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Original Study

# The Dietary Approaches to Stop Hypertension Diet, Cognitive Function, and Cognitive Decline in American Older Women

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## ABSTRACT

*Objectives:* To examine the association between long-term adherence to the Dietary Approaches to Stop Hypertension (DASH) diet with cognitive function and decline in older American women.
*Design:* Prospective cohort study.
*Setting:* The Nurses' Health Study, a cohort of registered nurses residing in 11 US states.
*Participants:* A total of 16,144 women from the Nurses' Health Study, aged ≥70 years, who underwent cognitive testing a total of 4 times by telephone from 1995 to 2001 (baseline), with multiple dietary assessments between 1984 and the first cognitive examination. DASH adherence for each individual was based on scoring of intakes of 9 nutrient or food components.
*Measurements:* Long-term DASH adherence was calculated as the average DASH adherence score from up to 5 repeated measures of diet. Primary outcomes were cognitive function calculated as the average scores of the 4 repeated measures, as well as cognitive change of the Telephone Interview for Cognitive Status score and composite scores of global cognition and verbal memory.
*Results:* Greater adherence to long-term DASH score was associated with better average cognitive function, irrespective of apolipoprotein E ε4 allele status [multivariable-adjusted differences in mean z-scores between extreme DASH quintiles = 0.04 (95% confidence interval, CI 0.01−0.07), $P$ trend = .009 for global cognition; 0.04 (95% CI 0.01−0.07), $P$ trend = .002 for verbal memory and 0.16 (95% CI 0.03 −0.29), and $P$ trend = .03 for Telephone Interview for Cognitive Status, $P$ interaction >0.24]. These differences were equivalent to being 1 year younger in age. Adherence to the DASH score was not associated with change in cognitive function over 6 years.
*Conclusions:* Our findings in the largest cohort on dietary patterns and cognitive function to date indicate that long-term adherence to the DASH diet is important to maintain cognitive function at older ages.

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With the aging population, it is important to find modifiable risk factors to prevent cognitive decline and reduce the number of people with dementia.[1] One hypothesized factor is nutrition, and specifically dietary patterns in which combinations of nutrients and foods are studied simultaneously.[2] A frequently studied dietary pattern is the Mediterranean Diet, which has been associated with a lower rate of cognitive decline.[3]

Another dietary pattern of interest is the Dietary Approaches to Stop Hypertension (DASH) diet. The DASH diet specifies higher intakes of fruits, vegetables, low-fat dairy products, whole grains, poultry, fish, and nuts and low intakes of fats, red meat, sweets and sugar-containing beverages.[4] This diet has been shown to lower blood pressure in prehypertensive and hypertensive adults.[5] It has been hypothesized that the DASH diet could impact cognitive function, as high blood pressure is associated with higher risk of mild cognitive impairment,[6] vascular dementia,[7] and neuro-cognitive deficits.[8] A few observational studies have evaluated the DASH diet in relation to cognitive function and reported that the DASH diet was associated with a better cognitive function in elderly men and women (n = 3831) in the United States (US) over an 11-year period,[9] and with less cognitive decline among elderly American men and women (n = 826) after 4.1 years of follow-up.[10] A dietary intervention study (n = 124) demonstrated that 4 months on the DASH diet improved psychomotor speed in hypertensive American adults.[11]

We examined the association of long-term DASH diet adherence to cognitive function and 6-year cognitive decline among 16,144 women.

## Methods

### Study Population

The Nurses' Health Study began in 1976, with 121,700 female, registered nurses, aged 30–55 years, residing in 11 US states. Participants completed a mailed questionnaire about their health and lifestyle. Follow-up questionnaires are sent every 2 years; follow-up of the cohort remains ∼90% to date. In 1984, participants completed a 116-item semiquantitative food frequency questionnaire (FFQ),[12] and similar FFQs were sent in 1986 and every 4 years thereafter. During 1995–2001, women who were ≥70 years old and free of stroke were invited to participate in their first telephone-based study of cognitive function. For the first interview, 93% of eligible women participated (n = 19,415). Follow-up assessments were performed 3 times at 2-year intervals until 2008, with a high participation rate (>90% among those remaining alive at each follow-up point). The study was approved by the Institutional Review Board of Brigham and Women's Hospital (Boston, MA).

In the present study, we excluded those who had not completed at least 1 of the 2 initial FFQs in 1984 or 1986 (n = 2892), without at least 1 complete cognition battery at follow-up (n = 334), had no data for physical activity (n = 36), or no information on energy intake (n = 9), resulting in a total population for analysis of 16,144 participants.

### Dietary Assessment and DASH Diet Score

For each item of the FFQ, responses ranged from "never or <1 time/month" to "≥6 times/day"; a standardized portion size was specified for each food item to estimate quantities consumed daily. Food intake estimations were converted into nutrient intakes by multiplying the frequency of consumption of each food by its nutrient content by using the US Department of Agriculture database.

In this study, we used the 1984, 1986, 1990, 1994, and 1998 FFQs to estimate daily energy intake and to construct, at each of these time points, an alternate DASH 9-point score.[13] This score enhances the

original DASH score by Appel et al[4] and is based on 8 criteria: high intake of fruits, vegetables, nuts and legumes, whole grains, low-fat dairy products, and low intake of sodium, red and processed meats, and sweetened beverages.[13] As the DASH diet also aims for lower amounts of saturated fat and cholesterol with higher levels of unsaturated fatty acids, the component monounsaturated fatty acids plus polyunsaturated fatty acids has been added to the original score, resulting in a total of 9 components. For each of the components, we classified women into quintiles according to their intake ranking. Component scores were the women's quintile ranking; 1 point was given for the lowest quintile of intake and 5 points for the highest intake. The scoring was reversed for components to limit (sodium, red and processed meat, and sweetened beverages). Long-term dietary habits are likely most relevant because cognitive decline develops over many years.[14] Therefore, long-term DASH score was computed as the mean of up to 5 DASH scores from all dietary assessments from 1984 (or 1986, if 1984 FFQ was missing) to the questionnaire immediately preceding the first cognitive examination. Total long-term DASH scores were divided into quintiles based on the study population distribution.

### Cognitive Assessment

Cognitive testing was performed by trained interviewers using validated telephone interviews. The cognitive battery included (1) the Telephone Interview for Cognitive Status (TICS)[15]; (2) immediate; and (3) delayed recalls of the East Boston Memory test (EBMT)[16]; (4) delayed recall of the TICS 10-word list; (5) category fluency; and (6) digit span-backward. In the initial cognitive interview, we administered only the TICS and gradually added the 5 other tests. Thus, the sample size slightly differs across tests, but the participation rate remained identical for all tests.

The TICS[15] (range 0–41 points) is a telephone adaptation of the Mini-Mental State Examination,[17] which assesses global cognitive performance. The immediate and delayed recalls of the EBMT[16] (range 0–12 points) assess verbal (episodic) memory. The delayed recall of the TICS 10-word list (range 0–10 points) also assesses verbal memory. A category fluency test assesses language and executive function[18] by scoring performance on naming as many animals as possible in 1 minute. Finally, the digit-span backward test (range 0–12 points), in which participants repeat backwards and increasingly long series of digits, assesses working memory and attention.

The primary outcomes were the TICS and composite scores of global cognition and verbal memory. A global cognition score was computed as the mean of z-scores of all 6 cognitive tests in the cognitive battery. A verbal memory score was calculated as the mean of z-scores of the 4 tests assessing verbal memory (ie, immediate and delayed recalls of both the EBMT and the TICS 10-word list). We calculated z-scores at each time point using the distribution of scores at the first cognitive assessment.

### Other Variables

Sociodemographic, lifestyle, and health-related information were obtained from the questionnaires. Using cumulative and updated information from 1976, covariates were determined at the time of the first cognitive interview, except physical activity and energy intake, for which values were averaged across multiple assessments over time, similar to diet. Physical activity was assessed in 1986, 1988, and 1992, and every 2 years thereafter by estimating mean energy expended per week (in metabolic equivalent-hours, mets). In a randomly selected subsample of 5822 participants, data on apolipoprotein E (ApoE) ε4 polymorphisms was available from cheek cell specimens (n = 3469) and genome-wide association studies (n = 2353).