates. Total portions of fruit and vegetable intake per day were significantly associated with a decreased odds of cognitive impairment after adjusting for age and gender; when total intake of fruit and vegetable a day increased 1 portion, the odds for mental disorders decreased 37% (OR=0.63; 95% CI: 0.49–0.90). The association did not change much in the multivariable-adjusted model (OR=0.68; 95% CI: 0.54–0.87). The multivariable-adjusted associations did not materially change after further adjustment for depression and anxiety.

Compared to participants who did not meet recommendations of 5 or more servings of fruit and vegetable per day, participants who met recommendations had an 86% (OR=0.14; 95% CI: 0.03–0.73) decreased odds to be at increased risk of dementia after adjusting for age and gender (Table 3). Multivariable-adjusted model showed that participants who met recommendations had an 84% decreased odds (OR=0.16; 95% CI: 0.03–0.86). Total portions of fruit and vegetable intake per day were significantly associated with a 38% decreased odds of being at increased risk of dementia after adjusting for age and gender (OR=0.62; 95% CI: 0.40–0.96). The association did not materially alter in the multivariable-adjusted model with the adjustment of age, gender, smoking, body mass index, meeting physical activity guideline, metabolic health, per capita income and census tracts and blocks (OR=0.61; 95% CI: 0.38–0.97) (data not shown in tables), but became not statistically significant if further adjusted for per capita income and language used in the interview. The

multivariable-adjusted associations did not materially change after further adjusting for depression and anxiety.

Meeting recommendations of 5 or more servings of fruit and vegetable per day did not affect depression after adjusting for age and gender (OR=0.49; 95% CI: 0.20–1.20), and after adjusting for other covariates (OR=0.52; 95% CI: 0.21–1.28), compared with those who did not meet recommendations (Table 3). Total portions of fruit and vegetable intake per day were not significantly associated with depression either after adjusting for age and gender (OR=0.92; 95% CI: 0.81–1.04) or after adjusting multi-covariates (OR=0.91; 95% CI: 0.81–1.03). The multivariable-adjusted associations did not materially change after further adjustment for anxiety.

Meeting recommendations of 5 or more servings of fruit and vegetable per day was inversely and significantly associated with the scores to measure symptoms of anxiety, while total portions of fruit and vegetable intake per day were not significantly associated with it after adjusting for other covariates (Table 4). Meeting recommendations of 5 or more servings of fruit and vegetable per day was not significantly associated with the scores to measure symptoms of cognitive impairment, while total portions of fruit and vegetable intake per day were inversely and significantly associated with it after adjusting for other covariates. Both meeting recommendations of 5 or more servings of fruit and vegetable per day and total portions of fruit and vegetable intake per day were not significantly associated with the scores to measure symptoms of depression after adjusting for other covariates.

All interaction terms were not statistically significant and did not affect the results.

DISCUSSION

In a Mexican-American cohort, participants who met recommendations of 5 or more servings of fruit and vegetable per day had a significantly 78% decreased odds of anxiety, an 84% reduced odds of cognitive impairment and an 84% decreased odds of being at increased risk of dementia compared with those who did not meet recommendations, after adjusting for covariates. Total portions of fruit and vegetable intake per day was inversely associated with the presence of symptoms of all mental disorders, cognitive impairment, and the indication of increased risk of dementia; when total intake of fruit and vegetable per day increased 1 portion, the odds of mental disorders decreased by 11%, and the odds of cognitive impairment lowered by 32%, after adjusting for covariates.

To our knowledge, this study is the first to examine the inverse association of fruit and vegetable intake with the presence of mental disorders symptoms among Mexican-Americans. According to the American Heart Association dietary guidelines, the recommendations for healthful food consumption include 5 or more portions of fruit and vegetable daily (Krauss et al., 2000). One meta-analysis reported that increased consumption of fruit and vegetables was related to a reduced risk of cognitive impairment (OR: 0.82; 95% CI: 0.72–0.93) and the indication of increased risk of dementia (OR: 0.73; 95% CI: 0.54–0.83) (Jiang et al., 2017). However, only 1 out of 7 studies in that meta-analysis was conducted in the US and it showed that high vegetable intake (>191 g/day vs. ≤109.6 g/day)

was borderline significantly associated with the prevalence of mild cognitive impairment (OR: 0.66; 95% CI: 0.44–0.99; $P = 0.05$) among elderly populations (98.6% Caucasians) (Roberts et al., 2010). Another meta-analysis reported that the combined relative risk (RR) of depression for the highest versus lowest category of fruit and vegetable intake was (RR: 0.86; 95% CI: 0.81– 0.91) and (RR: 0.89; 95% CI: 0.83–0.94), respectively (Liu et al., 2016), but only 1 out of 10 studies was from the US and focused on women with 2.7% Hispanics (Gangwisch et al., 2015). A cross-sectional study of Canadians reported that fruit and vegetable intake was significantly associated with lower odds of depression or anxiety disorder (all Ps < 0.05) (McMartin et al., 2013). Another cross-sectional study of US adults reported both depression and anxiety symptoms were associated with fewer fruit/vegetable servings consumed, but it did not observe the associations in Mexican-Americans (Ellis et al., 2015). Our study provides further evidence by showing the association between consumption of fruits and vegetables and the odds of symptoms of cognitive impairment, the indication of increased risk of dementia, and anxiety in Mexican-Americans. Our study finds an inverse but not a significant association of fruit and vegetable intake with the odds of depression, although a meta-analysis showed that fruit and vegetable consumption might be inversely associated with the risk of depression (Liu et al., 2016). The reason is not clear, but our ongoing prospective cohort will provide an opportunity to further explore the association when more data are available. Although further longitudinal data are needed, our findings still provide important information for the prevention and control of anxiety, cognitive impairment, and the indication of increased risk of dementia among Mexican-Americans.

The underlying mechanism supporting the relationship between consumption of fruit and vegetable and mental health remains to be clarified. A high intake of fruit and vegetable is rich in antioxidants such as vitamin E, and consequently may alleviate the harmful effects of oxidative stress on mental health (Jacka et al., 2007; Joseph et al., 1998). For example, an animal study reported that blueberries, grapes, apples, spinach, strawberries, wine and green tea, all rich in antioxidants, have demonstrated effectiveness in slowing or preventing age-associated pathophysiological and cognitive changes (Joseph et al., 1998), while foods high in vitamins C and E, such as various fruits, nuts, and green leafy vegetables, have been shown to be effective in reducing the risk of Alzheimer’s disease (Engelhart et al., 2002). Fruits and vegetables are high in nutrients and fiber and relatively low in calories and hence have a high nutrient density (Krauss et al., 2000). Habitually consuming a variety of fruits and vegetables helps ensure adequate intakes of micronutrients, especially fruits and vegetables that are dark green, deep orange, or yellow. Fruits and vegetables also contain a high water content and thus a low energy density. Consuming foods of low energy density assist in reducing energy intake and may help in weight control (Krauss et al., 2000).

The study had several limitations. The study was cross-sectional in design; thus, only associations but not causal relationship may be inferred. It is difficult to determine whether the symptoms of mental disorders followed fruit and vegetable intake in time or fruit and vegetable intake resulted from the symptoms of mental disorders, or the associations might be due to a third variable. Prospective studies are needed to further investigate the effect or dose-response of fruit and vegetable intake on mental disorder risk. Our longitudinal data currently being collected will provide that opportunity. Fruit and vegetable intake was self-reported, which may affect its precision as a predictor. We only examined the association of

fruit and vegetable consumption but other foods consumed by the participant were not accounted for and thus we are unable to make broad conclusions about eating patterns generally. And our measure of fruit and vegetable is an aggregate assessment, not providing details of produce consumed. Per capita income was obtained based on the total income of participants and their spouses, but not everyone living in the same household, thus the current calculation of per capita income might cause inaccurate estimation. We could not completely rule out the possibility of residual confounding due to unmeasured or inadequately measured covariates.

There were some strengths in our research. First, this is a general population-based randomly selected Mexican-American cohort with relatively large sample size, thus avoiding bias inherent in studies drawing from clinic populations or other non-randomly selected populations with established disease or mixed ethnicity. Second, we are first to show that fruit and vegetable intake might be a modifiable protective factor for which Mexican-Americans can make changes to reduce their risk for mental disorders in Mexican-Americans. Finally, detailed information on several mental disorders was available, allowing us to get a relatively comprehensive analysis of the relevant factors.

CONCLUSION

Increased fruit and vegetable intake was associated with a significant reduction in odds of symptoms of cognitive impairment, the indication of increased risk of dementia, and anxiety after excluding the effect of other confounding factors. We have an aging population with more chronic diseases including more cognitive decline and dementia. Any research that can lead to potential mitigation of these trends is not only warranted but should be strongly supported. Fruit and vegetable intake might be a modifiable protective factor for which Mexican-Americans can make changes to reduce their risk for cognitive impairment, dementia, and anxiety. Efforts need to be focused on improving fruit and vegetable intake intervention and to devising high-quality studies to measure the effect on mental health.

Acknowledgement

We thank our cohort team, particularly, Rocio Uribe (Brownsville), Becky Erazo (Laredo), Ariana Garza (Harlingen) and their teams, who recruited and documented the participants. We thank the Tu Salud Si Cuenta data collection team since they collect the fruit and vegetable measures in Brownsville. We also thank Marcela Morris and other laboratory staff for their contributions, and Christina Villarreal for administrative support. We thank Valley Baptist Medical Center, Brownsville, Texas for providing us space for our Center for Clinical and Translational Science Clinical Research Unit. We also thank the community of Brownsville, Laredo, and Harlingen and the participants who so willingly participated in this study in their city.

Sources of support: This work was supported by MD000170 P20 funded from the National Center on Minority Health and Health Disparities, the Centers for Translational Science Award 1U54RR023417–01 from the National Center and the Centers for Disease Control Award RO1 DP000210–01 for Research Resources.

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Table 1.

Cohort Demographics and Metabolic Characteristics Stratified by Symptoms of Mental Disorders: Cameron County Hispanic Cohort Study (2003-2016)[a,b]

Variable	Symptoms of mental disorders[c]		
	Yes (n=787, 29.13%)	No (n=1,915, 70.87%)	*P*-value
Categorical variables, n (%)			
Men	182 (23.73)	744 (39.43)	0.65
Employed	306 (40.00)	1032 (54.81)	0.06
Education, below high school	478 (62.89)	850 (45.14)	0.10
Met minimum recommendations for physical activity of ≥ 600 MET-minutes/week	105 (27.34)	342 (35.01)	0.52
Met recommendations of ≥ 5 servings of fruit & vegetable per day	45 (13.68)	108 (12.63)	0.57
Ever smokers	228 (29.77)	554 (29.39)	0.48
Ever alcohol drinkers	236 (34.86)	670 (40.43)	0.72
Metabolically healthy	362 (47.20)	985 (52.20)	0.04
Language used in the interview			
English	203 (26.47)	642 (34.02)	0.70
Spanish	564 (63.53)	1245 (66.98)	
Continuous variables, Mean (standard error)			
Age at enrollment (years)	50.21 (2.28)	47.09 (1.39)	0.24
Per capita annual income (US dollars)[d]	5810.42 (1.15)	8245.23 (1.12)	0.05
Body mass index (kg/m^2)	31.87 (0.8)	31.98 (0.51)	0.90
Waist-to-hip ratio	0.95 (0.01)	0.94 (0.01)	0.89
Total portions of fruit and vegetable intake per day	2.00 (0.21)	2.55 (0.17)	0.04

[a]Abbreviation: MET: metabolic equivalent

[b]All descriptive results and the models were adjusted for the probability of sampling using weights taking into consideration clustering effects arising from the same census block and household. Linear regression models were used for continuous variables and Rao-Scott F adjusted chi-square statistic for categorical variables.

[c] Mental disorders include depression, anxiety, dementia and cognitive impairment.

[d] Geometric means. Annual income was calculated from the subject and spouse's income.

Table 2

The frequency of the participants with different symptoms of mental disorders: Cameron County Hispanic Cohort Study (2003-2016)

Symptoms of mental disorders	Frequency
Anxiety	196
Cognitive impairment	213
The indication of increased risk of dementia	61
Depression	626
Cognitive impairment and depression	34
Anxiety and depression	147
Anxiety and cognitive impairment	2
Cognitive impairment and indication of increased risk of dementia	36
Cognitive impairment, indication of increased risk of dementia and depression	16
Anxiety, cognitive impairment and depression	16
Anxiety, cognitive impairment and indication of increased risk of dementia	1
Anxiety, cognitive impairment and depression	8

Table 3

Association between consumption of fruit and vegetables and mental health status

Symptoms of mental disorders	Age, gender-adjusted model		Multivariable-adjusted model	
	OR (95% CI)	*P*	OR (95% CI)	*P*
Mental disorders				
Met recommendations of ≥ 5 servings of fruit & vegetable per day				
No	1.00		1.00	
Yes	0.42 (0.18-0.97)	0.04	0.46 (0.20-1.03)	0.06
Total portions of fruit and vegetable intake per day	0.87 (0.77-0.99)	0.03	0.89 (0.79-0.99)	0.04
Anxiety				
Met recommendations of ≥ 5 servings of fruit & vegetable per day				
No	1.00		1.00	
Yes	0.28 (0.11-0.68)	0.005	0.22 (0.08-0.65)	0.006
Total portions of fruit and vegetable intake per day	0.85 (0.71-1.01)	0.06	0.89 (0.75-1.05)	0.17
Cognitive impairment				
Met recommendations of ≥ 5 servings of fruit & vegetable per day				
No	1.00		1.00	
Yes	0.15 (0.05-0.40)	0.0002	0.16 (0.05-0.46)	0.0008
Total portions of fruit and vegetable intake per day	0.63 (0.49-0.90)	0.0002	0.68 (0.54-0.87)	0.002
Indication of increased risk of dementia				
Met recommendations of ≥ 5 servings of fruit & vegetable per day				
No	1.00		1.00	
Yes	0.14 (0.03-0.73)	0.02	0.16 (0.03-0.86)	0.03
Total portions of fruit and vegetable intake per day	0.62 (0.40-0.96)	0.03	0.68 (0.43-1.07)	0.10
Depression				
Met recommendations of ≥ 5 servings of fruit & vegetable per day				
No	1.00		1.00	
Yes	0.49 (0.20-1.20)	0.12	0.53 (0.22-1.29)	0.16
Total portions of fruit and vegetable intake per day	0.92 (0.81-1.04)	0.19	0.93 (0.83-1.05)	0.23

OR: odds ratio; CI: confidence interval

[a]Multivariable-adjusted model: adjusted for age, gender, smoking, body mass index, meeting physical activity guideline, metabolic health, per capita income, language used in the interview and census tracts and blocks.

Table 4

Multivariable-adjusted association between consumption of fruit and vegetables and scores to measure symptoms of mental disorders[a]

Logarithmical transformed scores to measure symptoms of mental disorders	Regression Coefficients (Standard Errors)	*P*
Anxiety (Zung's self-Rating Anxiety Scale)		
Met recommendations of ≥ 5 servings of fruit & vegetable per day	−0.12 (0.05)	0.02
Total portions of fruit and vegetable intake per day	−0.01 (0.01)	0.08
Cognitive impairment (Mini Mental State Exam scores)		
Met recommendations of ≥ 5 servings of fruit & vegetable per day	0.02 (0.009)	0.08
Total portions of fruit and vegetable intake per day	0.005 (0.002)	0.003
Depression (Centers for Epidemiologic Studies Scale)		
Met recommendations of ≥ 5 servings of fruit & vegetable per day	−0.09 (0.15)	0.54
Total portions of fruit and vegetable intake per day	−0.04 (0.02)	0.10

[a]Multivariable-adjusted model: adjusted for age, gender, smoking, body mass index, meeting physical activity guideline, metabolic health, per capita income, language used in the interview and census tracts and blocks.