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The Associations Between Diet Quality, Body Mass Index (BMI) and Health and Activity Limitation Index (HALEX) In The Geisinger Rural Aging Study (GRAS)

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Abstract

Objectives—To determine the associations between diet quality, body mass index (BMI), and health-related quality of life (HRQOL) as assessed by the health and activity limitation index (HALex) in older adults.

Design—Multivariate linear regression models were used to analyze associations between Dietary Screening Tool (DST) scores, BMI and HALex score, after controlling for gender, age, education, living situation, smoking, disease burden and self-vs. proxy reporting.

Setting—Geisinger rural aging study, Pennsylvania.

Participants—5,993 GRAS participants were mailed HRQOL and DST questionnaires with 4,009 (1,722 male, 2,287 female; mean age 81.5 ± 4.4) providing complete data.

Results—HALex scores were significantly lower for participants with dietary intakes categorized as unhealthy (<60) (0.70, 95% CI 0.69, 0.72, p<0.05) or borderline (60-75) (0.71, 95% CI 0.70, 0.73, p<0.05) compared to those scoring in the healthy range (>75) (0.75, 95% CI 0.73, 0.77) based on DST scores. HALex scores were significantly lower for underweight (0.67, 95% CI 0.63, 0.72, p<0.05), obese class II (0.68, 95% CI 0.66, 0.71, p<0.05) and class III participants (0.62 95% CI 0.57, 0.67, p<0.05) compared to those with BMI 18.5-24.9.

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Conclusions—Poor diet quality, as assessed by the DST, is associated with lower HRQOL in adults ≥ 74 years of age.

Keywords

Diet quality; quality of life; HALex; aging

Introduction

Though life expectancy continues to rise, the increase in length of life does not necessarily equate with an increase in quality years of living (1). Quality of life (QOL) is a broad multidimensional concept based on subjective measures of life (2). More specifically, health related quality of life (HRQOL) encompasses aspects of quality of life that have been shown to affect health including physical and mental health perceptions (2). HRQOL is a research priority in the aging population (2). Evaluating measures for monitoring HRQOL in the United states is a goal of healthy People 2020 (3, 4). Greater understanding of the factors that impact HRQOL in an aging population with a high prevalence of chronic health conditions can guide interventions to improve QOL (1, 3, 5). The health and activity Limitation index (HALex) is a single measure of HRQOL consisting of two components: perceived health and activity limitation. While both poor diet quality (6) and a BMI ≥ 30 have been shown to contribute to decreased HRQOL (7-9) in older adults, this association has not been well characterized. Furthermore, understanding of the relationship between diet quality and HRQOL is even more limited (10). The objective of this study was to determine the associations between diet quality as assessed by the Dietary screening tool (DST), BMI and HRQOL assessed by the HALex in adults aged 74 and older.

Subjects and Methods

The Geisinger Rural Aging Study (GRAS) began in 1994 with more than 20,000 adults > 65 years old enrolled in a Medicare managed health maintenance organization (11). Specific details of subject recruitment have been published previously (11). Participants have been followed as a longitudinal cohort over time. Repeated measures of height, weight, medication use, living environment, self-rated health and functional status are available.

All surviving GRAS participants (n=5,993) were mailed a demographic and health questionnaire and the DST for the current study in fall of 2009. After follow-up 4,009 (67%) (1,722 male, 2,287 female; mean age 81.5 years) participants provided complete information including age, height, weight, smoking status, dietary information, self-rated health and self-reported functional limitations among other characteristics. Additionally, self-report or proxy reporting by someone other than the participant was noted. The study protocol was approved by both 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.

DST, BMI and HALex

The DST has been described in detail previously (11, 12). Briefly, extensive analysis of the dietary intake of rural older adults in the GRAS cohort was used to derive 25 food-based questions. All questions were created to capture usual intake and points were allotted for each question based upon breakdown of major dietary components of the Healthy Eating Index (HEI)-2005. The possible score range is from 0-100 points; with five “bonus” points for multivitamin/mineral supplement use (score could not exceed 100). Responses were scored according to the previously validated scoring algorithm with a score < 60 considered ‘unhealthy’, 60-75 ‘borderline’, and > 75 ‘healthy’ (12). The DST demonstrated good test-retest reliability with a coefficient of 0.83 ($p<0.0001$) (12) and was validated through analyzing relations between dietary patterns and dietary data derived from multiple 24 hour recalls (11). For this analysis, BMI was assessed per National Institutes of Health (NIH) guidelines with a BMI of < 18.5 considered low, 18.5-24.9 healthy, 25-29.9 overweight, > 30 obese class I, 35-39.9 obese class II and ≥ 40 obese class III.

The HALex is a measure that combines an individual's report of activity limitation and self-rated health into a single HRQOL score that ranges from 0.00 (death) to 1.00 (optimal health) (13). An individual who reports being in excellent health and having no functional limitations (i.e., no limitations in activities of daily living (ADLs) or instrumental activities of daily living (IADLs)) receives a score 1.00. Scores on this 0-1.00 continuum were derived based on five states of self-rated health (excellent, very good, good, fair and poor) and six levels of activity limitation (not limited, limited- other, limited- major, unable- major, limited in IADL, limited in ADL) (13). The HALex was originally developed using data from the National Health Interview Survey (NHIS) and validated using 41,104 persons over the age of 18 standardized to 10,000 persons by age and gender group (14). Age was a consideration for placement on the score matrix regarding activity limitation categories (14). In the present analysis, all participants were ≥ 74 years old, so to model findings as closely as possible to those analyses used in tool development, only categories befitting these age groups (not limited, limited in IADL, limited in ADL) were used. The range of present scores is 0.1 to 1.00.

Statistical Analysis

All data were analyzed using the Statistical Analysis Software Package 9.3 (SAS Institute Inc., Cary, NC). Multivariate linear regression models were used to analyze associations between continuous HALex score as the dependent variable with BMI and DST based on previously derived categories. Results are presented as adjusted mean (LSMEAN) HALex score with 95% CI adjusted for age (continuous), gender, education (< high school v. > high school), smoking status (ever/never), living situation (with spouse, son/daughter, other family, other, alone), self-vs. proxy reporting and disease burden. The disease burden covariate is a continuous variable accounting for self-reported diseases including hypertension, diabetes, high cholesterol, lung disease or breathing problems, cancer, coronary heart disease, heart failure, angina and heart attack. P-values represent the comparison between the indicated group and the referent group. Participants missing any of the aforementioned variables made up a combined total of less than two percent of the sample and were excluded in multivariate analyses. Effect modification by gender, BMI, age, education, smoking, living situation, self-vs. proxy reporting and disease burden was assessed by including the individual factor (e.g., gender) and its cross-product term in separate models with each of the independent variables of interest, DST score and BMI. Effect size was determined using f^2 and effect sizes for both models were moderate (0.19) (15). We used Bonferroni's adjustment for multiple comparisons, and significance was set at P<0.05.

Results

Descriptive characteristics are presented in Table 1. Compared to those who provided complete information, non-responders and those with incomplete information were older (83.2 vs. 81.4; p<0.05) and more likely to be female (OR: 1.3 95% CI 1.2, 1.50, p<0.05). The entire cohort was comprised of primarily non-Hispanic white, high-school educated, self-reporting individuals. While females had significantly higher diet quality than males (DST scores 61.9± 12.7 vs. 58.2 ± 12.5, p<0.05), the inverse was true for HALex scoring (Males: 0.75 ± 0.20, Females: 0.73 ± 0.22, p<0.05). However, this interaction did not reach statistical significance. the mean DST score overall was very close to the 'unhealthy' range (60.4 ±12.7).

The association between DST score and HALex score was assessed (Table 2). Adjusted HALex score was examined by categorical DST score based on previously defined breakdowns (12). Participants with both 'unhealthy' (0.70, 95% CI 0.69, 0.72, p<0.05) and 'borderline' diets (0.71, 95% CI 0.70, 0.73 p<0.05) had significantly lower adjusted HALex score than those with a 'healthy' diet (0.75, 95% CI 0.73, 0.77) even after correction for multiple adjustments. There were no differences in mean HALex scores between unhealthy and borderline diets (p=0.38). No significant and meaningful interactions were found for any of the potential effect modifiers examined. Additionally, there was no significant interaction effect between DST and BMI.

Differences in HALex score between all BMI categories were examined. BMI categories that differed from the referent group (i.e. BMI 18.5-24.9; 0.76, 95% CI 0.75, 0.77) included those who were underweight (BMI < 18.5; 0.67, 95% CI, 0.63, 0.72, p<0.05) and those with a BMI of 35.0-39.9 (0.68, 95% CI 0.66, 0.71, p <0.05) or ≥ 40.0 (0.62, 95% CI 0.57, 0.67, p <0.05), presenting with much lower HALex scores. Those who were in the BMI ranges of 35-39.9 (p<0.05) and ≥ 40 (p<0.05) had lower HALex scores than those who were in the 25-29.9 range. No significant interaction terms were found for any potential effect modifiers.

Discussion

We found that poor diet quality is inversely associated with HRQOL. These results were not only statistically significant, but clinically meaningful with a moderate effect size (f^2=0.19). Other assessments have shown that adherence to higher quality diets is associated with increased HRQOL independent of weight status in 11,015 men and women greater than 18 years of age (16). Recent research found a relationship between adherence to dietary guidelines and both initial mental HRQOL at study baseline and a positive change in physical HRQOL over twelve years of follow-up in adults aged 45-60 years (17). It remains that the relationship between diet and HRQOL in older adults has not been extensively examined, and the association of diet with HALex, has to our knowledge, not previously been studied. Our investigation demonstrates a strong association between higher diet quality and greater quality of life in older adults. Poor diet quality has also been shown to contribute to frailty in older adults (18) and improvement in diet quality, through increased fruit and vegetable consumption and reduction in added fats, sugars and sweets, serve as potential targets for extending quality years of living.

Our results also suggest that underweight and obesity are associated with lower HRQOL. Large cross-sectional analyses of healthy men and women over 18 years (9, 19) have shown that both underweight and obesity are inversely associated with HRQOL. Cross sectional analysis of adults 65 years and older (n=7,080) (20) has also shown that both underweight and obesity are inversely associated with HRQOL. In all of these studies, HRQOL was assessed by varying tools that differed in domains of focus. Prior studies (21, 22) that related poorer HALex scores to elevated BMI examined much younger cohorts and contrary to our results found that associations with lower HALex scores began at a BMI of 25-29.9 as opposed to BMI ≥35 in our investigation. These observations highlight the importance of age in the consideration of BMI (21, 22).

Major strengths of the present analysis are the large sample and favorable response rate (67%) for an understudied population of rural community-dwelling older adults (≥74 years). There remain some limitations that should be addressed. Health rating, functional limitations, presence of disease, height, weight and dietary data were all self-reported, allowing for the possibility of recall bias. However, as the outcome of interest is an assessment of perceived quality of life, self-reporting of the aforementioned attributes may be more meaningful for interpretation. Of note, only 16% of participants in the present study reported any level of functional limitation compared to national averages of approximately 25% in 75-79 year olds and 50% in those ≥ 85 years old (23). This could be attributable to a relatively healthy cohort of older community-dwelling adults, or to under-reporting of functional limitations. The DST was developed based on the dietary patterns of a very homogenous sample. Validity of the DST should be tested in more diverse populations to broaden its applicability. Lastly, only gender and projected age were available for non-responders, and so further non-responder analysis could not be performed.

The DST is a validated self-administered questionnaire that can be completed in various settings in under ten minutes (11). The HALex is also easily administered and scored. the association between these variables indicates that diet quality plays a role in HRQOL in older adults independent of BMI; thus, improving diet may help to promote increased quality years of life. additionally, BMI less than 18.5 or greater than 35 and especially greater than 40 was associated with lower HRQOL supporting previous studies that have suggested that both low and high BMI result in poorer HRQOL (9, 20). In a population where 86% of the sample had a sub-optimal diet (DST <75), there would appear to be opportunity for improvements in diet quality that could benefit many older persons.

Conclusions

The population continues to age, and though associations between aging and lower HRQOL have been found, the impact of age alone is attenuated after controlling for covariates (24). These observations, together with the findings from the present study, indicate that improving diet quality and promoting appropriate weight status in older adults may together maintain or improve HRQOL in aging.

References

1. National Center for Chronic Disease Prevenation and Health Promotion. Healthy Aging: Helping People to Live Long and Productive Lives and Enjoy a Good Quality of Life. Atlanta, GA: 2011.
2. US Centers for Disease Control and Prevention. Health-Related Quality of Life (HRQOL). Atlanta, GA: 2011.
3. Amarantos E, Martinez A, Dwyer J. Nutrition and quality of life in older adults. J Gerontol A Biol Sci Med Sci. 2001; 56 Spec No 2:54–64. [PubMed: 11730238]
4. US Department of Health and Human Services. Health-Related Quality of Life and Well-Being. Washington, D.C.: 2010.
5. Fortin M, Lapointe L, Hudon C, Vanasse A, Ntetu AL, Maltais D. Multimorbidity and quality of life in primary care: a systematic review. Health Qual Life Outcomes. 2004; 2:51. [PubMed: 15380021]
6. Keller HH, Ostbye T, Goy R. Nutritional risk predicts quality of life in elderly community-living Canadians. J Gerontol A Biol Sci Med Sci. 2004; 59(1):68–74. [PubMed: 14718488]
7. Bahat G, Tufan F, Saka B, Akin S, Ozkaya H, Yucel N, et al. Which body mass index (BMI) is better in the elderly for functional status? Arch Gerontol Geriatr. 2012; 54(1):78–81. [PubMed: 21628078]
8. Lopez-Garcia E, Banegas Banegas JR, Gutierrez-Fisac JL, Perez-Regadera AG, Ganan LD, Rodriguez-Artalejo F. Relation between body weight and health-related quality of life among the elderly in Spain. Int J Obes Relat Metab Disord. 2003; 27(6):701–9. [PubMed: 12833114]
9. Yan LL, Daviglus ML, Liu K, Pirzada A, Garside DB, Schiffer L, et al. BMI and health-related quality of life in adults 65 years and older. Obes Res. 2004; 12(1):69–76. [PubMed: 14742844]
10. Drewnowski A, Evans WJ. Nutrition, Physical Activity, and Quality of Life in Older Adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2001; 56(suppl 2): 89–94.
11. Bailey RL, Mitchell DC, Miller CK, Still CD, Jensen GL, Tucker KL, et al. A dietary screening questionnaire identifies dietary patterns in older adults. J Nutr. 2007; 137(2):421–6. [PubMed: 17237321]
12. Bailey R, Miller PE, Mitchel DC, Hartman TJ, Lawrence FR, Sempos CT, Smiciklas-Wright H. Dietary screening tool identifies nutritional risk in older adults. Am J Clin Nutr. 2009; (90):1–7.
13. Erickson P, Wilson R, Shannon I. Years of healthy life. Healthy People 2000. Stat Notes. 1995; (7):1–15.
14. Erickson P. Evaluation of a population-based measure of quality of life: the Health and Activity Limitation Index (HALex). Qual Life Res. 1998; 7(2):101–14. [PubMed: 9523491]
15. Cohen, J. Statistical Power Analysis for the Behavioral Sciences. Second. routledge academic; 1988. 2 ed
16. Henriquez Sanchez P, Ruano C, de Irala J, Ruiz-Canela M, Martinez-Gonzalez MA, Sanchez-Villegas A. Adherence to the Mediterranean diet and quality of life in the SUN Project. Eur J Clin Nutr. 2012; 66(3):360–8. [PubMed: 21847137]
17. Germain L, Latarche C, Kesse-Guyot E, Galan P, Hercberg S, Briancon S. Does Compliance with Nutrition Guidelines Lead to Healthy Aging? A Quality-of-Life Approach. J Acad Nutr Diet. 2013; 113(2):228–40 e2. [PubMed: 23351626]
18. Talegawkar SA, Bandinelli S, Bandeen-Roche K, Chen P, Milaneschi Y, Tanaka T, et al. A Higher adherence to a mediterranean-style diet is inversely associated with the development of frailty in

community-dwelling elderly men and women. J Nutr. 2012; 142(12):2161–6. [PubMed: 23096005]

19. Anandacoomarasamy A, Caterson ID, Leibman S, Smith GS, Sambrook PN, Fransen M, et al. Influence of BMI on health-related quality of life: comparison between an obese adult cohort and age-matched population norms. Obesity (Silver Spring). 2009; 17(11):2114–8. [PubMed: 19390522]
20. Jia H, Lubetkin EI. The impact of obesity on health-related quality-of-life in the general adult US population. J Public Health (Oxf). 2005; 27(2):156–64. [PubMed: 15820993]
21. Berraho M, Nejjari C, Raherison C, El Achhab Y, Tachfouti N, Serhier Z, et al. Body mass index, disability, and 13-year mortality in older French adults. J Aging Health. 2010; 22(1):68–83. [PubMed: 19920206]
22. Walter S, Kunst A, Mackenbach J, Hofman S, Tiemeier H. Mortality and disability: the effect of overweight and obesity. int J obes (Lond). 2009; 33(12):1410–8. [PubMed: 19786964]
23. Hung WW, Ross JS, Boockvar KS, Siu AL. Recent trends in chronic disease, impairment and disability among older adults in the United States. BMC Geriatr. 2011; 11:47. [PubMed: 21851629]
24. Netuveli G, Wiggins RD, Hildon Z, Montgomery SM, Blane D. Quality of life at older ages: evidence from the English longitudinal study of aging (wave 1). J Epidemiol Community Health. 2006; 60(4):357–63. [PubMed: 16537355]

Table 1

Demographic and personal characteristics by gender for Geisinger Rural Aging Study (GRAS)

Demographic and Personal Characteristics	Males N (%)	Females N (%)
N[1]	1722 [43.0]	2287 [57.0]
Mean Age (y)[2]	81.3 ±4.2	81.5 ±4.5
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		
Less than High School	435 [25.9]	548 [24.6]
≥High School	1246 [74.1]	1677 [75.4]
Ever smoke		
Yes	61 [3.6]	82 [3.7]
No	1629 [96.4]	2159 [96.3]
Self v. Proxy Report		
Self-Report	1525 [89.7]	2101 [93.0]
Proxy	175 [10.3]	158 [7.0]
Live With…		
Spouse	1225 [72.1]	870 [38.7]
Son or Daughter	77 [4.5]	232 [10.3]
Other Family	24 [1.4]	52 [2.3]
Other	30 [1.8]	43 [1.9]
Alone	344 [20.4]	1050 [46.8]
BMI		
<18.5 (Underweight)	14 [0.8]	59 [2.6]
18.5-24.9 (Normal weight)	460 [26.7]	696 [30.4]
25-29.9 (Overweight)	814 [47.3]	839 [36.7]
30-34.9 (Obese Class I)	350 [20.3]	478 [20.9]
35-39.9 (Obese Class II)	71 [4.1]	159 [7.0]
≥40 (Obese Class III)	13 [0.8]	56 [2.4]
Mean HALex Score		0.73 ±0.21
Mean DST Score	58.2 ±12.5	61.9 ±12.7
DST Categories		
Unhealthy (<60)	917 [53.3]	925 [40.4]
Borderline (60-75)	629 [36.5]	976 [42.7]
Health (>75)	176 [10.2]	386 [16.9]

[1]Number, Percentage;

[2]Mean ± St Dev

Table 2

Adjusted Mean HALex Score for DST score and BMI

Variable	Adjusted Mean HALex Score (95% CI)	P-Value
DST Score[1]		
Unhealthy (<60)	0.70 (0.69,0.72)	<0.0001
Borderline (60-75)	0.71 (0.70,0.73)	0.0005
Healthy (>75)	0.75 (0.73,0.77)	Referent
BMI[2]		
<18.5 (Underweight)	0.67 (0.63, 0.72)	0.01
18.5-24.9 (Normal Weight)	0.76 (0.74, 0.77)	Referent
25-29.9 (Overweight)	0.76 (0.75, 0.77)	1.00
30-34.9 (Obese Class I)	0.75 (0.73, 0.76)	1.00
35-39.9 (Obese Class II)	0.68 (0.66, 0.71)	<0.0001
≥40 (Obese Class III)	0.62 (0.57, 0.67)	<0.0001

[1]Controlling for categorical BMI (18.5-24.9 as referent), disease burden, sex, education, age, smoking status, living situation and self-vs. proxy report (Bonferroni's Adjustment);

[2]Controlling for Sex, categorical DST score (Healthy as referent), disease burden education age, smoking status, living situation and self-vs. proxy report (Bonferroni's Adjustment)