Original Article

Association Between Fruit/Vegetable Consumption and Mental-Health-Related Quality of Life, Major Depression, and Generalized Anxiety Disorder: A Longitudinal Study in Thailand

Supa Pengpid [1, 2] and Karl Peltzer [2, 3, *]

[1] ASEAN Institute for Health Development, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom, Thailand
[2] Department of Research and Innovation, University of Limpopo, Turfloop, Polokwane, South Africa
[3] HIV/AIDS/STIs and TB Research Program, Human Sciences Research Council, Pretoria, South Africa

Corresponding author: HIV, STIs and TB (HAST) Research Program, Human Sciences Research Council, Private Bag X41, Pretoria 0001, South Africa. Tel/Fax: +27-123022000, Email: kpeltzer@hsrc.ac.za

Abstract

Background: Fruit and vegetable consumption is associated with improvements in mental health, but few studies examined this relationship longitudinally.

Objectives: The current study aimed at assessing the effect of fruit and vegetable consumption on mental-health-related quality of life, major depressive disorder, and generalized anxiety disorders.

Methods: The study analyzed four waves of longitudinal trial data collected from 442 temple members with prehypertension and/or prediabetes, randomly selected from 12 Buddhist temples in Nakhon Pathom province from 2016 to 2018. The longitudinal associations between fruit and vegetable consumption and three mental-health-measures were calculated using generalized estimating equations (GEE).

Results: Results of GEE predicting mental-health-related quality of life indicated that more frequent fruit consumption (P = 0.485) was not, but more frequent vegetable consumption (P = 0.027) was in the fully adjusted model associated with greater mental-health-related quality of life. Fruit and vegetable consumption (P = 0.033) was associated with greater mental-health-related quality of life only in the unadjusted model. More frequent fruit (P = 0.566 and P = 0.751, respectively), vegetable (P = 0.173 and P = 0.399), and fruit and vegetable consumption (P = 0.252 and P = 0.634, respectively) did not significantly reduce the risk of major depression and generalized anxiety disorder.

Conclusions: The current longitudinal study did not find evidence that more frequent fruit and vegetable consumption was associated with mental-health-related quality of life, depression, and anxiety. However, more frequent vegetable consumption was associated with greater mental-health-related quality of life.

Keywords: Fruit, Vegetables, Mental Health, Depression, Anxiety, Thailand

1. Background

Various cross sectional studies (1, 2) show a positive relationship between fruit and vegetable (FAV) consumption and mental well-being, while results reported by longitudinal studies are controversial (3-5). For example, in a large longitudinal study in Australia, higher FAV consumption was associated with greater happiness, life satisfaction, and well-being (4). In a large longitudinal Canadian study, in models adjusted to other health-related factors, FAV consumption was no longer inversely associated with depression and psychological distress (3). Few investigations studied the longitudinal effects of FAV consumption on mental health, which prompted the current study.

2. Objectives

The current longitudinal study aimed at investigating the effect of FAV consumption on mental-health-related quality of life, major depressive disorder, and generalized anxiety disorder.

3. Materials and Methods

3.1. Study Design and Settings

The study employed longitudinal data from a lifestyle intervention trial of temple members with prediabetes and/or prehypertension, according to Pengpid et al. (6).

The study was conducted in Nakhon Pathom province, Thailand from 2016 to 2018.

3.2. Participants

At baseline, 442 temple members (aged 35 - 65 years) from 12 randomly selected Buddhist temples were included, in case they had prediabetes and/or prehypertension (6). Participants were consecutively recruited from selected temples. Inclusion criteria were age 35 - 65 years, visiting the temple, and having a diagnosis of prehypertension and/or prediabetes; exclusion criteria were age less than 35 and above 65 years, having a diagnosis of cardiovascular disease, type 2 diabetes, hypertension, substance abuse, and taking psychotropic medication (6). Based on the sample size calculated in a similar study, 88 participants were needed to demonstrate change in mental well-being (7).

3.3. Study Procedure

Participants were assessed at baseline, 6-, 12-, and 24-month follow-up time points with questionnaires and anthropometric measures. The follow-up rate at 24 months was 80%.

3.4. Questionnaire

Three scales were employed to measure mental health in the study as follows:

The short-form 8 (SF-8) health survey was used to assess the physical component (PCS) and mental component (MCS) continuous summary scores (8). Cronbach alpha of the SF-8 in the current study was 0.76.

The patient health questionnaire-9 (PHQ-9) was employed to assess major depression (9). The PHQ-9 was validated in Thailand with high sensitivity (0.84) and specificity (0.77), using a cutoff score of $\geq$ 9 for major depression (10). Cronbach alpha of the PHQ-9 in the current study was 0.80.

The generalized anxiety disorder, which is a seven-item (GAD-7) scale utilized to assess the severity of generalized anxiety; scores $\geq$ 10 on the GAD-7 indicated moderate or severe GAD (11). Cronbach alpha of the GAD-7 in the current study was 0.87.

Daily fruit and vegetables consumption was measured from the total number of servings (80 g = 1 serving) of FAV eaten per day in a typical week (12).

Anthropometric assessments were applied using standard procedures. Body mass index (BMI) was calculated using Asian criteria: normal weight (18.5 to < 23.0 kg/m^2), overweight (23.0 to < 25.0 kg/m^2), and 25+ kg/m^2 as obese (13).

Smoking was measured with the question: Do you currently smoke tobacco? Current smoking was defined as daily or less than daily smoking (12).

Problem drinking was measured with the alcohol use disorder identification test (AUDIT)-C (14). Cronbach alpha of the AUDIT-C in the current study was 0.86.

Physical activity was measured with the global physical activity questionnaire (GPAQ), and categorized into low, moderate, and high, following the GPAQ guidelines (15).

The assessed sociodemographic factors included gender, age, education, and subjective economic status (debt, enough to live, has savings).

3.5. Statistical Analysis

Descriptive statistics were used to describe the sample characteristics. Generalized estimating equations (GEE) regression models were utilized to estimate the associations between FAV consumption and three measures of mental health (mental-health-related quality of life scores-continuous, major depressive disorder, and generalized anxiety disorder status (binary) to account for repeated measures. GEE modelling was adjusted for sociodemographic factors, health risk behaviors, and the cluster design of the sample. P values < 0.05 were considered significant. Statistical analyses were conducted with IBM-SPSS version 25.0 (SPSS Inc., Chicago, IL, USA).

3.6. Ethical Consideration

The study was approved by the Ethics Committee (Social Sciences) of Mahidol University (MUSSIRB: 2016/053-B1). Written informed consent was obtained from all study participants prior to the study.

4. Results

4.1. Sample Characteristics

The sample included 442 participants at time 1 (baseline, 2016) (mean age 51.5 years, SD = 7.4; range 35 - 65), 394 at time 2 (six months), 334 at time 3 (12 months, 2017), and 352 participants at time 4 (24 months, 2018). More than two-thirds (74.2%) were female, 19.6% had post-secondary education, and 28.2% described their economic status as having debt. Almost all participants (93.2%) had prehypertension and 38.6% had prediabetes, 69.5% were overweight or obese, 10.5% were current smokers, 10.9% had problem drinkers, and 27.1% engaged in low physical activity. The prevalence of depression and general anxiety disorder and the mean mental summary scores did not significantly differ across the follow-up period. FAV consumption increased over the study period (Table 1).

Table 1. Descriptive Statistics of the Study Variables Over Time[a]

Variable	Time 1: 0 Month, N = 442	Time 2: 6 Months, N = 394	Time 3: 12 Months, N = 334	Time 4: 24 Months, N = 352
Gender (female)	328 (74.2)	305 (75.1)	253 (79.3)	264 (77.2)
Post-secondary education	86 (19.6)	85 (21.10)	59 (18.7)	68 (19.9)
Economic debt status	124 (28.2)	120 (29.9)	89 (28.3)	86 (25.1)
Major depression	57 (13.0)	50 (15.7)	39 (12.5)	48 (14.0)
General anxiety disorder	22 (5.0)	10 (3.1)	11 (3.5)	8 (2.3)
Overweight or obese	308 (69.5)	260 (71.6)	281 (71.5)	279 (72.8)
Current smoking	46 (10.5)	24 (7.5)	39 (12.3)	26 (7.6)
Problem drinking	48 (10.9)	45 (14.1)	33 (10.4)	38 (11.1)
Low physical activity	119 (27.1)	73 (22.9)	102 (33.3)	89 (26.2)
Age (range: 35 - 65)	51.5 ± 7.4	51.6 ± 7.4	52.6 ± 7.4	53.7 ± 7.3
Daily fruit and vegetable consumption (range: 0.29 - 14)	2.14 ± 1.4	2.97 ± 1.8	2.96 ± 1.8	2.96 ± 1.5
Daily fruit consumption (range 0.14 - 7)	1.08 ± 0.9	1.20 ± 1.0	1.24 ± 1.1	1.16 ± 0.9
Daily vegetable consumption (range 0.14 - 7)	1.06 ± 0.8	1.77 ± 1.2	1.72 ± 1.1	1.80 ± 1.0
Mental component summary	53.6 ± 8.8	51.8 ± 8.6	53.9 ± 8.7	55.6 ± 9.1

[a] Values are expressed as mean ± SD or No. (%).

4.2. Longitudinal Results Between FAV Consumption, and Mental-Health-Related Quality of Life, Depression, and Anxiety

Results of GEE predicting mental-health-related quality of life found that more frequent fruit consumption was not associated with greater mental-health-related quality of life, while vegetable consumption was associated with greater mental-health-related quality of life in a fully adjusted model. FAV consumption was associated with greater mental-health-related quality of life only in the unadjusted model; once adjusted to sociodemographic factors as well as health variables, this association was no longer significant. In addition, older age was positively and having debts and low physical activity were negatively associated with mental-health-related quality of life (Table 2).

More frequent fruit, vegetable, and FAV consumption did not significantly reduce the risk of major depression (Table 3) and generalized anxiety disorder (Table 4). In addition, debt economic status was associated with depression. In another model, subjects with a major depressive disorder at baseline were excluded, and the regression model was run with the incidence of major depressive disorder, but results were similar with those of the ones that depression at baseline was included; same results also apply to generalized anxiety disorder.

5. Discussion

The current study employed a longitudinal sample to examine the possible relationship between FAV consumption and three measures of mental health. After controlling the possible confounders including sociodemographic, lifestyle, BMI, and physical activity, no association was observed between FAV consumption frequency and mental-health-related quality of life or between FAV consumption frequency and major depressive and generalized anxiety disorders. The current study findings were consistent with those of a study in Canada when adjusted models no longer found a negative association between FAV consumption and depression and mental distress (3). However, when analyzing FAV consumption separately, more frequent vegetable consumption was associated with greater mental-health-related quality of life in a fully adjusted model. Similar results were observed in a study among female subjects in rural areas of Ghana (16). The relationship between FAV consumption and mental health seems to be more complex, and other factors such as poor economic status and other life style factors such as physical inactivity may be more likely to influence mental health.

The study found that with the increasing of age, mental-health-related quality of life increased, and having debt and engagement in low physical activity were negatively associated with mental-health-related quality of life. Having debt was also significantly associated with major depression. In a recent review, it was found that sedentary behavior increases the risk of depression or poor mental health (17). Poor mental health and depression can be triggered by stressful life events such as having debts or hav-

Table 2. Results of GEE Models Predicting Mental-Health-Related Quality of Life

Variable	Model 1[a]		Model 2[b]		Model 3[c]	
	B (95% CI)	P Value	B (95% CI)	P Value	B (95% CI)	P Value
Fruit consumption	0.33 (-0.20 - 0.87)	0.221	0.16 (-0.37 - 0.68)	0.561	0.19 (-0.34 - 0.72)	0.485
Vegetable consumption	0.53 (0.09 - 0.96)	0.018	0.44 (0.02 - 0.87)	0.043	0.48 (0.06 - 0.91)	0.027
Fruit and vegetable consumption	0.33 (0.03 - 0.64)	0.033	0.24 (-0.06 - 0.54)	0.117	0.26 (-0.04 - 0.56)	0.085
Age, y			0.15 (0.06 - 0.23)	< 0.001	0.15 (0.07 - 0.23)	< 0.001
Gender			-1.39 (-2.80 - 0.03)	0.055	-1.30 (-2.79 - 0.20)	0.090
Education						
No/primary school			Reference		Reference	
Secondary school			-0.03 (-1.48 - 1.43)	0.973	0.18 (-1.28 - 1.63)	0.812
Post-secondary			0.02 (-1.54 - 1.59)	0.977	0.20 (-1.38 - 1.77)	0.806
Economic status						
Enough or savings			Reference		Reference	
Debt			-1.47 (-2.66 - -0.28)	0.016	-1.41 (-2.60 - -0.22)	0.020
Overweight or obese					-0.12 (-1.31 - 1.07)	0.842
Smoking					-0.30 (-2.23 - 1.64)	0.764
Problem drinking					-0.13 (-1.92 - 1.65)	0.883
Low physical activity					-1.30 (-2.38 - -0.21)	0.019

[a]Unadjusted.
[b]Adjusted for sociodemographic variables.
[c]Adjusted for sociodemographic and health variables.

Table 3. Results of GEE Models Predicting Major Depression

Variable	Model 1[a]		Model 2[b]		Model 3[c]	
	B (95% CI)	P Value	B (95% CI)	P Value	B (95% CI)	P Value
Fruit consumption	-0.07 (-0.22 - 0.08)	0.488	0.06 (-0.14 - 0.26)	0.570	0.06 (-0.14 - 0.26)	0.566
Vegetable consumption	0.09 (-0.05 - 0.24)	0.206	0.12 (-0.04 - 0.27)	0.142	0.11 (-0.05 - 0.26)	0.173
Fruit and vegetable consumption	0.06 (-0.04 - 0.16)	0.235	0.07 (-0.04 - 0.18)	0.264	0.07 (-0.05 - 0.18)	0.252
Age			0.004 (-0.02 - 0.03)	0.782	0.007 (-0.02 - 0.03)	0.610
Gender			0.22 (-0.28 - 0.72)	0.394	0.43 (-0.08 - 0.94)	0.100
Education						
No/primary school			Reference		Reference	
Secondary school			-0.09 (-0.56 - 0.38)	0.707	-0.04 (-0.52 - 0.44)	0.878
Post-secondary			0.48 (-0.11 - 1.07)	0.110	0.53 (-0.05 - 1.12)	0.074
Economic status						
Enough or savings			Reference		Reference	
Debt			0.82 (0.44 - 1.20)	< 0.001	0.77 (0.39 - 1.15)	< 0.001
Overweight or obese					0.15 (-0.28 - 0.59)	0.487
Smoking					-0.40 (-1.02 - 0.22)	0.204
Problem drinking					-0.31 (-0.87 - 0.26)	0.284
Low physical activity					-0.30 (-0.65 - 0.05)	0.096

[a]Unadjusted.
[b]Adjusted for sociodemographic variables.
[c]Adjusted for sociodemographic and health variables.

ing a chronic illness (18).

Study limitations were that the study assessed FAV con-

sumption by self-report instead of also measuring urine or blood biomarkers for nutrients in FAVs. Factors such as

Table 4. Results of GEE Models Predicting Generalized Anxiety Disorder

Variable	Model 1[a]		Model 2[b]		Model 3[c]	
	B (95% CI)	P Value	B (95% CI)	P Value	B (95% CI)	P Value
Fruit consumption	-0.02 (-0.27 - 0.22)	0.851	-0.03 (-0.30 - 0.24)	0.832	-0.05 (-0.33 - 0.24)	0.751
Vegetable consumption	0.18 (-0.18 - 0.54)	0.329	0.20 (-0.16 - 0.56)	0.285	0.15 (-0.20 - 0.51)	0.399
Fruit and vegetable consumption	0.06 (-0.13 - 0.25)	0.514	0.07 (-0.13 - 0.27)	0.495	0.05 (-0.15 - 0.25)	0.634
Age			-0.009 (-0.05 - 0.03)	0.666	-0.01 (-0.05 - 0.03)	0.588
Gender			-0.002 (-0.87 - 0.86)	0.996	-0.11 (-1.04 - 0.82)	0.818
Education						
No/primary school			Reference		Reference	
Secondary school			-0.09 (-0.92 - 0.75)	0.841	-0.05 (-0.92 - 0.82)	0.914
Post-secondary			0.31 (-0.65 - 1.27)	0.527	0.47 (-0.59 - 1.52)	0.389
Economic status						
Enough or savings			Reference		Reference	
Debt			0.49 (-0.19 - 1.17)	0.154	0.59 (-0.08 - 1.26)	0.083
Overweight or obese					0.43 (-0.33 - 1.18)	0.265
Smoking					0.30 (-0.94 - 1.53)	0.640
Problem drinking					0.13 (-0.87 - 1.12)	0.799
Low physical activity					-0.18 (-0.87 - 0.48)	0.587

[a]Unadjusted.
[b]Adjusted for sociodemographic variables.
[c]Adjusted for sociodemographic and health variables.

age, gender, education, chronic illness, smoking, genetic, social, and spiritual may have an etiological role in depression and generalized anxiety disorder. The study groups were not matched by such factors, which was another limitation of the study.

5.1. Conclusions

The current longitudinal study did not find evidence that more frequent FAV consumption was associated with mental-health-related quality of life, depression, and anxiety. However, more frequent vegetable consumption was associated with greater mental-health-related quality of life.

Acknowledgments

Footnotes

Authors' Contribution: Supa Pengpid designed the study and analyzed the data and wrote the manuscript. All authors read and approved the final version of the manuscript.

Clinical Trial Registration Code: It is not declared by the authors.

Declaration of Interest: The authors declare that they have no conflict interest.

Ethical Approval: The study was approved by the Ethics Committee (Social Sciences) of Mahidol University (MUS-SIRB: 2016/053-B1).

Patient Consent: Written informed consent was attained from all study participants.

References

1. 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**(3-4):225–30. doi: 10.1016/j.ypmed.2012.12.016. [PubMed: 23295173].

2. Saghafian F, Malmir H, Saneei P, Milajerdi A, Larijani B, Esmaillzadeh A. Fruit and vegetable consumption and risk of depression: Accumulative evidence from an updated systematic review and meta-analysis of epidemiological studies. *Br J Nutr*. 2018;**119**(10):1087–101. doi: 10.1017/S0007114518000697. [PubMed: 29759102].

3. Kingsbury M, Dupuis G, Jacka F, Roy-Gagnon MH, McMartin SE, Colman I. Associations between fruit and vegetable consumption and depressive symptoms: Evidence from a national Canadian longi-

tudinal survey. *J Epidemiol Community Health*. 2016;**70**(2):155–61. doi: 10.1136/jech-2015-205858. [PubMed: 26311898].

4. Mujcic R, J Oswald A. Evolution of well-being and happiness after increases in consumption of fruit and vegetables. *Am J Public Health*. 2016;**106**(8):1504–10. doi: 10.2105/AJPH.2016.303260. [PubMed: 27400354]. [PubMed Central: PMC4940663].

5. Nguyen B, Ding D, Mihrshahi S. Fruit and vegetable consumption and psychological distress: Cross-sectional and longitudinal analyses based on a large Australian sample. *BMJ Open*. 2017;**7**(3). e014201. doi: 10.1136/bmjopen-2016-014201. [PubMed: 28298322]. [PubMed Central: PMC5353310].

6. Pengpid S, Peltzer K, Puckpinyo A, Chantarasongsuk IJ. Effectiveness of a cluster-randomized controlled trial community-based lifestyle intervention program to control prehypertension and/or prediabetes in Thailand. *Int J Diabetes Dev Ctries*. 2018;**39**(1):123–31. doi: 10.1007/s13410-018-0641-2.

7. Johnson R, Robertson W, Towey M, Stewart-Brown S, Clarke A. Changes over time in mental well-being, fruit and vegetable consumption and physical activity in a community-based lifestyle intervention: A before and after study. *Public Health*. 2017;**146**:118–25. doi: 10.1016/j.puhe.2017.01.012. [PubMed: 28404463].

8. Ware JE, Kosinski M, Dewey JE, Gandek B. *How to score and interpret single-item health status measures: A manual for users of the SF-8 health survey*. Lincoln RI: QualityMetric Incorporated; 2001.

9. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: Validity of a brief depression severity measure. *J Gen Intern Med*. 2001;**16**(9):606–13. doi: 10.1046/j.1525-1497.2001.016009606.x. [PubMed: 11556941]. [PubMed Central: PMC1495268].

10. Lotrakul M, Sumrithe S, Saipanish R. Reliability and validity of the Thai version of the PHQ-9. *BMC Psychiatry*. 2008;**8**:46. doi: 10.1186/1471-244X-8-46. [PubMed: 18570645]. [PubMed Central: PMC2443128].

11. Spitzer RL, Kroenke K, Williams JB, Lowe B. A brief measure for assessing generalized anxiety disorder: The GAD-7. *Arch Intern Med*. 2006;**166**(10):1092–7. doi: 10.1001/archinte.166.10.1092. [PubMed: 16717171].

12. World Health Organization. *STEPwise approach to noncommunicable disease risk factor surveillance (STEPS)*. 2018, [cited 18 March]. Available from: http://www.who.int/chp/steps/riskfactor/en/.

13. Wen CP, David Cheng TY, Tsai SP, Chan HT, Hsu HL, Hsu CC, et al. Are Asians at greater mortality risks for being overweight than Caucasians? Redefining obesity for Asians. *Public Health Nutr*. 2009;**12**(4):497–506. doi: 10.1017/S1368980008002802. [PubMed: 18547457].

14. Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. The AUDIT alcohol consumption questions (AUDIT-C): An effective brief screening test for problem drinking. Ambulatory care quality improvement project (ACQUIP). Alcohol use disorders identification test. *Arch Intern Med*. 1998;**158**(16):1789–95. [PubMed: 9738608].

15. World Health Organization. *Global physical activity questionnaire (GPAQ) analysis guide*. Geneva, Switzerland: World Health Organization; 2012, [cited 10 November]. Available from: https://www.who.int/ncds/surveillance/steps/resources/GPAQ_Analysis_Guide.pdf.

16. Azupogo F, Seidu JA, Issaka YB. Higher vegetable intake and vegetable variety is associated with a better self-reported health-related quality of life (HR-QoL) in a cross-sectional survey of rural northern Ghanaian women in fertile age. *BMC Public Health*. 2018;**18**(1):920. doi: 10.1186/s12889-018-5845-3. [PubMed: 30053856]. [PubMed Central: PMC6062975].

17. Zhai L, Zhang Y, Zhang D. Sedentary behaviour and the risk of depression: A meta-analysis. *Br J Sports Med*. 2015;**49**(11):705–9. doi: 10.1136/bjsports-2014-093613. [PubMed: 25183627].

18. MedlinePlus. *Major depression*. 2016. Available from: https://medlineplus.gov/ency/article/000945.htm.