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Research Article

Cognition and Differences in Self-Report and Biochemical Measurement of Dietary Intake: Food For Thought

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Abstract

Few studies have considered cognitive performance in older adults when assessing dietary intake with self-report measures. This pilot study used a small sample (N = 50) of predominantly African American older adults in a geriatric primary care center to better understand the role that cognition may play in obtaining an accurate assessment of dietary intake based on self-report. Two types of dietary self-report measures (Dietary Risk Assessment [DRA], Dietary Health Questionnaire [DHQ 11] Food Frequency Questionnaire [FFQ] combined with a Picture-Sort method) were used to compare the differences in self-report measurement of selected nutrients with two biochemical markers of nutritional status (total cholesterol, serum carotenoids) among participants grouped by levels of cognitive function. Two commonly used cognitive assessment tools (MMSE 11-SV, MiniCog) were found to identify dietary intake risk when cognitive function may be limited. Although the differences in dietary self-report measures and biochemical marker measures were not found to be related to cognitive function, the authors consider explanations to stimulate further research on this challenging topic.

Keywords: Ageing, Cognition, Dietary self-report, Nutrition biochemical markers

Introduction

Dietary intake is an important contributor in the etiology, prevention and management of chronic illnesses prevalent in older adults [1]. In addition to chronic medical conditions, older adults may face declining cognitive capacity, including memory loss and executive function deficit and the risk grows as they get older [2]. It is reported that increasing age is one of the strongest risk factors for dementia, with moderate to severe memory impairment gradually increasing from 4.4% for ages 65 to 69 years to 20.1% for ages 80-84 years [3]. Brain aging, secondary effects of chronic illness or nutritional deficiencies can account for loss of cognitive function among older adults [4-7].

Maintaining an adequate diet can be challenging for older adults as appetite decreases, the presence of chronic illness and medication use increases and memory loss or executive function deficits emerge [1,8]. It is critical that health care providers accurately assess the food consumption of the older adults in their care to help them maintain optimal health and quality of life. However, declining cognitive function may make it difficult for seniors to provide accurate assessments of dietary intake. Although it is well known that chronic illness and brain aging are associated with cognitive difficulty, few studies have considered cognitive performance in older adults when assessing dietary intake with self-report measures [8-10]. Thus, there is a critical need to understand the role cognitive difficulty may play in obtaining an accurate assessment of dietary intake. This pilot study measures dietary intake using two types of self-report measures and compares differences in these self-reports with two biochemical markers of nutritional status (total cholesterol, serum carotenoids) among a small sample of older adults grouped by different levels of cognitive function.

Method

Design

An exploratory and descriptive/comparative design was used in this study. The major outcomes of the study were two subjective measures of dietary intake, two objective biochemical markers reflecting dietary intake and two commonly used cognitive screening measurement tools for measuring cognitive function. Older adults (N = 50) were recruited from a geriatric primary care setting. Data were obtained through interview (food frequency questionnaire and a picture card-sort method of dietary self-report), blood tests (serum carotenoids, total cholesterol) and brief cognitive tests (Mini-Mental State Examination II-SV and Mini-Cog). Descriptive and inferential statistics including the test, ANOVA and Correlation analysis were used to analyze the data with the latest versions of SAS and SPSS. Significance level was set at a p-value equal to or less than 0.05.

Setting and Sample

Participants were recruited from eligible patients receiving primary care services at an urban geriatric medical center. The medical center serves over 1,000 individuals per year; 90% are African American, 60% are women and 80% are indigent based on criterion of income. Patients were eligible to participate if they were 1) 60 years of age or older, 2) English speaking and 3) capable of completing the assessment protocol. Patients who 1) use medications or dietary supplements that could interfere with accurate measurement of nutritional biomarkers, 2) had significant motor, visual or severe neurological and/or

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cognitive impairments; 3) had been diagnosed with chronic alcoholism, liver disease or inflammatory intestinal disorders that affect metabolism of pro-vitamin A carotenoids (e.g., beta-carotene); or 4) weighed less than 110 pounds were excluded from participation.

During a routine clinic visit, clinic staff introduced the study to patients and interested patients were contacted by project staff. Individuals who met the eligibility criteria were invited to participate and informed consent was obtained. A sample of 50 participants were recruited for this study, which was adequate to achieve 80% power to detect an effect size of 0.35 at a 0.05 level of significance [11]. The study was approved by the University and Medical Center's Human Investigation Committee and Institutional Review Boards.

Data collection

Project staff collected data at the geriatric medical center in two 60-90 minute visits over a 9-month period through structured interview and cognitive testing. At the first visit, participants were screened for their level of cognitive functioning, completed a dietary intake questionnaire and provided demographic information. A second appointment was scheduled within 1-4 weeks of the first and participants were told to fast for 12 hours prior to the next appointment, to avoid smoking and to refrain from heavy physical activity for at least two hours prior to their appointment. Again, appointments were confirmed by project staff 1-2 days before the second scheduled visit date and participants were reminded about preparation instructions. At the second visit, a blood sample was drawn at the medical center laboratory for analysis of nutritional biomarkers and a second dietary intake measurement was obtained.

Measurement Instruments

Cognitive, dietary intake, nutritional biomarkers and socio-economic demographic data were collected. Cognitive function was measured using the Mini-Mental State Examination (MMSE-2SV) and the Mini-Cog brief screening test. Dietary intake was measured using the Dietary Risk Assessment (DRA) and Dietary Health Questionnaire (DHQ 11) and Food Frequency Questionnaire (FFQ) combined with a Picture-sort method. Nutritional biomarkers were measured with serum total cholesterol and serum carotenoids (alpha carotene, beta carotene, zeaxanthin and lutein) forming a serum carotenoid index. Socio-economic demographic was collected using a brief investigator-generated questionnaire.

Cognitive function

Two measures of cognitive function were used in this study: The Mini-Mental State Examination, 2nd Edition Standard Version (MMSE-2SV) and the MiniCog assessment for dementia [12,13]. The MMSE-2SV is a widely used measure for screening cognitive functioning. It consists of 11 items (i.e., orientation, registration, recall, attention and calculation, naming, repetition, comprehension, reading, writing and drawing) and takes about 10 minutes to complete. Summing the individual items yields a total MMSE-2SV raw score (range = 0-30), with a higher score indicating better cognitive function. T-scores (a standardized score), adjusted for age and educational level, have been derived and published by PAR, Inc. For the purposes of this study, a participant who received a T-score greater than 2 SD from the mean of his/her referent group (referent group adjusts for age and education) was considered to be a failed cognitive screen. Likewise, a raw clinical score of 0-17 was designated as significant impairment, 18-23 = designated as mildly impaired and 24-30 = normal screening results (an algorithm commonly used by practitioners). The MiniCogis a brief screening test recommended by Nurses Improving Care for Health System Elders (NICHE). Easily administered in 5 minutes, the patient is asked to repeat three unrelated words and then recall the words after completing a clock drawing interpolated task. Each correctly recalled word receives 1 point and a correctly drawn clock face receives 2 points, for a possible total of 5 points. A total score less than two points indicates a failed screening test.

Dietary intake

Two self-report methods for measuring food intake were administered. The Dietary Risk Assessment (DRA), a Food Frequency Questionnaire (FFQ) developed for use by health care providers not trained in dietetics who provide nutritional counseling, was used to describe the dietary intake of participants [14]. The DRA was based on representative diets of African Americans and validated in a sample of African American women 40-64 years of age. It includes 54 questions about consumption of foods in the following four categories: 1) meats; 2) side dishes, desserts, snacks; 3) spreads, salad dressing, oils; and 4) dairy, eggs, cereal, and salt. To guide nutritional counseling of individuals, three columns are arranged to categorize responses for each question; the left column indicating healthy dietary intakes (0 points), while the middle (1 point) and right columns (2 points) indicate less healthy responses. Scores are summed for a total DRA score ranging from 0-108, with a higher score indicating a less healthy diet. Jillcott and colleagues developed Dietary Risk Assessment Indexes for fruits (2 items), vegetables (2 items), fruits and vegetables (4 items), fiber (9 items), total fat (27 items) and saturated fat (29 items) based on the original DRA [15]. Selected indexes were used to compare dietary intake with the nutritional biomarkers described below. As with the original DRA, item scores range from 0-2 with a higher score indicating a less healthy diet. The second assessment of dietary intake used a picture sort methodology based on a food frequency estimation process developed by Kumanyika and her colleagues [16,17]. The Picture-sort has been shown to be appropriate for use in diverse populations of older adults where literacy and language skills may be limited. One-hundred and forty picture cards were used to represent the items from the National Cancer Institute (NCI), Dietary Health Questionnaire (DHQ II) and Past Month questionnaire. Each card had a named color picture of a food or beverage item and was numbered to correspond to the numbered item listed on the printed form of the questionnaire. In step one, the participants were given the complete set of cards and requested to sort them into five separate trays according to their food intake during the previous month. Each tray had labels corresponding to five categories, from left to right: "about 1 to six times or more a day," "about 1 to 6 times per week," "about 2 to 3 times in the past month," "about 1 time in the past month," or "never." On completion of the initial self-administered activity which was facilitated by the interviewer when required, the interviewer guided the individual through step two by asking the participant about food and beverage cards they placed in each tray. The interviewer began by asking about the most frequently consumed category and determined the specific frequencies and portion size of consumption of the food or beverage item. Measuring cups and measuring spoons were used to assist with accurate identification of portion sizes. This two-step version permitted individuals to arrange the foods in a personalized order of consumption frequency followed by an opportunity to make corrections during a "second pass." The interviewer recorded the individual's step-two responses on the Dietary Health Questionnaire (DHQ II) Past Month Questionnaire. Responses from the DHQ II questionnaire were analyzed using the Diet*Calc software developed by NCI. The responses from the DHQ II questionnaire were transferred to the DHQ II Past month scantron and sent for processing to Optimum Solution Corporation (OSC), Lynbrook, NY (a recommended processor by NCI). The two-step Picture-sort method has been validated using dietary recalls with Pearson correlation coefficients ranging from 0.4 to 0.7 and in a sample of black women who participated in the Black Women's Health Study [16-18].

Biomarkers of nutritional status

The availability of nutritional biomarkers has offered a method for measuring change in biochemical functions, permitting the validation of dietary self-report assessments [15,19]. Of particular interest to this study was the reported association between plasma carotenoids and fruit and vegetable dietary intake and total cholesterol and dietary fat and cholesterol intake [15,20,21]. Serum carotenoids and total cholesterol were analyzed and compared with the self-report measures of dietary intake. Total intake of fruits and vegetables has been determined to be a significant determinant of each plasma carotenoid, except lycopene [20]. Carotenoids are potent antioxidants and have been associated with health effects [22]. Values for four serum carotenoids (alpha carotene, beta carotene, zeaxanthin, and lutein) were summed to provide a carotenoid index. Three of the four plasma carotenoids to be measured in this study (alpha-carotene, beta carotene and lutein) have been found in a crossover analysis to demonstrate a high degree of sensitivity to minimal changes in dietary servings [23]. Serum total cholesterol was analyzed and used to compare with self-report measures of dietary fat.

Socio-economic demographic data

Participants completed the Interview guide and Health screening form, a demographic and health screening interview developed by Artinian and colleagues which was modified for the purpose of this study [24].

Findings

Sample description

The sample consisted of fifty participants with an age range of 61-90 years (Mean age = 75.53 years, SD 7.95 years). The majority (76%, n = 38) of the sample were women and 24% (n = 12) were men. African Americans were the predominant race represented (82%, n = 41) with few Caucasians (18%, n = 9). About 82% (n = 41) of the sample were widowed, divorced, or separated. A large proportion of the men and women lived alone (42%, n = 21). Although the range of education in years of the sample was large (3-22 years), most of the participants had completed high school (median = 12 years) and a large percentage (42%, n = 21) had some college or had received graduate degrees. The income of the sample was diverse with approximately half of the sample (56%) reporting an annual income below $20,000, while a significant percentage (16%) reported income greater than $50,000 annually (6% refused to report on their income or did not know). Cognitive screening using 1) the MiniCog, found a negative screen for dementia in 36 participants and a positive screen for 14 participants and 2) the MMSE II SV Standardized T scores, found impaired cognitive screening (= to or > than 2 SD from the mean adjusted for age and education) in 21 participants and normal cognitive screening (less than 2 SD from the mean adjusted for age and education) in 29 participants.

Dietary intake of older adults

Comparing dietary intakes for individuals grouped by two or three levels of cognitive function using independent t tests, and a one-way ANOVA, respectively, found significant differences in the self-report of dietary intake of fiber indicating individuals who scored higher on the DRA fiber index (higher scores represent higher dietary risk) were more cognitively impaired (MiniCog, $t(47) = -2.241$, $p = 0.03$ with a 95% confidence interval of -3.885 to -0.210; MMSE T scores, $t(47) = -2.241$, $p = 0.03$ with a 95% confidence interval of -3.885 to -0.210; MMSE raw score clinical grouping $F(2, 47) = 3.413$, $p = 0.04$). Participants scoring higher on the MiniCog brief cognitive screening test (representing higher cognitive functioning) had significantly lower scores (representing less dietary risk) on the total dietary risk assessment ($r = -0.342$, $p < 0.05$). There were no differences between cognitively normal and impaired groups in the self-report of dietary intake for all other indexes (fruit and vegetable, fat, saturated fat).

Relationship between self-report measures and biochemical markers reflecting dietary intake

There was a significant correlation between the DRA fruit and vegetable index and the serum carotenoids ($r = 0.45$, $p = 0.008$), however there was no significant relationship between the DHQ11 self-report of carotenoids and the serum lab carotenoids. Similarly, the correlation between total cholesterol and the self-reported DRA fat and DHQ 11 cholesterol was not statistically significant.

Cognitive function and the differences in standardized self-report dietary intake measures and biochemical markers of dietary consumption

Controlling for age, the differences in the self-report measures (DRA and DHQ 11) and the biochemical markers were not significantly related to the MMSE standardized T scores for participants.

Differences in standardized self-report dietary intake measures and biochemical marker scores according to established clinical cut points of cognitive functioning

There were no significance differences in the dietary intake measure and biochemical marker scores among the participants grouped by usual clinical cut-off scores for cognitive functioning.

Discussion

This pilot study, using a small sample of predominantly African American older adults in a geriatric primary care center, attempted to better understand the role that cognition may play in obtaining an accurate assessment of dietary intake based on self-report. Two cognitive assessment tools commonly used in primary care practice settings were found to both be potentially adequate in identifying dietary intake risk when cognitive function may be limited. The fact that both cognitive assessment tools performed the same and with the same dietary index (fiber) is noteworthy, as the MiniCog can be easily and rapidly integrated (5 minutes) into a busy practitioner's assessment. Moreover, the Dietary Risk Assessment (DRA) tool's significant relationship of the fruit and vegetable index to the serum carotenoid's index supports prior findings on the validity of this tool for use in dietary assessment with this population [15]. Although the DHQ 11 with the picture sort method did not demonstrate a similar relationship, it was useful in its ability to generate an individualized computer printout of an individual's dietary intake (e.g., total daily calories, individual nutrients in comparison to recommended intake). However, the DHQ 11 combined with a picture sort-method, was found to be time consuming in its administration (~ 60 minutes) and processing was challenging, therefore may be better reserved for research purposes as opposed to use by practitioners.

The inability of the difference in dietary assessment measures (subjective measure [e.g., fruit and vegetable index as self-reported] and objective measure [e.g., serum carotenoids]) to be related to cognitive function was surprising. It would seem intuitive that there would be a greater spread between what one says they ate and what the body shows it ate according to how cognitively impaired an individual is. But, the small sample size could be an answer for the lack of relationship. Several alternative and challenging explanations may also be considered. Could it be that people do not accurately report their dietary intake, whether they are cognitively impaired or not? While the literature has reported on the inaccuracies of dietary self-report, the role of cognitive function has not been given a good deal of attention [25]. In the OPEN (observing protein and energy nutrition) study to assess dietary measurement error using self-report instruments (e.g., Food Frequency Questionnaire [FFQ]) and biomarkers of energy and protein intake among 484 men and women, age 40-69, the investigators found 35% of men and 23% of women under-reported intake using the FFQ; however, cognition was not explored [25]. Alternatively, Morris et al., (2003) found the food frequency questionnaire as a reasonable dietary assessment method, even in the presence of cognitive impairment in a biracial sample of older adults in the Chicago Health and Aging Project.

Could it be, and "food for thought," that reporting dietary intake accurately is a "last to go" phenomenon, such that, one must be severely cognitively impaired before an individual cannot recall foods they have eaten? The picture sort method used with the DHQ 11 in this study may have served as a memory aid to individuals more impaired and thereby suppressing the expected differences in subjective and objective measurements for cognitively impaired individuals. Also, the pleasure older adults find in eating when faced with so much loss in other physical realms, may make the time spent in thinking of foods (what has been eaten and what is going to be eater) a cognitive function that considerable time is devoted to, and making memories easier to recall.

Future directions for study learned from this small pilot study, would be to further explore the effect of severe cognitive impairment in comparison to those determined to be dementia-free. Moreover, a study of an ethnically homogeneous sample may help to provide internal validity. Given the wide age range in the sample of this study (61-90 years), future study may consider additional analyses for younger and older adults with sectoring the sample by median age for additional analyses. Moreover, the use of linear and logistic regression models while controlling for age, education and income when examining cognitive functioning and dietary intake measures would provide a more robust understanding of the associations. It must be appreciated that the cognitive screening tools used in this study (MMSE and Mini-cog) do have their limitations of significant ceiling effects which may limit inference from the simple analyses that were conducted in this study.

Conclusion

Brief cognitive screening assessments may assist in the identification of older adults who have unhealthy dietary intakes. To improve the accuracy of nutritional status assessment in older adults, researchers and practitioners alike, may need to account for cognitive functioning in their sample and patient population. More research is needed to better understand how the use of cognitive function assessment may be used to guide individually tailored dietary intake assessment.

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