Association of nutritional components with falls in oldest-old men

The Helsinki Businessmen Study (HBS)

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Abstract

Introduction: Falls are associated with increased morbidity and mortality in older people. We examined how nutritional factors are associated with self-reported falls in the oldest-old community-dwelling men.

Methods: Participants of the longitudinal and socioeconomically homogenous Helsinki Businessmen Study are men born in 1919-1934. A cross-sectional analysis from a random sample of 122 home-living oldest-old men who underwent medical examinations in 2017-2018 is reported here. Food and nutrient intakes were retrieved from 3-day food diaries, and the number of falls during past year was requested in the screening questionnaire. Nutritional status was assessed using Mini Nutritional Assessment Short Form (MNA-SF) and waist circumference was measured. Body composition was assessed with dual-energy X-ray absorptiometry (DXA)-scans, physical performance with short physical performance battery (SPPB), sarcopenia status using European Working Group on Sarcopenia in Older People's 2 (EWGSOP2) criteria, and frailty with phenotypic criteria.

Results: Mean age of participants was 87 years (range 83-99 years) and 30% reported at least one fall during past year. Falls were associated with higher waist circumference ($p=.031$), frailty ($p<.001$) and sarcopenia ($p = .002$), and inversely associated with SPPB total score ($p=.002$). Of nutritional factors, intakes of fish ($p=.016$), fish protein ($p=.039$), berry ($p=.027$) and vitamin D ($p=.041$), and snacking more protein between breakfast and lunch ($p=.017$) were inversely associated with falls. Red meat intake was associated with higher frequency of falls ($p=.044$).

Conclusion: Higher waist circumference, but not body mass index, was associated with increased frequency of falls. Healthy dietary choices appeared protective from falls in these oldest-old men of similar socioeconomic status.

Keywords: Falls, waist circumference, fish intake, berry intake, vitamin D, snacking,

Introduction

Falls are a leading cause of morbidity and mortality in older adults (1). Every year, more than 30% of community-dwelling older adults > 65 years of age fall at least once, while percentage of falls of those over 75 years is even higher (2-5). Accidental falls with even minor injuries are associated with an increased fear of falling which may lead to self-imposed limitations, avoidance of physical activity, and reduced quality of life (6,7). General risk factors for falls among community-dwelling older adults include higher age, history of falls, problems with balance or slow gait disorders, muscle weakness, walking difficulty, cognitive or visual impairment, arthritis, stroke, frailty and polypharmacy (2,4, 8-10).

Malnutrition manifested as unintentional weight loss, insufficient intake of energy, protein and micronutrients, anemia and vitamin D deficiency along with dehydration are associated with increased risk of falls in older adults (11-14). However, findings from specific nutritional factors have so far been inconsistent. Higher protein intake, for example, has been associated with reduced fall risk (15), been neutral to it (16), or reduced fall risk in younger (50-69 years), but not in older age groups (70-89 years) of adults (17). Moreover, protein source and distribution in connection to falls are less studied (18). In Framingham longitudinal study with two years follow-up, protein intake from both animal and plant sources were linked to fewer falls in older people who experienced weight loss (15, 18). Even mealtime protein distribution was associated with higher muscle strength, but not physical decline during 3-years follow-up in older adults in Quebec longitudinal study on Nutrition as a Determinant of Successful Aging (18). Vitamin D supplementation has reduced falls in residential care and hospital settings (19).

. Besides overall nutritional status and vitamin D supplementation, other nutrition related factors are often overlooked as potential factors in the etiology of falls, especially in the oldest-old age group.

Our objective here was to explore the association between a wide variety of nutrition-related factors and falls in oldest-old community dwelling men.

Methods

In the Helsinki Businessmen Study (HBS), a socioeconomically homogenous cohort of men, born between 1919 and 1934, has been followed-up since the 1960s (20). In the present cross-sectional analysis, we report findings from the most recent clinic visit in 2017/18. A random sub-cohort of 180 home-living survivors of HBS was invited to the clinic.

At the clinic visit, body mass index (BMI) was calculated as weight (kg)/height (m) squared, nutritional status assessed with Mini Nutritional Assessment (MNA) (21), and body composition measured with dual-energy X-ray absorptiometry (DXA)-scans. Physical performance was assessed with Short Physical Performance Battery (SPPB) (22). Sarcopenia status was determined according to the European Working Group on Sarcopenia in Older People 2 (EWGSOP2)'s criteria 1) Low muscle strength (< 27 kg), 2) low appendicular muscle mass (< 20 kg), and 3) low physical performance (Short Physical Performance Battery ≤ 8 points) (23). Participants were classified into robust (none of the criteria fulfilled), probable sarcopenia (1 criterium) and being sarcopenic (at least 2 criteria). Frailty phenotype was determined according to Fried phenotype criteria: 1) Weight loss >5% of body weight during the last year; 2) Low physical activity/exercise, explored with a question "Do you exercise regularly?"; 3) Walking speed ≤0.8 m/s; 4) Handgrip strength <27 kg; and 5) self-reported exhaustion, explored with a question: "Have you felt unusually tired or exhausted most of the time or all the time during last month?" (24). Accordingly, participants were classified to robust, (zero criteria fulfilled), pre-frail (1 to 2 criteria) and frail (at least 3 criteria).

Food, energy and nutrient intakes were retrieved from 3-day food diaries. Furthermore, daily protein distribution and protein source (amounts of vegetable, animal; milk, meat, fish, and egg proteins) were calculated from 3-day food diaries.

Frequency of falls was explored with a question: “How many times did you fall during past year?” response options being 0 times, 1-2 times, more than 2 times. Since only six participants reported falling more than two times, the falls were further categorized into: 1) no falls and 2) one or more falls during past year. The participants were further asked whether a fall resulted a bone fracture.

Statistical significance for differences between non-fall and fall groups were evaluated using independent t-test for evenly distributed continuous variables and Mann Whitney U-test for unevenly distributed variables. Univariate general linear model was used to investigate associations with waist circumference and falls between fall groups. Results are shown as parameter estimates using three different statistical models for each outcome: model 1 includes intercept, age, and fall groups. Model 2 additionally includes MNA-SF score, and Model 3 additionally includes protein intake. Effect sizes (B) provide the estimated differences in the outcome variables between variables. The level of significance was set at two-sided $p < 0.05$. Analyses were performed using the SPSS statistical program, version 24 (SPSS IBM, Armonk, NY, USA).

Ethics

All participants signed an informed consent and the study protocol was approved by the Ethics Committee of the Helsinki University Hospital, Department of Medicine. The study is registered with ClinicalTrials.gov identifier: NCT02526082.

Results

Of the random sample, 130 (70% of the invited) men participated in the clinic visits, 126 returned food diaries, and 122 reported both falls and returned food diaries. Mean age of the participants in this analysis was 87 years (range 83-99 years) and 30% reported at least one fall during past year and 12 participants reported an injurious fall, resulting a bone fracture. Those reporting an injurious falls did not differ in baseline characteristics or in nutrition related factors from fallers without injuries

While age, MNA or BMI were not associated with falls (Table 1), those in the fall group had more sarcopenia ($p = .002$) and frailty ($p < .001$) and higher waist circumference ($p=.031$), whereas SPPB total score ($p=.002$) was higher in the no falls- group. Of the nutritional factors, fish ($p=.016$) and berry ($p=.027$) consumption, vitamin D intake ($p=.041$), as well as snacking more protein between breakfast and lunch ($p=.017$) were higher in the group with no falls. Of the participants a little over half (n = 65) reported snacking between breakfast and lunch. More red meat was consumed by the fall group ($p=.044$) (Table 2). Protein intake g/kg BW/d was somewhat higher in the no falls- group, but this result did not reach statistical significance ($p = .071$). Of the protein sources, only fish protein ($p=.039$) was significantly higher in the no falls-group. In univariate models adjusted for age, MNA, and protein intake, higher waist circumference remained significantly associated with falls in models 1-3 (Table 3).

Discussion

In our study of oldest-old community-dwelling men with similar socioeconomic status, healthy dietary habits were inversely associated with falls, whereas those who reported falling during last year had larger waist circumference – but no difference in BMI -- and consumed more red meat.

Similarly to our findings, abdominal obesity was associated with increased fall risk in community-dwellers Taiwanese older people aged ≥ 65 years (n = 1377) who participated annual geriatric health examinations (25). In addition to increasing metabolic problems, abdominal obesity may cause unstable center-of-gravity predisposing to falls and more severe injuries (26). Furthermore, larger waist circumference combined with sarcopenia is especially harmful for balance increasing fall risk considerably (27). Frailty has also been associated with abdominal obesity (28). In our oldest-old participants, all these factors – sarcopenia, frailty and wider waist circumference – were more common in the fall group.

Fish intake was higher in the no falls-group compared to the fall-group of our participants. Fish contains several essential and bioactive compounds important for human health (29). Especially fatty fish is a source of anti-inflammatory omega-3 fatty acids that may be beneficial for muscle health in old age (30, 31). Fish is also a major source of dietary vitamin D shown to be important for fall prevention (32). Eating more fish increases vitamin D intakes, which was significantly higher in the no falls-group, in agreement with findings from randomized controlled trials (32).

Berry intake was higher in no falls-group. Berries are high in vitamins and bioactive compounds that could affect heath (33). On the other hand, their intake could also indicate healthier diet as a whole, whereas higher red meat consumption could indicate the opposite. Higher red meat intake has also been associated with increased obesity risk which could explain our finding of higher red meat intake in the fall-group (34).

Protein intake in relation to falls has been studied extensively but the results are conflicting (15-17). In our study, protein intake was somewhat higher in the no falls-group compared to the fall group, but this finding did not reach statistical significance, perhaps due to low power in our study. Protein distribution in respect to falls has not been thoroughly studied. In our study, those in the no falls-group snacked more protein between breakfast and lunch compared to the fall group. Although the difference was not marked, keeping stable blood sugar throughout the day and avoiding long pauses between meals could potentially affect fall risk. This hypothesis, however, needs to be verified in other studies.

Unlike in previous studies (11-13), overall nutritional status did not differ between the no-falls and fall groups in our study. This could be due to the homogeneity of our cohort, minimizing any effect of social or economic factors on nutrition. Although frailty was associated with falls, in this study on nutrition, we did not adjust for frailty, because it is likely to be in the pathogenic pathway.

The strengths of our study include its robust findings – despite the relatively small study sample -- and the fact that there are few other studies on oldest-old (> 85 years of age) people. Limitations to this study include the measurement of falls by a single question and thus relying on respondents' memory of the past year, which may cause bias to the results. Dietary records are subject to under- or over-reporting. However, a nutritionist gave the participants oral and written instruction how to fill the food diaries and called the participants after the return of the food records in order to verify amounts and types of eaten foods used as accurately as possible. The mealtime distribution of protein intake differed between fallers and non-fallers in our study. However, due to low power of our study, it is not possible to define protein patterns related to falls.The participants were home-living men from upper socioeconomic class differing in many ways from the general population. This limits the generalizability of our findings. However, this is also a strength as it probably reduces confounding by socioeconomic factors. Finally, the cross-sectional design of the study prevents drawing conclusions about temporal relationships.

Conclusion

Not falling was associated with healthier dietary habits and lower abdominal obesity in the oldest-old men. These findings suggest that promoting healthy diet and avoiding abdominal obesity may be important for fall prevention. Several results of our study point to new research ideas for fall preventions: interventions targeting abdominal obesity with simultaneously increasing muscle strength through healthy nutrition and exercise should be more thoroughly investigated. In addition, protein distribution during day and even meals spacing should be further explored in respect to falls in larger and more diverse cohorts.

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Conflict of interest

SKJ: reports no conflict of interest

AU: reports no conflict of interest

MK: reports no conflict of interest

TES: reports having various educational and consultative cooperation with several companies, including Nutricia, Abbott, Amgen, Merck, Pfizer, Novartis, and Novo-Nordisk; a minor amount of stock in Orion Pharma; and is a board member and former president of executive board of European Union Geriatric Medicine Society which has cooperation also with the nutrition industry.

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Table 1. Baseline characteristics, protein distribution and source according to fall groups.

Falls during past year / Baseline characteristics	No falls n = 36	≥ 1 fall n = 86	p- value*
Age, years	87.4 (3.0)	87.2 (3)	.686
BMI, kg/m^2	25.5 (2.5)	26.4 (3.0)	.087
Waist circumference, cm	100.1 (8.2)	104.0 (10.0)	**.031**
MNA points (range 0-14) (SD)	13 (1.3)	13 (1.3)	.722
SPPB points (range 1-12) (SD)	9.9 (2.3)	8.3 (2.5)	**.003**
Sarcopenia, %			**<.001**
robust	50.0	19.4	
probable sarcopenia	36.0	44.4	
sarcopenia	14.0	36.1	
Frailty, %			**<.001**
robust	38.4	13.9	
pre-frail	52.3	52.8	
frail	9.3	33.3	
Protein distribution between daily meals, g			
Breakfast, g (SD)	16 (8)	16 (8)	.897
Morning snack, g (SD)	4 (7)	2 (3)	**.017**
Lunch, g (SD)	23 (14)	20 (19)	.843
Dinner, g (SD)	20 (19)	19 (14)	.764
Afternoon snack, g (SD)	5 (7)	4 (5)	.262
Evening snack, g (SD)	7 (7)	8 (6)	.424
Total Protein, g (SD)	75 (24)	72 (17)	.447
Protein % of total energy	18.5%	18.6%	.791
Protein source, g			
Animal protein total, g (SD)	53 (21)	51 (16)	.513
Meat protein, g (SD)	21 (13)	22 (13)	.803
Milk protein, g (SD)	17 (10)	18 (11)	.654
Egg protein, g (SD)	2 (3)	2 (3)	.692
Fish protein, g (SD)	13 (11)	9 (9)	**.028**
Vegetable protein, g (SD)	21 (8)	21 (6)	.690

*Difference between higher and no-fall group and fall-group was tested with independent t-test in even distributed variables and Mann-Whitney U test for unevenly distributed variables, differences between categorical variables were tested with chi-square-test. SD = Standard deviation; BMI = body mass index, kg = kilo, m = meter, MNA = Mini Nutritional Assessment, SPPB = Short Physical Performance Battery; ALM = Appendicular Lean Mass

Table 2. Food group intakes according to falls during past year.

Falls during past year / Food intakes day	No falls n = 36	≥ 1 fall n = 86	p- values*
Total fruits and vegetables, g (SD)	295 (225)	318 (225)	.619
Vegetable intake, g (SD)	148 (135)	177 (132)	.289
Fruit intake, g (SD)	129 (150)	134 (174)	.842
Berry intake, g (SD)	24 (33)	12 (23)	**.027**
Cereal products, g (SD)	331 (153)	347 (140)	.603
Legumes, g (SD)	6 (18)	10 (24)	.315
Nuts, g (SD)	5 (16)	4 (7)	.732
Fish, g (SD)	71 (59)	44 (45)	**.016**
Milk products, g (SD)	329 (246)	320 (206)	.848
Red meat, g (SD)	41 (44)	61 (57)	**.044**
Processed meat, g (SD)	33 (38)	30 (34)	.714
Chicken, g (SD)	28 (43)	21 (39)	.429
Egg, g (SD)	15 (28)	17 (26)	.770
Alcohol, g (SD)	5 (8)	5 (8)	.851
Tea, g (SD)	109 (143)	117 (198)	.814
Coffee, g (SD)	266 (203)	263 (177)	.935
Energy and nutrient intakes			
Energy, kcal (SD)	1609 (381)	1543 (311)	.361
Protein, g (SD)	75 (24)	72 (17)	.445
g/kg BW/d	1.0 (.3)	.9 (.2)	.071
Carbohydrates, g (SD)	171 (47)	169 (34)	.827
Fat, g (SD)	65 (20)	60 (19)	.215
Vitamin D, µg (SD)	10 (8)	7 (5)	**.041**
Vitamin E, mg (SD)	11 (5)	9 (4)	.063
Iron, mg, (SD)	10 (3)	10 (3)	.888

*Difference between higher and no-fall group and fall-group was tested with independent t-test in even distributed variables and Mann-Whitney U test for unevenly distributed variables, differences between categorical variables were tested with chi-square-test. SD = Standard deviation, g = gram; mg = milligram; µg = microgram.

Table 3. ANCOVA models of factors associated with higher waist circumference

		95% confidence interval		
	B	**Lower Bound**	**Upper Bound**	**P-value**
Model 1				
Intercept	129.085	82.426	175.745	<.001
Age	-.287	-.821	.246	.288
Falls; no falls vs. falls	-3.851	-7.370	-.331	.032
Adjusted R^2	**.032**			
Model 2				
Intercept	86.024	32.617	139.43	.002
Age				
Falls; no falls vs. falls	-4.140	-7.578	-.702	.019
MNA	1.939	.689	3.189	.003
Adjusted R^2	**.103**			
Model 3				
Intercept	80.484	27.735	133.233	.003
Age	-.069	-.612	.476	.805
Falls; no falls vs. falls	-4.392	-7.775	-1.009	.011
MNA	1.857	.632	3.083	.003
Protein intake, g	.079	.010	.148	.026
Adjusted R^2	**.134**			

MNA = Mini Nutritional Assessment; Bold value indicates the amount of observed variation that can be explained by the model’s inputs