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POOR APPETITE AND DIETARY INTAKE IN COMMUNITY-DWELLING OLDER ADULTS

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Abstract

Background/Objectives—Poor appetite in older adults leads to sub-optimal food intake and increases the risk of undernutrition. The impact of poor appetite on food intake in older adults is unknown. The aim of this study was to examine the differences in food intake among older community-dwelling adults with different reported appetite levels.

Design—Cross-sectional analysis of data from a longitudinal prospective study.

Setting—Health, Aging, and Body Composition Study, USA.

Participants—2,597 community-dwelling adults aged 70–79.

Measurements—A semi-quantitative interviewer-administered 108-item food frequency questionnaire to estimate dietary intake. Poor appetite was defined as the report of a moderate, poor or very poor appetite in the past month and was compared with good or very good appetite.

Results—The mean age of the study sample was 74.5 ± 2.8 years, 48.2% were men, 37.7% were black and 21.8% reported a poor appetite. After adjustment for total energy intake and potential confounders (including biting/chewing problems), participants with a poor appetite had a significantly lower consumption of protein and dietary fiber, solid foods, protein rich foods, wholegrains, fruits and vegetables, but a higher consumption of dairy foods, fats, oils, sweets and sodas compared to participants with very good appetite. In addition, they were less likely to report consumption of significant larger portion sizes.

Conclusion—Older adults reporting a poor appetite showed a different dietary intake pattern compared to those with (very) good appetite. Better understanding of the specific dietary intake pattern related to a poor appetite in older adults can be used for nutrition interventions to enhance food intake, diet variety and diet quality.

Keywords

appetite; elderly; aged; undernutrition; food preferences

Introduction

Poor appetite is an important problem in older persons, with prevalence rates in community-dwelling older persons varying between 11 and 15% (1,2). A poor appetite is an important independent determinant of a reduced energy intake (3,4) associated with a lower diet quality (4) and less diet variety (5) in older adults. Consequently, a poor appetite in community-dwelling older persons is a risk factor for undernutrition (2,6–8). As undernutrition is associated with adverse clinical outcomes and reduced quality of life and survival (9–11), effective strategies to increase food intake in these older persons are needed.

Common approaches to improve appetite and food intake in older adults include meal adaptations, such as reducing portion sizes or increasing meal frequency (12–14) and the use of flavor enhancers (15,16). However, no consistent effects of these adaptations on food intake in older adults have been observed. A few studies in hospitals (14) and nursing homes (12,17,18) showed promising effects of feeding assistance, protected meal times, improved meal ambiance and family-style meals on food intake (12,14,17–20) and body weight

(17,18). However, these measures require motivated staff and sufficient finances (21). A final approach is to stimulate appetite by orexigenic drugs, but these drugs may have serious side effects (22).

Novel, more feasible approaches are needed to increase the food intake of older persons with a poor appetite (23). Research among specific groups suggests that subjects with a poor appetite have specific food preferences (24,25). Knowledge on those food preferences could be used to identify the risk of nutrient deficiencies, develop attractive and nutritious foods and to improve dietary intake and diet quality. With a poor appetite being an independent parameter of undernutrition and poor outcomes in this group, the aim of this study was to examine the differences in dietary intake among community-dwelling older adults with various levels of appetite.

Methods

Study sample

The Health, Aging and Body Composition study is a prospective cohort study investigating associations among body composition, health conditions, and functional limitations in older adults. Between April 1997 and June 1998, 3075 community-dwelling black and white men and women were enrolled. Participants were recruited from a random sample of white Medicare-eligible residents and all of the black Medicare-eligible residents in the Pittsburgh, PA, and Memphis, TN (U.S.), metropolitan areas.

Subjects who reported no difficulty walking one-fourth of a mile, climbing up 10 steps, or performing basic activities of daily living; were free of life-threatening illness; planned to remain in the geographic area for 3 years or more, not enrolled in lifestyle intervention trials were eligible. All participants provided written informed consent. All protocols were approved by the institutional review board at each study site. The current study uses dietary intake data from the year 2 examination and therefore has a cross-sectional approach.

Dietary intake

A semi-quantitative Block Food Frequency Questionnaire (FFQ) was administered by trained interviewers at the year 2 follow-up visit. This FFQ contained 108-items and was used to estimate dietary intake over the previous year (thereby excluding seasonal influences on food choice). The FFQ was developed for the Health, Aging, and Body Composition Study by Block Dietary Data Systems (Berkeley, CA, USA)(26) using 24-h recalls obtained in NHANES III from older (>65 years) non-Hispanic white and black adults in the Northeast or Southern U.S.. Trained interviewers used wood blocks, food models, standard kitchen measures, and flash cards to estimate portion sizes. Interviews were periodically monitored to ensure the quality and consistency of the data collection procedures. The intake of energy, macronutrients, food groups and solid foods was determined by Block Dietary Data Systems. The Healthy Eating Index was calculated to measure compliance with U.S. dietary guidelines (27). In addition, the relative consumption of specific types of foods (processed fruits and fruit juices, white bread and high-fat products) was determined by dividing energy

from these specific types of foods by the energy consumed within the corresponding food group. For example: (processed fruit + fruit juices) / all fruits).

Appetite

Appetite was assessed using the question ‘In the past month, would you say that your appetite or desire to eat has been.....?’. The response options (very good, good, moderate, poor, very poor, don’t know) were read by the interviewer and showed on a flash card. We excluded three subjects who responded with ‘don’t know’. Appetite was categorized into three groups: ‘very good’, ‘good’ and ‘poor’. The group with a poor appetite combined relatively small numbers of subjects reporting either a moderate, poor or very poor appetite, all of which indicate the absence of a good appetite. This categorization was justified by preliminary analysis showing that subjects with a moderate, poor or very poor appetite had a comparable energy and macronutrient intake. Supplementary Appendix S1 reports the dietary intake for the 5 appetite levels.

Potential confounders

Age, sex, self-identified racial group, study site, education, income, cognitive function, depression, number of household members, self-rated health status, smoking status and physical activity were all considered as potential confounders of the association between appetite and dietary intake.

Age, sex, racial group, education (postgraduate, college, vocational training or some college, high school, <high school), yearly family income (>\$50K, \$25K to <50K, \$10K to <25K, <\$10K), cognitive function (Mini Mental State Examination, MMSE) (28), depression, self-rated health status (excellent, very good, good, fair, poor), smoking (current, past, never), and physical activity were measured at year 1 of the Health, Aging and Body Composition Study (1997). Depression was assessed by the CES-D10 scale, a 10-item instrument designed to measure depressive symptoms experienced during the previous week (29,30). A score greater than 10 out of 30 was judged as symptomatic depression. Physical activity was assessed by self-report of time spent walking and exercising (31). Number of household members and trouble with biting/chewing foods (always, often, sometimes, seldom, never) were measured at the year 2 examination.

Statistical analysis

General characteristics of the study sample were examined by general descriptive statistics. For normally distributed characteristics, differences between appetite groups were examined using univariate logistic regression with appetite (‘good’ or ‘poor’ vs. ‘very good’) as dependent variable. Differences in dietary intake between appetite groups were examined by multinomial logistic regression using standardized variables (z-scores) of dietary intake variables as independent variables and appetite as dependent variable. For non-normally distributed variables, log-transformed variables were entered into the regression model.

Multivariate analyses were adjusted for confounding by adding the confounders to the regression model. Total energy intake was added to the model if the (independent) dietary intake variable was not expressed as percentage of total energy intake. Sex and race were

tested as potential modifiers of the association between dietary intake and appetite (interaction terms with $P < 0.10$ were regarded as significant). The cut-off level for statistical significance for differences between groups was $P < 0.05$. Statistical analyses were performed using SPSS Statistics version 22.0 (SPSS Inc., New York, NY, USA).

Results

At year 2 of the Health, Aging, and Body Composition Study, 3,043 persons (99%) were still alive and 2,998 participated in the follow-up visit. After excluding participants with missing values on appetite ($n=13$) or FFQ ($n=284$), serious errors on the FFQ ($n=30$) (e.g. many missing items or inconsistent answers) or unreasonably dietary intakes (<800 or >4000 kcal/day in men or <500 or >3500 kcal/day in women, $n=74$) (32), 2,597 participants were included for data analyses (Supplementary Appendix S2).

General characteristics of the study sample are presented in Table 1. The mean age was 74.6 ± 2.8 years, 48.2% were men and 37.7% were black. A poor appetite was reported by 21.8% of the study sample ($n=565$). Compared to the groups with a very good or good appetite, the poor appetite group was on average older (75.0 vs. 74.5 y, $P < 0.005$), had a lower BMI ($P < 0.005$), and more often experienced unintentional weight loss (having lost weight without trying), biting/chewing problems and depression ($P < 0.001$). Furthermore, they were significantly more often female, black, current smoker and had a lower education level, income, health status, daily energy intake and Healthy Eating Index ($P < 0.05$).

Intake of macronutrients and solid foods

Table 2 shows the average daily macronutrient and food group intake by level of appetite and reports the results of univariate analyses. Results of multivariate analyses on differences in macronutrient and food group intakes between appetite groups, adjusted for total daily energy intake and other potential confounders, are reported in Table 3. Participants with a poor appetite had a lower intake of (animal and vegetable) protein, higher intake of fat, and lower intake of dietary fiber (consistent for fiber from beans, grains, vegetables & fruits) compared to participants with a very good appetite. They also reported a lower consumption of solid foods, but the energy density of solid foods was higher. The consumption of carbohydrates and alcohol was not significantly different between participants with a poor or a very good appetite in multivariate analyses.

Participants with a good appetite showed a significantly lower intake of energy, total protein, animal protein, fiber from vegetables and fruits and solid foods, and a higher energy density of solid foods when compared to participants with a very good appetite, but differences were smaller than differences between the poor and very good appetite groups (Tables 2 and 3). Sensitivity analyses to identify the impact of excluding subjects with a moderate appetite from the poor appetite group showed larger and more significant differences in macronutrient and food group intake compared to the very good appetite group (data not shown).

Food groups and portion size

Participants with a poor appetite reported a significantly lower consumption of protein rich foods, fruits and vegetables, grains and wholegrains, but a significantly higher consumption of dairy foods (milk, yoghurt, cheese), fats and oils, sweets and sodas after adjustment for potential confounders. For grains, only the absolute consumption (number of servings per day) was lower in participants with a poor appetite compared to participants with a very good appetite (Tables 2 and 4).

Similar trends but with smaller differences were observed for participants with a good appetite compared to a very good appetite, for all food groups except for dairy foods, grains, wholegrains, sweets and desserts (Table 4). Both participants with a poor and a good appetite consumed less large or extra-large portions than participants with a very good appetite (Table 4).

Intake of specific types of foods

Compared to those with a very good appetite, older adults with a poor appetite showed a significant higher intake of fruit juices and processed fruits when expressed as % of the total fruit intake (poor vs. very good appetite: $63.6 \pm 23.6\%$ vs. $58.8 \pm 24.1\%$; OR 1.18 95% CI [1.04;1.34]). The relative amount of white bread (as % of total breads) in the poor appetite group was higher than in the very good appetite group (poor vs. very good appetite: $76.5 \pm 26.1\%$ vs. $68.8 \pm 28.3\%$; OR 1.38, 95% CI [1.22;1.56]). Subjects with a poor appetite chose more high-fat foods, such as whole milk (poor vs. very good appetite: $23.2 \pm 42.3\%$ of total milk vs. $12.3 \pm 32.9\%$, OR 2.41 95% CI [1.60;3.65] and high fat meat (poor vs. very good appetite: $33.2 \pm 37.0\%$ of total meat vs. $28.0 \pm 34.6\%$, OR 1.18 95% CI [1.06;1.33]). In participants with a good appetite, no significant differences for specific types of foods were observed compared to participants with a very good appetite (data not shown).

Effect modification

Race and gender modified the association of appetite with certain dietary intake variables ($P < 0.10$ for significant interaction between race or gender and dietary intake variable). In summary, gender modified the association between alcohol intake and appetite, as well as race. Gender also modified the association between the intake of wholegrain foods and appetite. Race modified the association between the intake of dairy foods and appetite. Results for alcohol, wholegrain foods and dairy foods stratified for race and gender are displayed in Supplementary Appendix S2.

Discussion

This study revealed differences in dietary intake between community-dwelling older adults with various levels of appetite. As expected, older adults with a poor appetite reported a lower intake of energy, protein, fiber, solid foods, fruits and vegetables and large/XL portions, while consuming more fats, sweets, sodas and dairy foods than older adults with a very good appetite. In addition, the energy density of solid foods was higher than in older adults with a very good appetite.

The appetite of participants was classified into ‘very good’, ‘good’ and ‘poor’. We expected that older adults with a poor appetite would have a different dietary intake than older adults with a good or very good appetite. However, our data show that participants with a good appetite also reported a slightly lower intake of protein rich foods, fruits and vegetables and large portion sizes and higher consumption of fats and oils, sweets and sodas. Thus, there appears to be a continuous relationship between patterns of dietary intake and levels of appetite from poor to good to very good.

Besides a reduced energy intake, the dietary patterns identified in this study show that a poor appetite is associated with a reduced protein, fruit and vegetable intake, which could exacerbate sarcopenia (36) and osteoporosis (37). Improvement of dietary patterns at an early stage could prevent these unfavorable health issues. It would be interesting to identify predictors of a poor appetite and the associated dietary patterns, in order to maintain healthy eating patterns. Together with offering attractive and nutritious foods and treating underlying diseases impairing appetite, this could be a cost-effective approach to prevent and treat undernutrition in older adults, thereby reducing morbidity and mortality.

The distinct food choices of older adults with a poor appetite could be explained by different food preferences in those with anorexia of ageing or disease-related anorexia. So far, small studies performed in various countries, care settings and disease backgrounds published inconsistent findings on food preferences in older persons with a poor appetite. One study in cognitively impaired elderly with anorexia showed a reduced global food intake and a reduced consumption of certain food groups (“meat, eggs, fish” and “fruit and vegetables”) and a similar consumption of milk and cereals compared to non-anorexic elderly (38). Others showed a dislike fatty and heavy food (25) or a preference for certain protein and non-protein foods in chronic ill elderly with anorexia (24). We previously conducted computer tests, presenting pairs of photographic images of foods, categorized according to a certain characteristic (e.g. high- or low-fiber) to older adults. A forced choice methodology was used for every pair by asking “Which food do you most want to eat now?”. The number of choices for foods with a certain characteristic was indicative of a certain food preference. We found that older adults with a poor appetite preferred (color) variation, non-dairy, high-fiber foods and solid texture (39).

Similar to the literature (38,40), the current study showed that older adults with a poor appetite had a lower intake of protein-rich foods (1.6 vs. 1.8 servings/d), fruits (1.8 vs. 2.1 servings/d) and vegetables (2.6 vs. 3.2 servings/d) than those with a very good appetite, implying that older adults with a poor appetite consume 10 to 20% less than the group with a very good appetite, which is clinically relevant, especially with a long-lasting poor appetite and dietary intake. Some findings are inconsistent with previous studies (24,38,39): older adults with a poor appetite had a higher intake of dairy foods than subjects with a very good appetite (38) and a lower (instead of higher) intake of dietary fiber and solid foods (39).

The higher energy density of solid foods in older adults with a poor appetite suggests a preference for fatty and heavy foods. Consuming smaller portions of high density foods is a common way to provide sufficient energy, for instance in subjects with insufficient dietary intake such as hospital patients (33), or astronauts consuming foods with an energy density

of 3 to 4 kcal/g. We hypothesize that choosing higher-density foods could be a natural mechanism to ingest sufficient energy and nutrients and mitigate against weight loss. This mechanism and the effect on ingestion of other essential nutrients such as protein and vitamin D need to be investigated in humans. However, evidence shows that increasing the energy density of meals and snacks effectively improves energy intake and body weight stabilization in older adults. This strategy is widely used in daily practice (35).

This is the first large-scale quantitative study investigating dietary intake in older adults with various appetite levels. The Health, Aging, and Body Composition Study cohort provides data on food intake and a number of general and health characteristics that may confound the associations under study. However, the large sample size and large number of statistical tests can result in statistically significant differences that may have limited clinical meaningfulness. Moreover, it needs to be mentioned that our conclusions are based on an American sample and cannot be translated to older adults in other countries. Another limitation of this study is that it used dietary intake patterns obtained by a food frequency questionnaire as a measure of food preference. We cannot exclude that other factors, such as income and household member food preferences, may have influenced intake.

The validity of the appetite question could also be questioned: appetite is a subjective entity and no gold standard to assess appetite is available. However, the different appetite levels were related to weight loss and energy intake, indicating face validity of the applied appetite question. Appetite was assessed at one time point only, while appetite may fluctuate over time. The use of 3 appetite levels resulted in an under- or overestimation of dietary intake related to a poor appetite: sensitivity analyses showed larger and more significant differences after exclusion of subjects with a moderate appetite.

The results of this study show several differences in food consumption among community-dwelling older persons with various appetite levels. This information is an important first step in identifying specific food preferences in older adults with a poor appetite and can be used to refine nutrition interventions that aim to improve dietary intake and diet quality in older adults with a poor appetite.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Conflicts of interest

The authors have no financial or personal conflicts in the cover letter as well as in the manuscript.

Authors contributions

van der Meij: data analyses, data interpretation, and preparation of manuscript

Wijnhoven and Visser: supervision, design and interpretation of data analyses, preparation of manuscript.

Lee, Hue, Harris, Kritchevsky, Newman: study initiation, concept and design, recruitment of participants, acquisition of data.

Houston: preparation of manuscript

All coauthors have been notified on the manuscript being submitted to JAGS and of all changes in the revised versions, and the final decision of the Editor in Chief of JAGS on the paper.

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References

- Schilp J, Wijnhoven HaH, Deeg DJH, Visser M. Early determinants for the development of undernutrition in an older general population: Longitudinal Aging Study Amsterdam. *Br J Nutr*. 2011; 106(5):708–17. [PubMed: 21450117]
- Castel H, Shahar D, Harman-Boehm I. Gender differences in factors associated with nutritional status of older medical patients. *J Am Coll Nutr* [Internet]. 2006; 25(2):128–34. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/16582029>.
- Shahar D, Shai I, Vardi H, Fraser D. Dietary intake and eating patterns of elderly people in Israel: who is at nutritional risk? *Eur J Clin Nutr* [Internet]. 2003; 57(1):18–25. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12548292>.
- Shahar DR, Yu B, Houston DK, Kritchevsky SB, Lee J-S, Rubin SM, et al. Dietary factors in relation to daily activity energy expenditure and mortality among older adults. *J Nutr Health Aging*. 2009; 13(5):414–20.
- Dean M, Raats MM, Grunert KG, Lumbers M. Factors influencing eating a varied diet in old age. *Public Health Nutr*. 2009; 12(12):2421–7. [PubMed: 19344544]
- Wijnhoven HAH, Schilp J, van Bokhorst-de van der Schueren MAE, de Vet HCW, Kruizenga HM, Deeg DJH, et al. Development and validation of criteria for determining undernutrition in community-dwelling older men and women: The Short Nutritional Assessment Questionnaire 65 + *Clin Nutr*. 2012; 31(3):351–8. [PubMed: 22119209]
- van der Pols-Vijlbrief R, Wijnhoven HAH, Schaap LA, Terwee CB, Visser M. Determinants of protein-energy malnutrition in community-dwelling older adults: A systematic review of observational studies. *Ageing Research Reviews*. 2014:112–31. [PubMed: 25257179]
- Lee JS, Kritchevsky SB, Tylavsky F, Harris TB, Ayonayon HN, Newman AB. Factors associated with impaired appetite in well-functioning community-dwelling older adults. *J Nutr Elder* [Internet]. 2006 Jan; 26(1–2):27–43. cited 2016 Mar 30. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17890202>.
- Sullivan DH, Bopp MM, Roberson PK. Protein-energy undernutrition and life-threatening complications among the hospitalized elderly. *J Gen Intern Med*. 2002; 17(12):923–32. [PubMed: 12472928]
- Keller HH. Nutrition and Health-Related Quality of Life In Frail Older Adults. *J Nutr Health Aging* [Internet]. 2004; 8(4):245–52. Available from: https://www.lib.uwo.ca/cgi-bin/ezpauthn.cgi?url=http://search.proquest.com/docview/620595515?accountid=15115%5Cnhttp://vr2pk9sx9w.search.serialssolutions.com/?ctx_ver=Z39.88-2004&ctx_enc=info:ofi/enc:UTF-8&rft_id=info:sid/ProQ%253Apsycinfo&rft_val_fmt=info:ofi.
- Liu L, Bopp MM, Roberson PK, Sullivan DH. Undernutrition and risk of mortality in elderly patients within 1 year of hospital discharge. *J Gerontol A Biol Sci Med Sci* [Internet]. 2002; 57(11):M741–6. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12403803>.
- Lorefält B, Wissing U, Unosson M. Smaller but energy and protein-enriched meals improve energy and nutrient intakes in elderly patients. *J Nutr Health Aging* [Internet]. 2005; 9(4):243–7. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15980933>.

13. Taylor KA, Barr SI. Provision of Small, Frequent Meals Does Not Improve Energy Intake of Elderly Residents with Dysphagia Who Live in an Extended-Care Facility. *J Am Diet Assoc.* 2006; 106(7):1115–8. [PubMed: 16815130]
14. Barton AD, Beigg CL, Macdonald IA, Allison SP. A recipe for improving food intakes in elderly hospitalized patients. *Clin Nutr* [Internet]. 2000; 19(6):451–4. Available from: <http://www.sciencedirect.com/science/article/pii/S0261561400901493>.
15. Essed NH, Oerlemans P, Hoek M, Van Staveren WA, Kok FJ, De Graaf C. Optimal preferred MSG concentration in potatoes, spinach and beef and their effect on intake in institutionalized elderly people. *J Nutr Heal Aging.* 2009; 13(9):769–75.
16. Mathey MF, Siebelink E, de Graaf C, Van Staveren Wa. Flavor enhancement of food improves dietary intake and nutritional status of elderly nursing home residents. *J Gerontol A Biol Sci Med Sci.* 2001; 56(4):M200–5. [PubMed: 11283191]
17. Mathey M-FAM, Vanneste VGG, de Graaf C, de Groot LC, van Staveren WA. Health Effect of Improved Meal Ambiance in a Dutch Nursing Home: A 1-Year Intervention Study. *Prev Med (Baltim)* [Internet]. 2001; 32(5):416–23. Available from: http://www.sciencedirect.com/science/article/pii/S0091743501908163%5Cnhttp://ac.els-cdn.com/S0091743501908163/1-s2.0-S0091743501908163-main.pdf?_tid=774c88ba-7551-11e5-9665-00000aab0f6b&acdnat=1445143025_08dd9940de9dd941ffb2dd020db8d45b.
18. Nijs, KaND., de Graaf, C., Kok, FJ., van Staveren, Wa. Effect of family style mealtimes on quality of life, physical performance, and body weight of nursing home residents: cluster randomised controlled trial. *BMJ.* 2006; 332(7551):1180–4. [PubMed: 16679331]
19. Young AM, Mudge AM, Banks MD, Ross LJ, Daniels L. Encouraging, assisting and time to EAT: Improved nutritional intake for older medical patients receiving Protected Mealtimes and/or additional nursing feeding assistance. *Clin Nutr.* 2013; 32(4):543–9. [PubMed: 23211758]
20. Manning F, Harris K, Duncan R, Walton K, Bracks J, Larby L, et al. Additional feeding assistance improves the energy and protein intakes of hospitalised elderly patients. A health services evaluation. *Appetite.* 2012; 59(2):471–7. [PubMed: 22735333]
21. Nijs K, Vanneste V, de Graaf K, van Staveren W. Project models to improve the ambiance during meal times in Dutch nursing homes: incentives and barriers for implementation. *Tijdschr Gerontol Geriatr* [Internet]. 2003; 34(6):246–53. Available from: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=15007956.
22. DRT. Guidelines for the use of orexigenic drugs in long-term care [Internet]; Nutrition in Clinical Practice. 2006. p. 82-7. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed7&NEWS=N&AN=2006066283>
23. Dunne JL, Dahl WJ. A novel solution is needed to correct low nutrient intakes in elderly long-term care residents. *Nutr Rev.* 2007; 65(3):135–8. [PubMed: 17425065]
24. Ohri-Vachaspati P, Sehgal AR. Correlates of poor appetite among hemodialysis patients. *J Ren Nutr* [Internet]. 1999; 9(4):182–5. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med4&AN=10528049>.
25. Gustafsson K, Ekblad J, Sidenvall B. Older women and dietary advice: occurrence, comprehension and compliance. *J Hum Nutr & Diet.* 2005; 18(6):453–60. [PubMed: 16351704]
26. Block G, Hartman aM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. *Am J Epidemiol.* 1986; 124(3):453–69. [PubMed: 3740045]
27. KENNEDY ET, OHLS J, CARLSON S, FLEMING K. The Healthy Eating Index. Design and Applications. *J Am Diet Assoc.* 1995; 95(10):1103–8. [PubMed: 7560680]
28. Kurella M, Chertow GM, Luan J, Yaffe K. Cognitive impairment in chronic kidney disease. *J Am Geriatr Soc.* 2004; 52(11):1863–9. [PubMed: 15507063]
29. Radloff L. The CES-D scale: A self-report depression scale for research in the general population. *Appl Psychol Meas.* 1977; 1:385–401.
30. Andresen EM, Malmgren Ja, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *Am J Prev Med* [Internet]. 1994; 10(2):77–84. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8037935>.

31. Rosano C, Simonsick EM, Harris TB, Kritchevsky SB, Brach J, Visser M, et al. Association between physical and cognitive function in healthy elderly: The health, aging and body composition study. *Neuroepidemiology*. 2005; 24(1–2):8–14. [PubMed: 15459503]
32. Willet, WC. *Nutritional Epidemiology*. 2. New York, NY: Oxford University Press; 1998.
33. Mila R, Abellana R, Padro L, Basulto J, Farran A. High consumption foods and their influence on energy and protein intake in institutionalized older adults. *J Nutr Heal Aging*. 2012; 16(2):115–22.
34. Cooper M, Douglas G, Perchonok M. Developing the NASA Food System for Long-Duration Missions. *J Food Sci*. 2011; 76(2)
35. Morilla-Herrera JC, Martín-Santos FJ, Caro-Bautista J, Saucedo-Figueroa C, García-Mayor S, Morales-Asencio JM. Effectiveness of food-based fortification in older people a systematic review and meta-analysis. *J Nutr Health Aging* [Internet]. 2016 Feb 23; 20(2):178–84. cited 2017 Apr 13. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26812514>.
36. Houston DK, Nicklas BJ, Ding J, Harris TB, Tylavsky FA, Newman AB, et al. Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. *Am J Clin Nutr* [Internet]. 2008 Jan; 87(1): 150–5. cited 2017 Apr 14. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/18175749>.
37. Qiu, R., Cao, W., Tian, H., He, J., Chen, G., Chen, Y. Kunze, G., editor. Greater Intake of Fruit and Vegetables Is Associated with Greater Bone Mineral Density and Lower Osteoporosis Risk in Middle-Aged and Elderly Adults; *PLoS One* [Internet]. 2017 Jan 3. p. e0168906 cited 2017 Apr 14 Available from: <http://www.ncbi.nlm.nih.gov/pubmed/28045945>
38. Donini LM, Poggiogalle E, Piredda M, Pinto A, Barbagallo M, Cucinotta D, et al. Anorexia and Eating Patterns in the Elderly. *PLoS One*. 2013; 8(5)
39. van der Meij BS, Wijnhoven HAH, Finlayson GS, Oosten BSH, Visser M. Specific food preferences of older adults with a poor appetite. A forced-choice test conducted in various care settings. *Appetite*. 2015; 90:168–75. [PubMed: 25772198]
40. Nieuwenhuizen WF, Weenen H, Rigby P, Hetherington MM. Older adults and patients in need of nutritional support: review of current treatment options and factors influencing nutritional intake. *Clin Nutr* [Internet]. 2010 Apr; 29(2):160–9. [cited 2016 Aug 31]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19828215>.

Table 1

Characteristics of Health, Aging and Body Composition study participants by level of self-reported appetite

| n=2597 | Appetite | | |
|----------------------------|----------------------|---------------|-----------------|
| | Very good n=1,049 | Good n=983 | 'Poor' n=565 |
| Age (y) | 74.5 (2.8) | 74.6 (2.9) | 75.0 (2.9) ** |
| Male (%) | 48.7 | 52.4 | 40.0 *** |
| White (%) | 62.9 | 66.6 | 53.5 *** |
| Education level (%) | | | |
| Less than high school | 22.0 | 21.5 | 25.0 * |
| High school graduation | 31.8 | 31.5 | 35.6 |
| Postsecondary school | 46.2 | 47.1 | 39.4 |
| Income | | | |
| Less than 10,000 \$ | 12.6 | 8.6 | 16.0 *** |
| 10,000 to 25,000 \$ | 35.2 | 39.4 | 39.2 |
| 25,000 to 50,000 \$ | 32.7 | 33.8 | 32.1 |
| 50,000 \$ | 19.6 | 18.3 | 12.7 |
| Smoking status (%) | | | |
| Never | 44.7 | 44.4 | 44.4 *** |
| Current | 6.3 | 8.3 | 15.4 |
| Former | 49.0 | 47.3 | 40.2 |
| Physical activity | | | |
| 50 kcal/kg/wk | 32.9 | 38.0 | 37.5 |
| >50 and 75 kcal/kg/wk | 20.2 | 21.5 | 20.9 |
| >75 and 100 kcal/kg/wk | 15.1 | 14.3 | 13.6 |
| >100 kcal/kg/wk | 31.8 | 26.1 | 28.0 |
| Depression score (CES-D10) | 2.6 (2.9) | 2.8 (3.2) * | 4.1 (4.1) *** |
| BMI (kg/m ²) | 27.6 (4.7) | 27.0 (4.6) * | 26.8 (5.2) ** |
| General health status (%) | | | |
| Excellent | 20.6 | 11.4 | 7.8 *** |
| Very good | 36.7 | 32.8 | 22.7 |
| Good | 31.1 | 42.5 | 42.9 |
| Fair | 10.6 | 12.4 | 23.6 |
| Poor | 1.0 | 0.9 | 3.0 |

| n=2597 | Appetite | | |
|--|----------------------|-------------------------|----------------------------|
| | Very good n=1,049 | Good n=983 | 'Poor' n=565 |
| Biting/chewing problems - sometimes/often/always | 16.5 | 20.3 | 29.8 ^{***} |
| >5% unintentional weight loss (past 12 mo) (%) | 4.3 | 5.5 | 14.0 ^{***} |
| Use of breakfast/diet shakes or liquid supplements (kcal/d) ¹ | 9.0 (46.5) | 5.5 (29.8) [*] | 14.0 (57.2) |
| Healthy Eating Index (range 0–100) | 70.8 (12.0) | 70.3 (11.8) | 67.2 (11.7) ^{***} |

Mean (SD), except when stated otherwise

Appetite was assessed by asking "In the past month, would you say that your appetite or desire to eat has been: Very good, Good or Moderate, Poor, Very poor or Don't know?". For this study, appetite level was classified as Very good, Good, or Poor (Moderate, Poor or Very poor). Subjects who responded with "Don't know" were excluded from analysis.

Unintentional weight loss was defined as having lost weight without trying

^{*} P<0.05;

^{**} P<0.005;

^{***} P<0.001 compared to 'Very good appetite' (univariate multinomial logistic regression)

Table 2

Average macronutrient and food group intake per day of Health, Aging and Body Composition study participants by level of self-reported appetite

| | n=2597 | Appetite | | |
|---|----------|---------------------|----------------|-----------------|
| | | Very good n=1049 | Good n=983 | 'Poor' n=565 |
| Energy (kcal/d) | | 1,887 (654) | 1,831 (636) | 1,807 (626)* |
| <i>Macronutrients</i> | | | | |
| Fats (% of kcal, alcohol excluded) | | 33.8 (7.6) | 33.7 (7.6) | 35.0 (7.5)* |
| Carbohydrates (% of kcal, alcohol excluded) | | 53.7 (8.4) | 54.2 (8.1) | 53.1 (8.2) |
| Protein (% of kcal, alcohol excluded) | | 15.0 (3.2) | 14.7 (3.0)* | 14.3 (3.0)*** |
| Protein (g) | | 69.0 (27.1) | 65.2 (24.1)** | 62.6 (23.4)*** |
| Protein from animal sources (g) | | 40.1 (21.0) | 37.2 (17.6)*** | 36.6 (18.1)*** |
| Protein from vegetable sources (g) | | 28.9 (11.5) | 28.0 (11.0) | 26.0 (10.2)*** |
| Alcohol (% of kcal) | | 1.9 (4.1) | 2.1 (4.6) | 1.8 (4.3) |
| Dietary fiber (g) | | 18.7 (7.8) | 17.6 (7.1)** | 15.5 (6.4)*** |
| Dietary fiber from beans (g) | | 2.5 (2.8) | 2.3 (2.7) | 2.0 (2.3)*** |
| Dietary fiber from grains (g) | | 8.8 (4.4) | 8.8 (4.4) | 7.6 (3.8)*** |
| Dietary fiber from vegetables & fruits (g) | | 7.7 (4.1) | 6.8 (3.5)*** | 6.2 (3.4)*** |
| Solid foods (g) | | 914 (360) | 839 (312)*** | 786 (294)*** |
| Energy density of solid foods (kcal/g) | | 2.2 (0.6) | 2.3 (0.6)*** | 2.4 (0.7)*** |
| <i>Food groups</i> | | | | |
| Fruits & fruit juices | Servings | 2.1 (1.2) | 1.9 (1.1)** | 1.8 (1.1)*** |
| Vegetables | Servings | 3.2 (2.0) | 2.9 (1.8)*** | 2.6 (1.6)*** |
| Grains | Servings | 6.7 (3.1) | 6.6 (2.9) | 6.2 (2.9)** |
| Wholegrains | Servings | 2.5 (2.0) | 2.4 (1.8) | 2.1 (1.8)*** |
| Meat, fish, poultry, beans, egg | Servings | 1.8 (1.2) | 1.6 (0.9)*** | 1.6 (1.0)*** |
| Milk, yogurt, cheese | Servings | 1.4 (1.1) | 1.4 (1.2) | 1.4 (1.3) |

| n=2597 | | Appetite | | |
|----------------------------------|----------|---------------------|----------------|-----------------|
| | | Very good n=1049 | Good n=983 | 'Poor' n=565 |
| Fats & oils, sweets, sodas | Servings | 3.0 (1.8) | 3.2 (1.9) | 3.4 (1.9) *** |
| Sweets, desserts | Kcal | 253.1 (237.3) | 264.6 (256.8) | 271 (242) ** |
| <i>Portion size (% of foods)</i> | | | | |
| Small | | 11.5 (7.2) | 11.9 (8.0) | 12.4 (8.4) * |
| Medium | | 75.2 (9.3) | 76.2 (9.1) * | 76.3 (9.1) * |
| Large / Extra-large | | 13.3 (8.5) | 11.9 (7.8) *** | 11.3 (7.3) *** |

Mean (SD) per day, except when stated otherwise

* P<0.05;

** P<0.005;

*** P<0.001 compared to 'Very good appetite' (univariate multinomial logistic regression)

[†] P-value of chi-square test

Table 3

Multivariate analyses of macronutrients, dietary fiber and solid foods intake (good appetite and poor appetite versus very good appetite) of Health, Aging and Body Composition study participants

| n=2597 | Good appetite n=983 | | 'Poor' appetite n=565 | |
|--|--------------------------|--------|--------------------------|--------|
| | OR [95% CI] ¹ | P | OR (95% CI) ¹ | P |
| Energy ² | 0.89 [0.81;0.98] | 0.02 | 0.90 [0.80;1.02] | 0.10 |
| <i>Macronutrients</i> | | | | |
| Fats (% of kcal, alcohol excluded) ² | 0.99 [0.90;1.09] | 0.81 | 1.14 [1.01;1.28] | 0.03 |
| Carbohydrates (% of kcal, alcohol excluded) ² | 1.06 [0.96;1.17] | 0.24 | 0.94 [0.84;1.06] | 0.32 |
| Protein (% of kcal, alcohol excluded) ² | 0.96 [0.93;0.99] | 0.02 | 0.92 [0.89;0.96] | <0.001 |
| Protein from animal sources (g) ³ | 0.84 [0.74;0.95] | <0.01 | 0.83 [0.71;0.96] | 0.02 |
| Protein from vegetable sources (g) ³ | 0.93 [0.78;1.09] | 0.36 | 0.55 [0.44;0.69] | <0.001 |
| <i>Alcohol</i> | | | | |
| % of kcal from alcohol (log-transformed) ² | 1.02 [0.92;1.13] | 0.74 | 1.10 [0.97;1.25] | 0.14 |
| 0 – 10% of kcal ^{2,4} | 0.95 [0.76;1.18] | 0.62 | 1.13 [0.86;1.48] | 0.37 |
| 10% of kcal ^{2,4} | 1.14 [0.76;1.73] | 0.52 | 1.47 [0.88;2.48] | 0.14 |
| Dietary fiber (g) ³ | 0.84 [0.74;0.96] | 0.01 | 0.50 [0.42;0.60] | <0.001 |
| Dietary fiber from beans (g) (log) ³ | 1.01 [0.91;1.13] | 0.84 | 0.84 [0.74;0.96] | <0.01 |
| Dietary fiber from grains (g) ³ | 1.01 [0.90;1.13] | 0.90 | 0.68 [0.58;0.79] | <0.001 |
| Dietary fiber from vegetables & fruits (g) ³ | 0.80 [0.72;0.89] | <0.001 | 0.65 [0.56;0.74] | <0.001 |
| Solid foods (g) ³ | 0.70 [0.61;0.81] | <0.001 | 0.50 [0.42;0.60] | <0.001 |
| Energy density solid foods (kcal/g) ² | 1.23 [1.11;1.37] | <0.001 | 1.59 [1.40;1.79] | <0.001 |

¹Multinomial logistic regression of standardized variables (reference category: very good appetite); the OR can be interpreted as the chance of having a lower (OR<1) or a higher (OR>1) intake than older adults with a very good appetite, with the other variables in the model held constant.

²Adjusted for potential confounders (age, sex, race, study site, education level, income, cognitive function, depression, number of household members, self-rated health status, smoking, physical activity, biting/chewing problems)

³Adjusted for potential confounders (age, sex, race, study site, education level, income, cognitive function, depression, number of household members, self-rated health status, smoking, physical activity, depression, biting/chewing problems, and total energy intake)

⁴Reference category for alcohol intake: 0% of kcal

Multivariate analyses of food groups and portion size (good appetite and poor appetite versus very good appetite) of Health, Aging and Body Composition study participants

Table 4

| n=2597 | Good appetite (n=983) | | | 'Poor' appetite (n=565) | | |
|--|------------------------|---------------------------------------|--------|--------------------------|--------|--------|
| | | OR ² [95% CI] ¹ | P | OR [95% CI] ¹ | P | P |
| Fruits & fruit juices | Servings ³ | 0.89 [0.80;0.98] | 0.02 | 0.75 [0.66;0.85] | <0.001 | <0.001 |
| | Kcal ³ | 0.91 [0.82;1.00] | 0.05 | 0.85 [0.76;0.97] | 0.01 | 0.01 |
| | % of kcal ² | 0.97 [0.88;1.07] | 0.49 | 0.89 [0.79;1.00] | 0.05 | 0.05 |
| Vegetables | Servings ³ | 0.81 [0.72;0.90] | <0.001 | 0.66 [0.57;0.76] | <0.001 | <0.001 |
| | Kcal ³ | 0.81 [0.73;0.90] | <0.001 | 0.67 [0.58;0.77] | <0.001 | <0.001 |
| | % of kcal ² | 0.84 [0.76;0.93] | <0.01 | 0.71 [0.62;0.81] | <0.001 | <0.001 |
| Grains | Servings ³ | 0.98 [0.86;1.11] | 0.69 | 0.77 [0.66;0.91] | <0.01 | <0.01 |
| | Kcal ³ | 1.04 [0.92;1.17] | 0.55 | 0.85 [0.73;0.99] | 0.03 | 0.03 |
| | % of kcal ² | 1.06 [0.96;1.17] | 0.21 | 0.89 [0.79;1.00] | 0.05 | 0.05 |
| Wholegrains | Servings ³ | 0.94 [0.85;1.05] | 0.26 | 0.67 [0.58;0.77] | <0.001 | <0.001 |
| | Kcal ³ | 0.99 [0.91;1.09] | 0.89 | 0.73 [0.64;0.83] | <0.001 | <0.001 |
| | % of kcal ² | 1.01 [0.99;1.02] | 0.58 | 0.95 [0.92;0.97] | <0.001 | <0.001 |
| Meat, fish, poultry, beans, egg | Servings ³ | 0.80 [0.70;0.90] | <0.001 | 0.74 [0.63;0.86] | <0.001 | <0.001 |
| | Kcal ³ | 0.83 [0.73;0.95] | <0.01 | 0.80 [0.69;0.94] | <0.01 | <0.01 |
| | % of kcal ² | 0.87 [0.79;0.97] | <0.01 | 0.84 [0.75;0.95] | <0.01 | <0.01 |
| Milk, yogurt, cheese | Servings ³ | 1.00 [0.90;1.11] | 0.99 | 1.17 [1.04;1.33] | 0.01 | 0.01 |

