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Modest Overweight and Healthy Dietary Habits Reduce Risk of Dementia: A Nationwide Survey in Taiwan

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Abstract

BACKGROUND: Evidence of the associations of dietary habits and body mass index with dementia is inconsistent and limited in East Asian countries.

OBJECTIVE: We aim to explore the associations of dietary habits and body mass index with the odds of dementia.

DESIGN: Cross-sectional observational study.

SETTING: A nationwide, population-based, door-to-door, in-person survey.

PARTICIPANTS: Selected by computerized random sampling from all 19 counties in Taiwan.

MEASUREMENT: Diagnosis of dementia using the criteria recommended by the National Institute on Aging-Alzheimer's Association. Lifestyle factors, dietary habits and demographic data were compared between normal subjects and participants with dementia.

RESULTS: A total of 10432 residents were assessed, among whom 2049 were classified as having a mild cognitive impairment (MCI), 929 were diagnosed with dementia, and 7035 were without dementia or MCI. After adjustment for age, gender, education, body mass index (BMI), dietary habits, habitual exercises and co-morbidities, including hypertension, diabetes and cerebrovascular diseases, we found inverse associations of dementia with the consumption of fish (OR 0.62, 95% CI 0.41-0.94), vegetables (OR 0.35, 95% CI 0.13-0.95), coffee (OR 0.59, 95% CI 0.35-0.97), green tea (OR 0.51, 95% CI 0.34-0.75) and other types of tea (OR 0.41, 95% CI 0.28-0.60). There was no association between dementia and fruit consumption. Compared with people who had a normal BMI (18 < BMI <= 24), older overweight people (24 < BMI <=30) had a reduced risk of dementia with an adjusted OR of 0.77 (95% CI 0.61-0.96).

CONCLUSIONS: Our study provides preliminary evidence that suggests that the consumption of fish, vegetables, tea, and coffee has potential benefits against dementia in East Asian population. Being modestly overweight (nadir risk at BMI = 25) in late life was associated with decreased odds of dementia. The benefit of fruits may be offset by their high sugar content.

Key words: Risk factor, diet, tea, coffee, body mass index.

Introduction

The aging population in Taiwan has grown rapidly in the past decades, with an increase in the percentage of the population over the age 65 from 6.8% in 1992 to 11.1% in 2012 (1). The size of the dementia population is expected to increase, with substantial societal impacts on health care costs and care giving.

Genetic and environmental factors could interact and modify the risk of dementia. In the absence of a currently effective disease-modifying treatment or cure, the importance of reducing the risk of dementia cannot be overemphasized. A previous report from the Alzheimer's Association found inconsistent evidence to support that a Mediterranean diet might reduce the risk of dementia, while mid-life obesity might increase the risk of dementia (2). On the other hand, low body mass index (BMI) in late life was found to be associated with an increased risk of dementia (3). Because the evidence of the associations of dietary habits and body mass index with dementia is limited in East Asian countries (4, 5), our study aimed to investigate the associations among lifestyle factors (including drinking tea or coffee), dietary habits (including the consumption of fish, vegetables, and fruits), BMI, and dementia among people aged 65 years and older in Taiwan.

Methods

Study design

This nationwide, population-based, cross-sectional study was approved by the ethics committee of the National Taiwan University Hospital. This study was completed by a door-to-door, in-person survey. After obtaining written informed consent from the participants or their proxies, we performed in-person interviews to collect a brief history that focused on cognitive and

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functional status and administered mental tests and a structured questionnaire that recorded demographic data and lifestyle factors, including dietary habits. The interview process was performed according to an operational manual that defines all variables examined in this questionnaire. Body weight and height were also collected during the interview to calculate BMI. Overall, 10432 participants aged 65 years and older across the country were enrolled between December 2011 and March 2013. The sampling process, interviewer training, home visiting procedure, quality control, and protocol approvals were detailed in our previous report (6). All the interviews were conducted by well-trained field interviewers and underwent continuous quality control to achieve necessary quality standards. The inter-rater reliability of global CDR was substantial, as demonstrated by a kappa value of 0.671. The participation rate of this original nationwide survey was 36.5%.

Diagnostic criteria

The diagnosis for all-cause dementia was based on the core clinical criteria recommended by the National Institute on Aging-Alzheimer's Association (NIA-AA) (7). Cognitive and functional status were determined from the participant evaluation or from a knowledgeable informant (who was a relative and a principal caregiver providing at least 10 hours of weekly direct care for the dementia patient). The informant should be capable of detecting insidious changes in behaviour personality or a decline in mentality or function at work or during activities of daily living (ADL). Objective assessments included the Clinical Dementia Rating (CDR) scale and the Taiwanese Mental State Evaluation (TMSE). Normal TMSE results were defined as a score > 24 in literate elders and > 13 in illiterate elders (8).

Functional status was assessed using the ADL scale and the instrumental activities of daily living (IADL) scale. Mild cognitive impairment(MCI) was diagnosed according to the NIA-AA criteria as a change in cognition with impairment in 1 or more cognitive domains but no evidence of impairment in social or occupational functioning as assessed by the CDR, ADL, and IADL (9). People with major depression, other mental disorders, delirium or other serious physical problems that led to cognitive or functional status decline were excluded because they did not fulfil the NIA-AA criteria for all-cause dementia.

Definition of variables of dietary habit

During an interview, lifestyle factors as well as dietary habits, including drinking tea or coffee, were recorded in detail. Information about the frequency of the habits was also recorded. These habits were developed before the onset of dementia.

Tea or coffee drinking habits were categorized into the following groups: no drinking, prior drinking habits, and frequent drinking habits (more than 3 days a week). Tea drinking habits were further divided into green tea (mostly or exclusively) and other types of tea. The frequency of specific food consumption, including fish, vegetables, and fruits, were categorized and recorded as consumed rarely (once or less than once a month), occasionally (at least twice a month), often (at least twice a week but not on a regular basis), or regularly (every day or almost every day). The BMI of each participant was measured and categorized into the following groups: underweight (BMI <= 18), normal weight (18 < BMI <= 24), overweight (24 < BMI <= 30), and obese (BMI > 30).

Statistical analyses

Categorical variables were represented by frequency or percentages, and chi square tests were used for inter-block comparisons. Means ± standard deviations and the t-test were used for continuous variables. Univariate logistic regression analyses were used to assess the associations among all the aforementioned lifestyle factors, BMI, dietary habits and dementia, and crude ORs with 95% confidence intervals (CIs) were calculated. Multiple logistic regression analyses were used to assess the aforementioned associations to obtain odds ratios (ORs) and 95% CIs adjusted by age, gender, years of education, BMI, dietary habits, habitual exercises and co-morbidities, including hypertension, diabetes and cerebrovascular diseases. All the analyses were performed using SAS statistical software (version 9.3) with a 2-tailed statistical test.

Results

Among the 28600 subjects screened, 18029 were non-respondents. Of the 10571 respondents, 139 were excluded due to incomplete or erroneous data. We finally enrolled 10432 subjects, reflecting a total participation rate of 36.5%. Among the enrolled subjects, 7035 (67.4%) were without dementia or MCI, 2049 (19.6%) were classified as having a mild cognitive impairment, 929 (8.9%) fulfilled the NIA-AA core clinical criteria for all-cause dementia, and 419 (4.0%) participants were categorized in an unclassified group (this group included those participants could not receive cognitive assessment due to severe hearing impairment, poor visual acuity, aphasia, abnormal consciousness levels and so on). The demographic data for the subjects with (n = 929) and with normal cognition (n = 7035) are shown in Table 1.

Table 2 shows the associations among dietary habits, BMI and dementia from the univariate logistic regression analyses. Underweight (BMI <= 18) was associated with an increased odds of dementia, while being overweight

Table 1. Demographic data of study participants (n=7964)

	Normal (n=7035)		Dementia (n=929)	
Continuous variables, n , %	*Mean*	*SD*	*Mean*	*SD*
Age	74.89	6.03	81.71	7.43
Men	75.45	6.22	81.51	7.56
Women	74.3	5.78	81.82	7.35
BMI	23.98	3.38	23.36	3.89
Categorical variables , n , %	*n*	*%*	*n*	*%*
Women	3593	51.1	350	37.7
Age group				
65- <75 y/o	3780	53.7	165	17.8
75-<85	2743	39.0	419	45.1
>=85	512	7.3	345	37.1
Body Mass Index (BMI)				
<=18	156	2.2	36	3.9
18<BMI<=24	3204	45.5	392	42.2
24<BMI<=30	2611	37.1	241	25.9
>30	301	4.3	35	3.8
Education years				
0	2427	34.5	561	60.4
1-6	2710	38.5	245	26.4
7-12	1338	19.0	90	9.7
>12	560	8.0	33	3.6
Life style				
Tea				
No drinking tea	4773	67.8	806	86.8
Drinking tea before	305	4.3	49	5.3
Drinking tea frequently	1957	27.8	74	8.0
Tea species				
Green tea	984	14.0	49	5.3
Other tea	1278	18.2	74	8.0
Coffee				
No drinking coffee	6002	85.3	884	95.2
Drinking coffee before	172	2.4	21	2.3
Drinking coffee frequently	861	12.2	24	2.6
Exercise				
Rare exercise	1955	27.8	654	70.4
Exercise sometimes	1762	25.0	173	18.6
Regular exercise	3191	45.4	101	10.9
Dietary habit				
Vegetarian	404	5.7	48	5.2
Vegans	222	3.2	26	2.8
Lacto-ovo	189	2.7	24	2.6
Fish				
Regular	2932	41.7	268	28.8
Often	2193	31.2	299	32.2
Occasional	1138	16.2	200	21.5
Rare	354	5.0	113	12.2
Vegetables				
Regular	6265	89.1	735	79.1
Often	557	7.9	105	11.3
Occasional	165	2.3	49	5.3
Rare	48	0.7	40	4.3
Fruits				
Regular	4838	68.8	392	42.2
Often	1251	17.8	239	25.7
Occasional	758	10.8	229	24.7
Rare	188	2.7	69	7.4
Co-morbidities				
Hypertension	3512	50.9	513	57.9
Diabetes mellitus	1376	19.9	283	32.0
Cerebrovascular disease	251	3.6	188	20.8

Table 2. Crude ORs of the risk factors for dementia using univariate logistic regression analyses

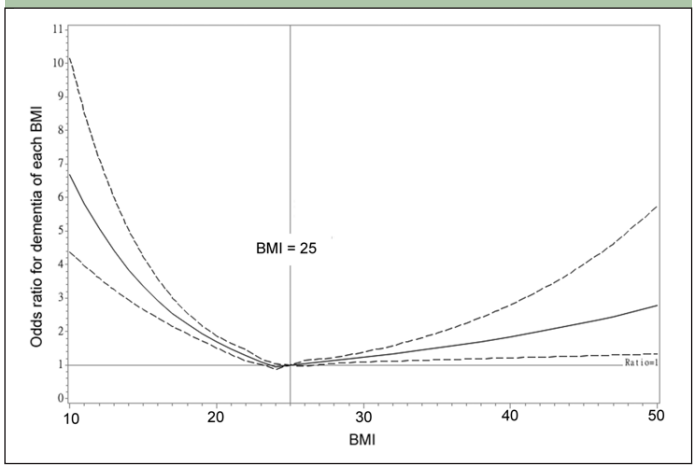
Variables	cORs	p value	95% CI
Age (65<=age<75 as reference)			
75<=age<85	3.50	<.0001	2.90 - 4.22
age>=85	15.44	<.0001	12.55 - 18.99
Women	1.73	<.0001	1.50 - 1.99
Body mass index (18<BMI<=24 as reference)			
BMI<=18	1.89	0.00	1.29 - 2.75
24<BMI<=30	0.75	0.00	0.64 - 0.89
BMI>30	0.95	0.79	0.66 - 1.37
Education years (>12 as reference)			
0	3.92	<.0001	2.73 - 5.64
1-6	1.53	0.03	1.05 - 2.23
7-12	1.14	0.53	0.76 - 1.72
Lifestyle			
Tea (no drinking tea as reference)			
Drinking tea before	0.95	0.75	0.70 - 1.30
Drinking tea frequently	0.22	<.0001	0.18 - 0.29
Tea species (no drinking tea as reference)			
Green tea	0.30	<.0001	0.22 - 0.40
Other tea	0.34	<.0001	0.27 - 0.44
Coffee (no drinking coffee as reference)			
Drinking coffee before	0.83	0.42	0.52 - 1.31
Drinking coffee frequently	0.19	<.0001	0.13 - 0.29
Exercise (rare exercise as reference)			
Exercise sometimes	0.29	<.0001	0.25 - 0.35
Regular exercise	0.09	<.0001	0.08 - 0.12
Dietary habits			
Vegetarian	0.89	0.48	0.66 - 1.22
Vegans	0.88	0.55	0.58 - 1.33
Lacto-oval	0.96	0.84	0.62 - 1.47
Fish (rare eating fish as reference)			
Regular	0.29	<.0001	0.22 - 0.37
Often	0.43	<.0001	0.33 - 0.55
Occasional	0.55	<.0001	0.42 - 0.71
Vegetables (rare eating vegetables as reference)			
Regular	0.14	<.0001	0.09 - 0.22
Often	0.23	<.0001	0.14 - 0.36
Occasional	0.36	0.00	0.21 - 0.60
Fruits (rare eating fruits as reference)			
Regular	0.22	<.0001	0.16 - 0.30
Often	0.52	<.0001	0.38 - 0.71
Occasional	0.82	0.22	0.60 - 1.13
Co-morbidities			
Hypertension	1.33	<.0001	1.15 - 1.53
Diabetes mellitus	1.90	<.0001	1.63 - 2.21
Cerebrovascular disease	7.03	<.0001	5.73 - 8.63

cORs: crude odds ratios; CI: confidence interval.

(24 < BMI <= 30), drinking, drinking tea (both green and other teas), drinking coffee, chewing betel nuts, eating fish or vegetables (regardless of frequency), and having fruits (either every day or often) were associated with decreased odds of dementia. Obesity (BMI > 30) and vegetarianism (veganism and lacto-oval vegetarianism) were not associated with an increase or decrease in the odds of dementia.

The results of the multiple logistic regression model for the aforementioned associations after adjustment for age, gender, education years, BMI, dietary habits, habitual exercises and co-morbidities, including hypertension, diabetes and cerebrovascular diseases, are shown in Table 3. Compared with the normal-weight group (18 < BMI <= 24), the overweight group (24 < BMI <= 30) had a 0.77 (95% CI =0.61 - 0.96) decreased adjusted odds of dementia. As for dietary habits, dementia was inversely associated with eating fish (R 0.62, 95% CI 0.41-0.94), eating vegetables (OR 0.35, 95% CI 0.13-0.95), drinking coffee (OR 0.59, 95% CI 0.35-0.97), drinking green tea (OR 0.51, 95% CI 0.34-0.75) and drinking other types of tea (OR 0.41, 95% CI 0.28-0.60). There was no association between dementia and eating fruits.

Figure 1. The figure shows the odds of dementia (solid curve) for each body mass index (BMI) category relative to the risk of those whose BMI were > 18 and ≤ 24; the dashed curves represent the upper and lower boundaries of the 95% confidence interval. The optimal BMI for nadir odds of dementia risk is 25



Discussion

This study is the first and only large-scale, nationwide epidemiology study with a detailed random sampling plan that investigated dementia and its associated factors, including BMI, various daily lifestyle factors and dietary habits in Taiwan. All the participants underwent a detailed assessment to make a reliable diagnosis of dementia, and the criteria were based on the NIA-AA score clinical criteria, which are one of the principle diagnostic guidelines for dementia research.

Table 3. Adjusted ORs of lifestyle and diet habit risk factors for dementia using multiple logistic regression analyses

Variables	aORs	p value	95% CI
Age (65<=age<75 as reference)			
75<=age<85	3.16	<.0001	2.46 - 4.06
age>=85	16.42	<.0001	12.20 - 22.08
Women	1.38	0.00	1.11 - 1.73
Body mass index (18<BMI<=24 as reference)			
BMI<=18	1.41	0.18	0.85 - 2.35
24<BMI<=30	0.77	0.02	0.61 - 0.96
BMI>30	0.85	0.49	0.53 - 1.36
Education years (>12 as reference)			
0	1.83	0.02	1.09 - 3.08
1-6	1.11	0.70	0.66 - 1.86
7-12	0.87	0.62	0.49 - 1.53
Lifestyle			
Tea species (no drinking tea as reference)			
Green tea	0.51	0.00	0.34 - 0.75
Other tea	0.41	<.0001	0.28 - 0.60
Coffee (no drinking coffee as reference)			
Drinking coffee before	1.07	0.85	0.52 - 2.19
Drinking coffee frequently	0.59	0.04	0.35 - 0.97
Exercise (rare exercise as reference)			
Exercise sometimes	0.40	<.0001	0.31 - 0.50
Regular exercise	0.14	<.0001	0.10 - 0.18
Dietary habit			
Fish (rare eating fish as reference)			
Regular	0.62	0.03	0.41 - 0.94
Often	0.90	0.60	0.59 - 1.35
Occasional	0.81	0.35	0.53 - 1.25
Vegetables (rare eating vegetables as reference)			
Regular	0.35	0.04	0.13 - 0.95
Often	0.25	0.01	0.09 - 0.69
Occasional	0.36	0.07	0.12 - 1.07
Fruits (rare eating fruits as reference)			
Regular	0.59	0.07	0.33 - 1.04
Often	1.37	0.29	0.77 - 2.44
Occasional	1.48	0.19	0.82 - 2.65
Co-morbidities			
Hypertension	1.02	0.84	0.83 - 1.27
Diabetes mellitus	2.04	<.0001	1.62 - 2.57
Cerebrovascular disease	6.49	<.0001	4.71 - 8.96

Multiple regression adjusting age, gender, education, body mass index, dietary habit, exercise and comorbidity; CI: confidence interval; aORs (adjusted odds ratios).

These demographic data were extensively collected by an in-person, face-to-face interview to customize the recording to the culture of this region and the lifestyles of the Taiwanese people.

A rapidly growing literature strongly suggests that exercise may attenuate cognitive impairment and reduce dementia risk. The results of this study showed that exercise is a protective factor of dementia. After full adjustment of variable lifestyle factors, exercise still showed a decreased odds for dementia, whether "regular exercise" or "exercise sometimes". This study result is consistent with other cross-sectional case-controlled or prospective cohort or meta-analysis studies in other countries as well as our previous report investigating the association between lifestyle and dementia (10, 11). Physical activity should be encouraged among the elderly population.

The results of this study showed that overweight elders (with 24 < BMI <= 30) had decreased odds of dementia compared with those in the normal-weight group (18 < BMI <= 24) (3, 12, 13). Most previous studies have revealed that overweight or obesity in middle age was linked to an increased risk of dementia in old age, which could be attributed to cumulative vascular risk related to metabolic syndrome in middle age. However, when examined in old age, higher BMIs were associated with better cognition (3, 12). These results revealed a complex interplay between body weight and cognition, and this relationship could evolve over the lifetime of an individual. Another study showed that dementia-associated weight loss began years before the onset of the clinical syndrome and was accelerated by the time of diagnosis; therefore, body weight loss could merely represent a preclinical symptom of dementia (14). However, the effects of late-life overweight on dementia could also be explained by the potentially beneficial effect of certain adipokines on the aging brain. Previous studies showed that leptin, an adipokine that is primarily secreted by adipose tissue and positively correlated with BMI, reduced β-secretase activity, suggesting that it has an effect against AD pathology (13). Finally, the risk of malnutrition due to eating behaviour problems and dysphagia in advanced stages of dementia can further aggravate weight loss, resulting in a lower BMI among this diseased group. Late-life obesity (BMI > 30) did not show the same beneficial effect against dementia risk as overweight did in this study. In obesity, a decreased sensitivity to leptin occurs, resulting in an inability to detect satiety despite high-energy stores. This probably suggests that increased metabolic syndrome and vascular risk factors due to further weight gain might offset the benefit. Therefore, the effect of body weight on cognition in old age might be represented by a U-shape function relative to the risk of dementia. We plotted the odds ratios of each BMI and found that the optimal BMI for the nadir odds of dementia risk was 25 (Fig. 1).

Our study suggested that drinking coffee or tea

might decrease the odds of dementia. Caffeine, the main psychoactive component of coffee and tea, may heighten alertness and arousal and improve cognitive performance. In addition to its short-term effects, recent epidemiological and experimental studies indicated that chronic administration of caffeine has beneficial effects against a number of acute and chronic neurological disorders, including stroke, Parkinson's disease, amyotrophic lateral sclerosis, dementia, and AD (15-17). In particular, animal studies suggested that chronic caffeine consumption might inhibit Aβ production in the brains of rodents (18). In tea and coffee, other substances in addition to caffeine might also improve cognition in man; for instance, theanine, a non-dietary amino acid that crosses the BBB and is present only in tea and mushroom, showed a protective effect against oxidative stress in an animal study and could improve attention in higher doses (20-22). Epigallocatechin-3-gallate (EGCG), the main polyphenolic constituent of green tea, was also shown to reduce beta-amyloid mediated cognitive impairment in Alzheimer transgenic mice (23, 24). It is also possible that people who drink coffee or tea lead a more active social life and may occasionally drink together, which may play a protective role against dementia. Prior coffee drinking habits did not show a protective effect in our study, which may be due to an insufficient dose of caffeine or may suggest that the acute beneficial effects of caffeine on cognitive performance are far more prominent than its chronic effects that became trivial after consumption was discontinued. It is also possible that some participants could not maintain a consistent coffee drinking habit due to progressive cognitive impairment; therefore, "the prior coffee drinking habit" group could potentially contain more cognitively impaired subjects, contributing to its insignificance compared with the "no coffee drinking" group.

Taiwan is an island country with prosperous and sophisticated agriculture and fisheries, providing easy access to fish, vegetables, and fruits that are part of the Taiwanese diet. The protective effect of fish consumption is usually attributed to its high content of long-chain omega-3 polyunsaturated fatty acids (PUFA), which are a major component of neuronal membranes and have vascular and anti-inflammatory properties, explaining their protective effect against dementia (25). On the other hand, the protective effect of vegetables and fruits is usually attributed to its rich anti-oxidant content. A previous systemic review of cohort studies, similar to our study, also showed that an increased intake of vegetables but not fruits was associated with a lower risk of dementia and slower rates of cognitive decline in older age, while most studies showed beneficial effects of both vegetables and fruits (26). We postulated that the protective effect of fruits could be counteracted by its high caloric or high sugar content, which might have detrimental effects on an aging brain compared with the effects of vegetables. The consumption of fruits showed a protective effect in the univariate regression analysis but the benefit disappeared after controlling for co-morbidity and other confounding variables in the multivariate regression.

There are some limitations of this study. First, the response rate (36.5%) of this population-based study was relatively low. The low participation rate was mainly due to difficulties to get the permission entering the residences of the randomly sampled target population distributed widely in the whole country. We have examined non-respondents and participants in 2 selected city and county and found no significant differences in the distribution of age and gender. Nevertheless, there is still some possible residual selection bias that must be taken into consideration in the generalization of the results. Second, we quantified tea, coffee, vegetables, fruits, and fish consumption by frequency but not the cumulative consumption of these dietary components. Third, the questionnaire was answered by non-demented participants or a proxy. This resulted in a global impression that probably spanned several decades of life. Fourth, these lifestyle factors and dietary habits were recorded if they were developed before dementia; however, these habits or lifestyle factors may have developed during a preclinical stage or as a result of early symptoms of dementia, which might be a consequence but not a cause of dementia pathology. Controversy also exists regarding the association of BMI with dementia. The observational bias and limitations of the cross-sectional design might result in a reversal of causality; therefore, a long-term prospective cohort study in the future is required to verify these observational findings.

In summary, the report demonstrates the potential benefit of fish, vegetable, tea, and coffee consumption against dementia on Taiwanese people. Being modestly overweight (24 < BMI <= 30) in late life was associated with decreased odds of dementia.

Conflict of Interest: All authors claim no conflict of interest.

Ethical Standards: The study was performed according to the Declaration of Helsinky.

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