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Communication

Cinnamon users with prediabetes have a better fasting working memory: a cross-sectional function study

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ABSTRACT

Working memory (WM) is impaired in prediabetes. We hypothesized that culinary herbs and spices may decrease insulin resistance (IR) and improve WM in prediabetes. Healthy people aged ≥60 years with prediabetes (fasting blood glucose 100-125 mg/dL) (47 men and 46 women) whose food and culinary herb intakes were established with a food frequency questionnaire had body composition assessed and fasting glucose and insulin measured. Working memory and Mini-Mental State Examination (MMSE) were assessed on the same occasion. The contributions to associations between WM and diet, body fat, and IR were estimated by linear regression. Compared with nonusers, cinnamon users had significantly less frequent physical activity (2.9 vs 4.4 times per week) and more often used fresh ginger (93.3% vs 64.1%) and ginger in cooking (60.0% vs 32.1%). Cinnamon users also had a better WM (2.9 vs 2.5, $P < .001$). Cinnamon had a significant effect (users were 0.446 higher), but not ginger or curry usage, in predicting WM. For sociodemographic variables, only education (years) was significant in predicting WM (β = 0.065). Other significant determinants of WM were total fat mass (kilograms) (β = –0.024) and MMSE (β = 0.075). After adjustment for age and sex, cinnamon use, education, and MMSE remained significant individual predictors. In the final model, in which all variables listed were adjusted simultaneously, cinnamon users still had a significantly higher WM than nonusers. Cinnamon usage is associated with a better WM, not accounted for by dietary quality or IR, in untreated prediabetes.

Abbreviations: WM, working memory; IR, insulin resistance; BMI, body mass index; HOMA-IR, homeostasis model assessment of insulin resistance; SFFQ, semiquantitative food frequency questionnaire; DDS, dietary diversity score; MMSE, Mini-Mental State Examination.

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1. Introduction

It is now known that, in diabetes [1–9] and prediabetes [10–13], the risk of cognitive impairment is increased. However, progressive impairment is not inevitable and can be slowed by more effective glycemic control [14]. The options for risk reduction of diabetes-related cognitive impairment are limited nevertheless and are eagerly sought where the prevalence of both diabetes and dementia is on the rise.

Culinary herbs and spices like cinnamon are candidates to reduce the burden of diabetes and cognitive impairment with relative safety and at low cost [15–18]. In the case of turmeric, it can improve both postprandial [19,20] and medium-term [20] working memory (WM) and may be associated with less dementia in curry-consuming populations. Ginger also may enhance cognitive function [21,22]. The mechanism whereby herbs and spices might favor neuronal activity are under active investigation and range from energy regulation and mitochondrial function [7,23] to neurotransmission and protein-folding disorders [23]. Moreover, it is now known that the usage of spices in China is associated with greater survival [24]. Cognition together with diet plays a role in survival among Taiwanese who are dominantly Chinese [25].

Working memory reflects short-term cognitive operations. It is an important mental attribute, required for planning, problem solving, and reasoning [26,27]. To evaluate the relationship between culinary herb intake and cognitive impairment, we documented the diet and assessed WM in older free-living Taiwanese men and women with prediabetes in a national health checkup program. They were not known to have cognitive impairment and were otherwise in good health.

Thus, we hypothesized that individuals predisposed to cognitive impairment on account of age and prediabetes would have a WM which was associated with culinary herb or spice usage as found in people accustomed to northeast Asian dietary patterns (dominantly Chinese). Specifically, we considered ginger, curry (turmeric), and cinnamon.

2. Methods and materials

2.1. Subjects and study design

A total of 93 participants (47 men and 46 women) with untreated prediabetes were studied from a health checkup program for older adults at Tri-Service General Hospital in Taiwan during 2012 and 2013. Some 1163 older inhabitants of Taipei City were screened and 280 with prediabetes found (Figure). Subject to consultation with a Family Medicine Practitioner, 99 people consented in writing to participate. All recruited participants met the following criteria: aged 60 years or older, body mass index (BMI) within 18.5-30 kg/m^2, and fasting glucose between 100 and 125 mg/dL (5.5-7.0 mmol/L), but no history of medication for diabetes, no severe chronic disease, and no recent acute illness or hospitalization in the preceding 2 months. The exclusion criteria were a history of heavy drinking in the previous 2 weeks, had used ginseng or garlic supplements, had an estimated glomerular filtration rate ≥45 mL/(min 1.73^2), or had been exposed to contrast medium within t3 days. On the morning of the study, Mini-Mental State Examination (MMSE) [28] and WM were assessed. Because 4 participants were noncompliant with fasting, they were excluded. A further 2 individuals had dietary intake data which were implausible and were also excluded. The study protocol was approved by the ethics committees of the Tri-Service General Hospital, National Defense Medical Center, and the National Health Research Institutes of Taiwan.

2.2. Working memory

The modified version of the WM test used, based on number sequence recall, has been described previously [19,26,27]. All participants performed the WM test after an overnight fast and before breakfast. Four of 10 digits were displayed randomly, and participants were asked to recall 1 digit by its order. If the answer was correct, then the subject gained 1 point. This was repeated 3 times, so that the maximum score was 3. Working memory was assessed by investigators experienced in the methodology and without knowledge of the background diet.

2.3. Questionnaires

Participants were administered 2 questionnaires by face-to-face interview with trained dietitians. One was to do with sociodemographic characteristics, personal behaviors (physical activity, smoking, drinking alcohol, betel nut chewing), clinical history, and medication usage. The other was a 32-item semiquantitative food frequency questionnaire (SFFQ) with an additional 5 questions focused on culinary herb and spice intake frequency to assess diet during the year before interview. The 7 intake frequency responses ranged from "never" to "6 or more times per day." The intraclass correlation coefficients of 2 repeats of the SFFQ 1 month apart were 0.4 to 0.8 for various nutrients. For biomarkers, the Spearman rank correlation coefficients were 0.34 for folate and 0.31 for vitamin B-6, respectively, which indicate that the dietary methodology has relatively good predictive power [29]. This SFFQ was also shown to be predictive of plasma docosahexaenoic acid [30].

A dietary diversity score (DDS), an indicator of dietary quality, with a range of 1-6 was derived on the basis of at least half a serving per day for a score of 1 for any of 6 food groups (dairy, eggs/legumes/fish/meat, grain, fruit, vegetable and oil/fat) and validated [31,32].

2.4. Investigations for body composition and glycemic status

Body composition was assessed by anthropometry for BMI and dual-energy x-ray absorption for body fat. Fasting glucose and insulin were measured to confirm prediabetes and to calculate the homeostatic model assessment for insulin resistance (HOMA-IR) [33,34].

2.5. Statistical analyses

Sample size calculations were based on WM responses previously reported where it was possible to recognize in