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Diet-related practices and BMI are associated with diet quality in older adults

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Abstract

Objective: To assess the association of diet-related practices and BMI with diet quality in rural adults aged ≥74 years.

Design: Cross-sectional. Dietary quality was assessed by the twenty-five-item Dietary Screening Tool (DST). Diet-related practices were self-reported. Multivariate linear regression models were used to analyse associations of DST scores with BMI and diet-related practices after controlling for gender, age, education, smoking and self- *v.* proxy reporting.

Setting: Geisinger Rural Aging Study (GRAS) in Pennsylvania, USA.

Subjects: A total of 4009 (1722 males, 2287 females; mean age 81·5 years) participants aged ≥74 years.

Results: Individuals with BMI < 18·5 kg/m^2 had a significantly lower DST score (mean 55·8, 95 % CI 52·9, 58·7) than those individuals with BMI = 18·5–24·9 kg/m^2 (mean 60·7, 95 % CI 60·1, 61·5; $P = 0·001$). Older adults with higher, more favourable DST scores were significantly more likely to be food sufficient, report eating breakfast, have no chewing difficulties and report no decline in intake in the previous 6 months.

Conclusions: The DST may identify potential targets for improving diet quality in older adults including promotion of healthy BMI, breakfast consumption, improving dentition and identifying strategies to decrease concern about food sufficiency.

Keywords
Diet quality
Ageing
Dietary-related practices

Diets consistent with dietary guidelines that are rich in fruits, vegetables, whole grains, low-fat dairy and lean meats are associated with decreased morbidity and mortality[1]. Quality of diet becomes increasingly important in old age due to declining physiological function, changes in body composition and decreased energy requirements[2,3]. Risk of undernutrition is also increased in older adults for some potentially modifiable reasons including financial constraints, appetite decline, poor dentition and functional and cognitive limitations[4]. The Dietary Screening Tool (DST) is a validated tool that utilizes food-based questions developed for use in assessing diet quality in older, rural adults[5]. It is a simple, self-administered questionnaire containing food- and behaviour-related questions that assess overall dietary quality of older adults[2]. The objective of the present study was to determine the relationship of the DST with diet-related practices and characteristics known to contribute to nutritional risk among a cohort of adults aged ≥74 years.

Materials and methods

Study participants

The Geisinger Rural Aging Study (GRAS) began in 1994 with adults aged 65 years or older enrolled in a Medicare-managed health maintenance organization. Study details have been published previously[6]. The participants have been followed as a longitudinal cohort over time with repeated measures of height, weight, medication use, diet-related practices, living environment, self-rated health and functional status. In-depth dietary assessment to estimate usual intakes has been conducted only on small subsets of the cohort in a cross-sectional manner and such data are not available for the entire cohort[5,7].

All surviving GRAS participants (*n* 5993) were mailed demographic and health questionnaires and the DST for the current study in the autumn of 2009. After follow-up, 4009 (67 %) participants (1722 males, 2287 females; mean age 81·5 years) returned completed surveys, providing

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information on age, height, weight, smoking status, diet-related practices and dietary information, among other characteristics. Additionally, self-reporting or proxy reporting by someone other than the participant was noted. The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Office of Research Protections at The Pennsylvania State University and the Human Research Protection Program of the Geisinger Health Systems Institutional Review Board. Consent was implied by survey completion.

Dietary screening tool

Detailed information on the development and validation of the DST has been described elsewhere[5,7]. The DST consists of twenty-five questions originally derived from extensive secondary analysis of the dietary intakes of rural older adults in the GRAS (see online supplementary material). The possible score range is from 0 to 100 points with 5 'bonus' points for multivitamin/mineral supplement use (score could not exceed 100). Responses to questions were then scored according to the previously validated scoring algorithm with a score <60 considered 'unhealthy', 60–75 considered 'borderline' and >75 considered 'healthy'[5]. An example of a DST question is 'How often do you usually eat whole grain breads?' Participants then chose from 'never', 'less than once a week', '1 or 2 times a week' and '3 or more times a week' to classify their intake. Cognitive interviewing was used to ensure understandability of questions for the population of interest[7]. Points were allotted for each question based upon breakdown of major dietary components of the Healthy Eating Index-2005[8]. Dietary quality was established by comparison with nutrient intakes[5,7] and food group intakes[5] derived from multiple 24 h recalls.

Eating behaviour measures

Nine total questions identified the presence of problems associated with diet-related practices through yes-or-no responses. All questions were self- or proxy reported. These questions addressed inadequate food or concerns about sufficient food, not eating on one or more days per month, having a decline in intake, eating alone, skipping breakfast, having more than one alcoholic drink per day for women or more than two per day for men, reporting chewing difficulty and mouth pain. Associations between all diet-related practices and DST score were analysed.

Statistical analyses

All data were analysed using the Statistical Analysis Software Package 9·3. Descriptive data were generated using PROC MEANS and PROC FREQ for all adults and by gender. Multivariate linear regression models were used to analyse associations of continuous DST score as the dependent variable with BMI and each of the nine diet-related practices after controlling for age (continuous), gender, education (<high school *v.* ≥high school), smoking (ever/never) and self- *v.* proxy reporting. BMI was calculated from self-reported height and weight collected in the demographic and health questionnaires, and was assessed both as a continuous variable and categorically according to National Institutes of Health guidelines (<18·5 kg/m^2, 18·5–24·9 kg/m^2, 25·0–29·9 kg/m^2 and ≥30·0 kg/m^2). All dietary behaviours that were related significantly to DST score at $P<0·05$ were retained as potential candidates for the multivariate model. Results are presented as mean DST scores with 95% confidence intervals adjusted for age, gender, self- or proxy reporting, and BMI when BMI was not the independent variable of interest. *P* values are for the tests of between-group differences from the multivariate models. Interactions between the predictors of interest (diet-related practices and BMI) and each covariate (gender, BMI, age, education, smoking, self- *v.* proxy reporting) were assessed by including each individual factor (e.g. gender) and its cross-product term in separate models. Significance was considered at $P<0·05$.

Results

Descriptive characteristics of the sample are shown in Table 1. Compared with those who completed the DST, non-responders were older (83·2 *v.* 81·4 years; $P<0·0001$) and more likely to be female (OR = 1·3, 95% CI 1·2, 1·5; $P<0·0001$). Less than 9% (*n* 333) of participants used proxy reporters and those who did were more likely to be male (OR = 1·5, 95% CI 1·2, 1·9; $P=0·0002$), less likely to report education beyond high school (OR = 0·5, 95% CI 0·3, 0·7; $P=0·0002$), older (mean 83·7 (SD 5·5) years *v.* 81·2 (SD 4·1) years; $P<0·0001$) and had lower DST scores (mean 57·6 (SD 12·3) *v.* 60·6 (SD 12·7); $P<0·0001$). The cohort was comprised almost exclusively of non-Hispanic whites (98·7%) with at least a high school degree. Less than half the sample was male (43%). BMI did not differ by gender. Although over half of the respondents lived with a spouse (*n* 2095), 46% of female respondents lived alone compared with only 20% of male respondents. The mean unadjusted DST score for the sample was 60·3 (SD 12·7), with females (mean 61·9 (SD 12·6)) reporting a significantly higher score than males (mean 58·2 (SD 12·4); $P<0·0001$).

Participants who had BMI < 18·5 kg/m^2 had significantly lower DST scores (OR = 55·8, 95% CI 52·9, 58·7) than those participants with BMI = 18·5–24·9 kg/m^2 (OR = 60·8, 95% CI 59·5, 60·9; $P=0·001$) after adjustment for age, sex, education, smoking status and self- *v.* proxy reporting. The adjusted DST score for those participants with BMI < 18·5 kg/m^2 remained significantly lower (OR = 55·8, 95% CI 52·9, 58·7) compared with the DST score for all other BMI classes combined (OR = 60·5, 95% CI 60·1, 60·9; $P=0·002$). In contrast, compared with

Table 1 Characteristics of study participants: rural adults aged ≥74 years, Geisinger Rural Aging Study (GRAS), Pennsylvania, USA, autumn 2009

	Men (*n* 1722; 43·0 %)		Women (*n* 2287; 57·0 %)	
Characteristic	Mean or *n*	SE or %	Mean or *n*	SE or %
Age (years)*	81·3	4·2	81·5	4·4
Race				
White	1654	98·2	2234	99·1
Non-Hispanic black	29	1·7	15	0·7
Other	1	0·1	4	0·2
Education				
<High school	1327	77·1	1942	84·9
≥High school	395	22·9	345	15·1
BMI (kg/m^2)				
<18·5	14	0·8	59	2·6
18·5–24·9	460	26·7	696	30·4
25·0–29·9	814	47·3	839	36·7
≥30·0	434	25·2	693	30·3
Ever smoke				
Yes	61	3·6	82	3·7
No	1629	96·4	2159	96·3
Eat breakfast				
Yes	1660	96·4	2190	95·8
No	62	3·6	97	4·2
Eat alone				
Yes	305	17·7	851	37·2
No	1417	82·3	1436	62·8
Intake decline				
Yes	111	6·5	161	7·0
No	1611	93·5	2126	93·0
Excess alcohol				
Yes	94	5·5	37	1·6
No	1628	94·5	2250	98·4
Food insufficient				
Yes	8	0·5	9	0·4
No	1714	99·5	2278	99·6
Enough food each day				
Yes	1681	97·6	2254	98·6
No	41	2·4	33	1·4
No food some days				
Yes	4	0·2	7	0·3
No	1718	99·8	2280	99·7
Chewing difficulty				
Yes	69	4·0	87	3·8
No	1653	96·0	2200	96·2
Mouth pain				
Yes	41	2·4	53	2·3
No	1681	97·6	2234	97·7
DST score*	58·2	12·4	61·9	12·6
DST category†				
<60	917	53·3	925	40·4
60–75	629	36·5	976	42·7
>75	176	10·2	386	16·9

DST, Dietary Screening Tool.
*These data are presented as mean and standard error; all other data are presented as number and percentage.
†Categories utilized from previously published data[1].

participants with BMI = 18·5–24·9 kg/m^2, there were no statistically significant differences in DST score for either overweight or obese individuals (see Table 2). There were also no significant associations between BMI and any of the diet-related practices.

Four of the nine diet-related practices were significantly associated with DST score after adjustment for BMI, age, sex, education, smoking status and self- *v.* proxy reporting (Table 2). Significantly lower DST scores were found in participants who reported a decline in intake over the previous 3 months, skipping breakfast, concern about having enough food and difficulty with chewing or swallowing. The remaining five diet-related practices were not significantly associated with DST score. No meaningful and significant effect modifications were observed between any variables tested (data not presented).

Discussion

It was our goal to investigate the associations between BMI, diet-related practices and diet quality in a population

Table 2 Association between adjusted mean DST score, diet-related practices and BMI: rural adults aged ≥74 years, Geisinger Rural Aging Study (GRAS), Pennsylvania, USA, autumn 2009

Eating practice*	Adjusted mean DST score	95 % CI	*P* value†
Skip breakfast	51·7	49·8, 53·7	<0·0001
Eat breakfast	60·8	60·4, 61·2	–
Eat alone	60·5	59·8, 61·3	0·71
Eat with others	60·4	59·9, 60·8	–
Intake decline	56·8	55·3, 58·3	<0·0001
No decline	60·7	60·3, 61·1	–
Excess alcohol	58·7	56·5, 60·9	0·12
No excess alcohol	60·5	60·1, 60·9	–
Food insufficient	53·9	48·0, 59·8	0·03
Food sufficient	60·4	60·0, 60·8	–
Not enough food each day	58·9	56·1, 61·8	0·32
Enough food each day	60·4	60·0, 60·8	–
No food some days	57·4	49·7, 65·1	0·44
Always have food	60·4	60·0, 60·8	–
Chewing difficulty	58·2	56·3, 60·2	0·03
No difficulty	60·5	60·1, 60·9	–
Mouth pain	59·8	57·2, 62·3	0·63
No mouth pain	60·4	60·0, 60·8	–
Underweight (BMI < 18·5 kg/m^2)‡	55·8	52·9, 58·7	0·001
Not underweight	60·5	60·1, 60·9	–

*Controlling for sex, BMI, age, smoking status, education and self- *v.* proxy reporting.
†Represent differences between groups (appetite decline *v.* no decline, concern about food *v.* no concern, etc.) after adjustment for covariates.
‡Controlling for sex, age, smoking status, education and self- *v.* proxy reporting.

of adults aged ≥74 years. There are limited data on dietary quality for large cohorts of older adults, particularly those living in rural areas. Our results indicate that a low DST score is associated with low BMI and poor diet-related practices including chewing difficulties, skipping breakfast, concerns of food sufficiency and decline in intake.

Older adults with low BMI had a much poorer diet quality than all other older adults, including those who were obese. Population studies suggest that risk of mortality is doubled in older adults who have a BMI <18·5 kg/m^2 compared with 18·5–24·9 kg/m^2 independent of recent weight change[9,10]. The association between obesity and mortality in older adults is complex, with overweight and mild obesity being associated with reduced mortality in cohort studies of adults ≥65 years old with follow-up periods ranging from 3 to 18 years[9–11]. In a prior investigation within a small subset of the GRAS cohort (*n* 179) we found that a low nutrient-dense diet was associated with increased odds of obesity[12] and lower waist circumference was associated with a prudent dietary pattern[7]. In the current study, an association between obesity and diet quality was not detected. Of note, no participants in our previous study had BMI < 18·5 kg/m^2[12].

Chewing difficulty, skipping breakfast, food insufficiency and decline in intake were associated with poor diet quality. Chewing difficulty is linked to many adverse clinical outcomes, including a variety of morbidities, hospitalization and earlier mortality, and has been shown to affect consistency and selection of food[4]. Skipping breakfast is associated with decreased nutrient intake, which may impact development and progression of chronic disease[13]. In a nationally representative sample of adults aged 60–90 years, those who were food-insufficient consumed significantly less energy, carbohydrate, protein, saturated fat, Fe and Zn among other micronutrients and were more likely to report poor self-rated health than their food-sufficient peers[14]. Decline in intake may lead to unintentional weight loss which is often indicative of underlying disease, and undernutrition in older adults is strongly associated with increased mortality[15,16]. The DST is able to identify these diet-related practices as targetable areas for improvement in diet quality and potentially other health outcomes in older adults.

A relatively high response rate (67 %) in an aged community-dwelling cohort is a major strength of this investigation. However, there are some notable limitations to address. The external validity of the DST remains to be determined in other races and geographic regions. The number of remaining underweight older adults was quite low, likely due to decreased survivorship in elderly individuals with a low BMI[9,10]. The screening questionnaires rely on self-report, making results subject to recall bias. Additionally, only information regarding age and sex was available for non-responders and so additional comparisons could not be made.

Previously the DST was administered in an out-patient clinic setting, requiring participants to visit their local medical clinic in order to complete the questionnaire[5]. Rural older adults experience many barriers to health care including but not limited to social isolation, lack of transportation and financial constraints[17]. By surveying rural adults in their own homes, we were able to find targetable areas for improvement of nutritional quality. Overall food consumption decreases with age and it becomes increasingly important for older adults to consume high-quality nutrient-dense foods to meet nutrient needs[18].

The diet-related practices found to be associated with DST score serve as potential targets for altering behaviour to promote nutrient and energy intakes sufficient to meet requirements. It should also be noted that the mean overall DST score was below optimal (mean = 60) with 86 % of participants scoring ≤75 on the DST. According to previous studies, this indicates that 86 % of this sample has either unhealthy or borderline diet quality, and so has room for improvement[5].

Conclusions

Older adults are at increased susceptibility for malnutrition due to age-associated changes in metabolism and physiology[18], and with the number of aged persons increasing rapidly in our population[19] improving nutritional status is a priority. Low DST scores were associated with low BMI, being food insecure, recent decline in food intake, skipping breakfast and chewing difficulties. These associations may help to identify opportunities for anticipatory guidance and interventions for health-care professionals to promote improvement in diet quality.

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Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1368980013001729

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