Original Research

The Journal of Prevention of Alzheimer's Disease - JPAD©
Volume 5, Number 1, 2018

Associations of Long-Term Tea Consumption with Depressive and Anxiety Symptoms in Community-Living Elderly: Findings from the Diet and Healthy Aging Study

S.-P. Chan[1,2,3,4], P.Z.Yong[5], Y. Sun[5], R. Mahendran[5,6,7], J.C.M. Wong[5,6], C. Qiu[8], T.-P. Ng[5], E.-H. Kua[5,6], L. Feng[5]

1. Department of Medicine, Yong Loo Lin School of Medicine, National University of Singapore; 2. Department of Decision Sciences, NUS School of Business, National University of Singapore; 3. Cardiovascular Research Institute, National University Heart Centre Singapore; 4. School of Engineering & Mathematical Sciences, La Trobe University, Australia; 5. Department of Psychological Medicine, Yong Loo Lin School of Medicine, National University of Singapore; 6. Department of Psychological Medicine, National University Hospital; 7. Duke-NUS Medical School, Singapore; 8. Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet-Stockholm University, Stockholm, Sweden

Corresponding Author: Dr Lei Feng, Department of Psychological Medicine, National University Health System Tower Block Level 9, 1E Kent Ridge Road, Singapore 119228, Republic of Singapore, Email: pcmfl@nus.edu.sg

J Prev Alz Dis 2018;5(1):21-25
Published online June 13, 2017, http://dx.doi.org/10.14283/jpad.2017.20

Abstract

OBJECTIVE: To examine the association between long-term tea consumption and depressive and anxiety symptoms in community-living elderly.
DESIGN: Community based cross-sectional study.
SETTING: The Diet and Healthy Aging Study (DaHA), a prospective cohort study in Singapore.
PARTICIPANTS: 614 elderly aged 60 years and above, who were free of dementia and cognitive impairment.
MEASUREMENTS: Information on tea consumption was obtained through interviewer-administered questionnaire. Long-term tea drinking was defined as regular consumption for at least 15 years. Depressive and anxiety symptoms were measured using the 15-item Geriatric Depression Scale (GDS-15) and the 20-item Geriatric Anxiety Inventory (GAI), respectively. A generalized structural equation model (gSEM) was applied to ascertain the association between long-term tea consumption and depressive and anxiety symptoms.
RESULTS: About 59% of the subjects had consumed tea for over 15 years. Long term tea consumption was significantly associated with a reduced odds of having depressive and anxiety symptoms, after adjusting for demographics (i.e., age, gender, education and ethnicity), comorbid conditions (i.e., heart disease, diabetes, stroke, hypertension and hyperlipidaemia) and long-term coffee consumption.
CONCLUSION: There was evidence suggesting that long-term tea consumption was associated with reduced depressive and anxiety symptoms among community-living elderly. This suggests that it is worthwhile to further investigate the role of tea's bioactive compounds in promoting mental health in aging.

Key words: Tea, aging, depression, anxiety, generalized structural equation model.

Introduction

The potential health benefits of tea consumption are well-documented (1-6). Recent studies have linked tea consumption with better mental health in aging (7-10). The neuroprotective effects of tea consumption could be attributed to its antioxidant and anti-inflammatory properties (4). Tea's antioxidant property is primarily contributed by tea catechins, theaflavins and thearubigins (11, 12). Tea leaves also contain L-theanine, a unique amino acid, which may promote human brain functions (13). While the short-term central nervous system stimulating effects of tea have been reported in literature (14), the association between long-term consumption of tea and elderly's psychological health has not been established. From a life-course perspective, the duration of healthy dietary habits could provide a more consistent measure of health-related behaviour and accumulated exposure. Although the importance of anxiety in late-life mental health is gaining much attention in recent years (15), no observational studies examining the long-term anxiolytic effects of tea have been reported to date.

The aim of this study was to ascertain the association between long-term regular consumption of tea (>15 years) and the depressive and anxiety symptoms in community-living elderly in Singapore using baseline data from the Diet and Healthy Aging Study (DaHA) cohort.

Methods

Subjects

The study subjects were community-living elderly from the ongoing Diet and Healthy Aging Study (DaHA) cohort. Commenced in July 2011, DaHA aims to study

Received February 24, 2017
Accepted for publication April 25, 2017

the relationship between Asian diets and health among community-living elderly in Singapore. Singapore citizens and permanent residents aged 60 years and above and residing in Jurong, an urban community in the western region of the city-state, were recruited by trained research staff through door-to-door visits. All interviews and assessments were conducted at the Training and Research Academy at Jurong Point (TaRA@JP), which is located in the targeted community. The protocol of DaHA was approved by the National University of Singapore Institutional Review Board, and written informed consent was obtained from all participants.

Data Collection

Detailed information on tea consumption was collated through an interviewer-administered questionnaire. The questions were designed according to the habitual consumption patterns among the elderly in Singapore. The common tea types were green tea, Chinese oolong tea, and English black tea. The key question on tea consumption was "How often do you consume each of the following food or drink?" at enrolment and at the age of 45, with six options for frequency, namely i. never or rarely, ii. more than once a month but less than once a week, iii. one to three times a week, iv. four to six times a week, v. one to two times a day, and vi. three times or more a day. With this one could determine whether the subjects had consumed tea for 15 years or longer (0: No, 1: Yes) given that they were at least 60 years old when enrolled. A subject was considered a long-term drinker (i.e., >15 years) if s/he had reported consuming tea or coffee regularly, at the age of 45 and at enrolment. Note that both tea and coffee are common beverages among the Singapore population.

The participants' level of depression was measured by the 15-item Geriatric Depression Scale (GDS-15) (16, 17). The severity of anxiety was ascertained using the 20-item Geriatric Anxiety Inventory (GAI) (18). For both scales, a higher score is reflective of a greater severity of the symptoms. Other relevant information such as socio-demographics (e.g., age, gender, ethnicity, marital status, educational attainment and housing type) and health/medical conditions (e.g., heart disease, stroke, diabetes, hypertension, and hyperlipidaemia) were self-reported through the interviewer-administered questionnaire. A subject was considered to have suffered from heart disease if s/he had reported heart failure, heart attack or irregular heart-beat (atrial fibrillation).

Statistical Analysis

The sample characteristics were presented in median/range for quantitative variables, and in frequency/percentage for qualitative variables. Exploratory analyses were carried out with Wilcoxon-Mann-Whitney test and chi-square test, depending on the nature of data. In view of the above-mentioned study aim, the multivariate generalized structure equation model (gSEM) (19) was applied for confirmatory analyses. With the admissible values of GDS and GAI bounded between 0-15 and 0-20 respectively, a continuous and bounded Beta distribution was applied as the underlying distributions for the two scores. The flexible Beta distribution could handle data that are symmetrical or skewed (20). Both the GDS and GAI were standardized based on the standard version of Beta distribution and according to the conventional practice without loss of information (21). Long-term tea consumption (>15 years vs. ≤ 15 years or non-drinker) and the presence of heart disease, stroke, diabetes, hypertension and hyperlipidaemia followed the Binomial distribution in view of their binary nature (0: Without, 1: With). In both instances, the link functions applied were logit, thus enabling the estimated coefficients be interpreted as adjusted odds ratios (AOR). A backward elimination with removal probability of 0.05 was executed to identify the final model, but the non-significant predictors could be retained if they were relevant for answering the key questions of the study. The final chosen model is depicted in Figure 1 in the form of a path diagram, which indicates all hypothesized directionality of the analysis. For example, Tea→GDS indicates that an analysis would be performed for ascertaining long-term tea consumption's effect on GDS-15 scores. A robust procedure was also implemented for correcting the standard errors in anticipation of outliers. The association between long-term coffee consumption and depression and anxiety was analyzed using the same approach for comparison and adjustment. The analysis was performed using Stata MP version 14 (Stata Corporation, Texas, USA), and all statistical tests were carried out at 5% level of significance.

Results

Of the total of 642 elderly subjects enrolled from 2011 to 2015, 614 (95.6%) were free from dementia and cognitive impairment (MMSE ≥ 24). Of these, 97.2% were Chinese, 69.7% were women, 70.2% were married and 67.5% had primary or no formal education. While relatively few reported with heart disease (9.6%) and stroke (3.6%), a large number of subjects had suffered from hypertension (48.2%) and hyperlipidaemia (50.8%). About 15% reported to have diabetes. The sample characteristics are depicted in Table 1.

Of the 614 subjects aged between 60 and 93, 362 (59.0%) reported to have consumed tea for more than 15 years. While there was no significant age, ethnicity and housing type differences detected, more male subjects were long-term tea consumers when compared with their female counterparts (65.0% vs. 56.1%; p: 0.04). There were also more elderly subjects with at least secondary school qualifications who consumed tea on a long-

term basis, when compared with those who had lower educational attainment (70.1% vs. 53.5%; p<0.01).

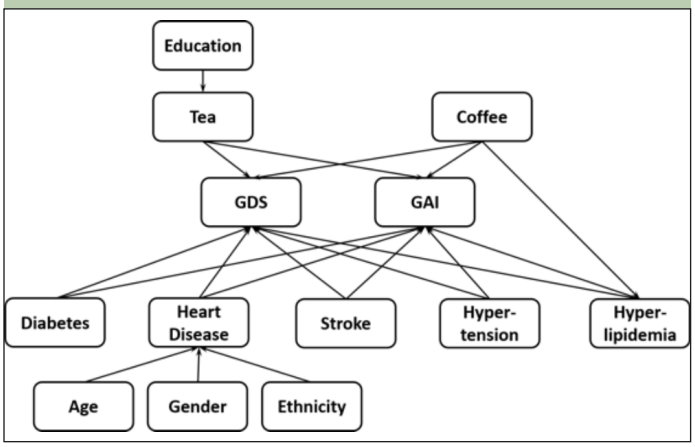
Table 1. Characteristics of the study sample

a. Socio-demographics:	n=614
Age	Median: 67 (range: 60-93)
Gender	
Male	183 (29.8%)
Female	428 (69.7%)
Missing	3 (0.5%)
Ethnicity	
Chinese	597 (97.2%)
Malay	5 (0.8%)
Indian	6 (1.0%)
Other	4 (0.7%)
Missing	2 (0.3%)
Marital status	
Single	24 (3.9%)
Married	431 (70.2%)
Divorced/separated	28 (4.6%)
Widowed	126 (20.5%)
Missing	5 (0.8%)
Educational attainment	
Primary & below	413 (67.5%)
Secondary	145 (23.7%)
Post-secondary/tertiary	56 (8.8%)
Housing type	
1/2/3-room flat	122 (19.9%)
4/5-room flat	428 (69.7%)
Executive/maisonette/ private apartment/ condominium/landed housing	63 (10.3%)
Missing	1 (0.1%)
b. Comorbid conditions:	
Heart disease	59 (9.6%)
Stroke	22 (3.6%)
Diabetes	95 (15.5%)
Hypertension	296 (48.2%)
Hyperlipidaemia	312 (50.8%)
c. Mental health	
Geriatric Depression Scale (GDS) score	Median: 1 (range: 0-11)
Geriatric Anxiety Inventory (GAI) score	Median: 0 (range: 0-17)
d. Long-term consumption of caffeinated drinks:	
Tea	
> 15 years	362 (59.0%)
≤ 15 years or non-drinker	252 (41.0%)
Coffee	
> 15 years	482 (78.5%)
≤ 15 years or non-drinker	129 (21.1%)
Missing	3 (0.4%)

The GDS-15 (median: 1; range: 0-11) and GAI (median: 0; range: 0-17) scores were positively skewed, as a total of 248 subjects (40.4%) did not present any symptoms of depression while 433 (70.5%) were free from anxiety. Confirmatory analysis with gSEM showed that subjects who had consumed tea for over 15 years were more likely to have lower scores for GDS-15 (AOR: 0.82, p=0.01) and GAI (AOR: 0.84, p<0.01), while adjusting for their demographics, comorbid conditions and long-term coffee consumption. However, long-term coffee consumption was not significantly associated with depressive symptoms and anxiety symptoms.

A further analysis with gSEM showed that age, gender and ethnicity were not significantly associated with the prevalence of diabetes, stroke, hypertension and hyperlipidaemia, but heart disease was more prevalent in Malay and Indian male subjects in their advanced years. Long-term tea and coffee consumption were also not significantly associated with the prevalence of heart disease, diabetes, stroke, hypertension and hyperlipidaemia.

Figure 1. Path diagram of the final gSEM



Discussion

The study found that long-term tea consumption was associated with a lower level of depression and anxiety among community living elderly in Singapore. The findings provide fresh evidence on the potential role of tea and its bioactive compounds in promoting mental health in the aging population.

Tea's antioxidant property is contributed by catechin, theaflavins and thearubigins. As a nonselective A1 and A2α adenosine receptor antagonist, caffeine could stimulate cholinergic neurons (22, 23) and help to prevent amyloid-β induced cognitive deficits (24). Tea leaves also contain L-theanine, a unique amino acid, which may promote human brain functions and has been found to have significant impact on mental state (13).

The findings on depression replicated our previous studies using data from the Singapore Longitudinal Aging study (10) and the Confucius Hometowns

Table 2. Final confirmatory analyses of GDS and GAI with gSEM

a. GDS	AOR	95% C.I.	p-value
Tea consumption for over 15 years *			
0: No	Reference	Reference	Reference
1: Yes	0.82	0.71—0.95	0.01
Coffee consumption for over 15 years			
0: No	Reference	Reference	Reference
1: Yes	0.86	0.71—1.04	0.12
Comorbid conditions:			
Heart disease	1.25	0.95—1.65	0.11
Diabetes *	1.29	1.04—1.61	0.02
Stroke	1.18	0.76—1.82	0.46
Hypertension	0.96	0.82—1.12	0.60
Hyperlipidaemia	1.01	0.86—1.17	0.94
b. GAI	**AOR**	**95% C.I.**	**p-value**
Tea consumption for over 15 years *			
0: No	Reference	Reference	Reference
1: Yes	0.84	0.76—0.94	<0.01
Coffee consumption for over 15 years			
0: No	Reference	Reference	Reference
1: Yes	0.92	0.81—1.05	0.22
Comorbid conditions:			
Heart disease	1.12	0.92—1.35	0.26
Diabetes	1.03	0.89—1.19	0.69
Stroke	1.19	0.83—1.66	0.32
Hypertension	1.06	0.95—1.18	0.27
Hyperlipidaemia	0.90	0.81—1.01	0.07

*Statistically significant at 5%.

Aging Project (9). The inverse association between tea consumption and depressive symptom suggests that tea drinking could be a potential preventive measure for promoting mental health at the population level. It reinforces the evidential support concerning tea's impact on preventing depression, as reported in literature (25, 26). But our findings concerning the association between long-term tea consumption and prevention of anxiety is novel. As such, the potential anxiolytic impact of tea should be further studied in clinical trials with biological markers of tea intake.

We used gSEM in statistical analysis because it is ideal for dealing with complex data structures. As the latest member of the SEM family of statistical techniques, gSEM is most suitable for dealing with and testing for complex inter-relationships among variables of mixed-types (qualitative and quantitative). A loss of precision (i.e., inflated standard errors) is expected should the data be analysed with the conventional models which could only deal with one outcome at a time, thus failing to handle the entire data structure in one single analytical setting and providing the much-needed comprehensive picture of the data patterns.

Our study has a few limitations. First, the reported statistically-significant association among variables are not to be interpreted as cause and effect in view of the cross-sectional study design. Second, depression and anxiety were measured using self-reported questionnaires but not clinical assessment and consensus diagnosis based on established criteria such as the DSM and ICD. Last but not least, the study was not designed to provide a compelling answer to tea's anti-pathogenic effects on depression and anxiety.

As such, a longitudinal study design is recommended for future studies. In fact, we are currently conducting a 5-year follow up of the DaHA cohort in Singapore, in order to facilitate the testing of dose-response relationship and to ascertain the effects of different types of tea (i.e., green tea, oolong tea and black tea).

Funding: Dr Lei Feng has received grant supports from the Virtual Institute for the Study of Aging, National University of Singapore (VG-8), the Alice Lim Memorial Fund, Singapore (Alice Lim Award 2010), the National Medical Research Council of Singapore (NMRC/TA/0053/2016), and an international grant from the Swedish Research Council for Health, Working Life and Welfare (Project No.: 2015-01352).

Acknowledgements: The research team would like to express its sincere gratitude to Lee Kim Tah Holdings Ltd., Singapore, Kwan Im Thong Hood Cho Temple, Singapore and the Presbyterian Community Services, Singapore, for their support.

Conflict of interest: None of the authors reported potential conflict of interest.

Ethical standards: The study was approved by the National University of Singapore Institutional Review Board. All participants gave informed consent before taking part.

References

1. Song J, Xu H, Liu F, Feng L. Tea and Cognitive Health in Late Life: Current Evidence and Future Directions. J Nutr Health Ageing 2012;16:31-34.
2. Peters U, Poole C, Arab L. Does Tea Affect Cardiovascular Disease? A Meta-Analysis. Am J Epidemiol 2001;154:495-503.
3. Liu G, Mi XN, Zheng XX, Xu YL, Lu J, Huang XH. Effects of tea intake on blood pressure: a meta-analysis of randomised controlled trials. Brit J Nutr 2014;112:1043-1054.
4. Arab L, Liu W, Elashoff D. Green and Black Tea Consumption and Risk of Stroke: A Meta-Analysis. Stroke 2009;40:1786-1792.
5. Ruan R, Feng L, Li J, Ng TP, Zeng Y. Tea consumption and mortality in the oldest-old Chinese. J Am Geriatr Soc 2013;61:1937-1942.
6. Ng TP, Aung KC, Feng L, Feng L, Nyunt MS, Yap KB. Tea consumption and physical function in older adults: a cross-sectional study. J Nutr Health Ageing 2014;18:161-166.
7. Feng L, Gwee X, Kua EH, Ng TP. Cognitive function and tea consumption in community dwelling older Chinese in Singapore. J Nutr Health Ageing 2010;14:433-438.
8. Feng L, Chong MS, Lim WS, Gao Q, Nyunt MS, Lee TS, Collinson SL, Tsoi T, Kua EH, Ng TP. Tea Consumption Reduces the Incidence of Neurocognitive Disorders: Findings from the Singapore Longitudinal Aging Study. J Nutr Health Ageing 2016;20:1002-1009.
9. Feng L, Yan Z, Sun B, Cai C, Jiang H, Kua EH, Ng TP, Qiu C. Tea consumption and depressive symptoms in older people in rural China. J Am Geriatr Soc 2013;61:1943-1947.
10. Feng L, Li J, Kua EH, Lee TS, Yap KB, John Rush A, Ng TP. Association between tea consumption and depressive symptoms in older Chinese adults. J Am Geriatr Soc 2012;60:2358-2360.
11. Inoue M, Tajima K, Hirose K, Hamajima N, Takezaki T, Kuroishi T, Tominaga S. Tea and coffee consumption and the risk of digestive tract cancers: data from a comparative case-referent study in Japan. Cancer Cause Control 1998;9:209-216.
12. Leung LK, Su Y, Chen R, Zhang Z, Huang Y, Chen ZY. Theaflavins in black tea and catechins in green tea are equally effective antioxidants. J Nutr 2001;131:2248-2251.
13. Nobre AC, Rao A, Owen GN. L-theanine, a natural constituent in tea, and its effect on mental state. Asian Pac J Clin Nutr 2008;17 Suppl 1:167-168.
14. Smith A. Effects of caffeine on human behavior. Food Chem Toxicol 2002;40:1243-1255.
15. Wolitzky-Taylor KB, Castriotta N, Lenze EJ, Stanley MA, Craske MG. Anxiety disorders in older adults: a comprehensive review. Depress Anxiety 2010;27:190-211.
16. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. In clinical gerontology: a guide to assessment and intervention, 1986. The Haworth Press, New York, pp.165-173
17. Broekman BF, Nyunt SZ, Niti M, Jin AZ, Ko SM, Kumar R, Fones CS, Ng TP. Differential item functioning of the Geriatric Depression Scale in an Asian population. J Affect Disorders 2008;108:285-290.
18. Pachana NA, Byrne GJ, Siddle H, Koloski N, Harley E, Arnold E. Development and validation of the Geriatric Anxiety Inventory. Int Psychogeriatr 2007;19:103-111.
19. Skrondal A, Rabe-Hesketh S. Generalized latent variable modeling: multilevel, longitudinal, and structural equation models. 2001. Chapman & Hall/CRC, Boca Raton
20. Gupta AK, Nadarajah S. Handbook of beta distribution and its applications. 2004. Marcel Dekker, New York
21. Smithson M, Verkuilen J. A better lemon squeezer? Maximum-likelihood regression with beta-distributed dependent variables. Psychol Methods 2006;11:54-71.
22. Fredholm BB, Bättig K, Holmén J, Nehlg A, Zvartau EE. Actions of caffeine in the brain with special reference to factors that contribute to its widespread use. Pharmacol Rev 1999;51:83-133.
23. Eskelinen MH, Ngandu T, Tuomilehto J, Soininen H, Kivipelto M. Midlife coffee and tea drinking and the risk of late-life dementia: a population-based CAIDE study. J Alzheimers Dis 2009;16:85-91.
24. Dall'Igna OP, Fett P, Gomes MW, Souza DO, Cunha RA, Lara DR. Caffeine and Adenosine A2β receptor antagonists prevent beta-amyloid (25-35)-induced cognitive deficits in mice. Exp Neurol 2007;203:241-245.
25. Niu K, Hozawa A, Kuriyama S, Ebihara S, Guo H, Nakaya N, Ohmori-Matsuda K, Takahashi H, Masamune Y, Asada M, Sasaki S, Arai H, Awata S, Nagatomi R, Tsuji I. Green tea consumption is associated with depressive symptoms in the elderly. Am J Clin Nutr 2009;90:1615–1622.
26. Zeng Y, Chan HS, Ni T, Ruan RP, Feng L, Nie C, Cheng LG, Li Y, Tao W, Gu J, Land KC, Yashin A, Tan QH, Yang Z, Bolund L, Yang HM, Hauser E, Willcox CD, Willcox BJ, Tian XL, Vaupel JW. GxE interactions between FOXO genotypes and tea drinking significantly affect cognitive disability at advanced ages in China. J Gerontol A Biol Sci Med Sci 2015;70(4):426-33.