Association of adherence to the Baltic Sea and Mediterranean diets with indices of sarcopenia in elderly women, OSPTRE-FPS study.

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Abstract

Purpose: To examine whether higher adherence to Baltic Sea diet (BSD) and Mediterranean diet (MED) have beneficial association with sarcopenia indices in elderly women.

Methods: In total 554 women, aged 65–72 years belonging to OSTPRE-FPS study filled a questionnaire on lifestyle factors and 3-day food record at baseline in 2002. Intervention group received calcium 1000 mg/d and cholecalciferol 800 IU for 3 years. Control group received neither supplementation nor placebo. Body composition was measured by dual-energy X-ray absorptiometry. Physical function measures included walking speed 10m, chair rises, one leg stance, knee extension, handgrip strength and squat at baseline and at year 3. Sarcopenia and short physical performance battery (SPPB) score were defined based on the European working group on sarcopenia criteria. Lower body muscle quality (LBMQ) was calculated as walking speed 10m/ leg muscle mass. BSD and MED scores were calculated.

Results: Women in the higher quartiles of BSD and MED scores lost less relative skeletal muscle index and total body lean mass (LM) over 3-year follow-up ($P_{trend} \leq 0.034$). At the baseline, women in the higher BSD score quartiles had greater LM, faster walking speed 10m, greater LBMQ, higher SPPB score ($P_{trend} \leq 0.034$), and higher proportion of squat test completion. Similarly, women in the higher quartiles of MED sore had significantly faster walking speed 10m, greater LBMQ ($P_{trend} \leq 0.041$) and higher proportion of squat test completion.

Conclusions: Better diet quality as measured by higher adherence to BSD and MED might reduce the risk of sarcopenia in elderly women.

INTRODUCTION

Sarcopenia, the degenerative and involuntary loss of skeletal lean mass (LM) and physical function (PF), has been determined as a major cause of mobility disability, and loss of independence. Sarcopenia is estimated to affect one-quarter of the elderly [1-3]. The pathogenesis of sarcopenia is multifactorial and is attributed to undernutrition, oxidative stress, inflammation, endocrine changes and physical inactivity [4]. Studies that assessed the role of nutrition in sarcopenia have focused on specific components of foods, often single nutrients. Although these studies have consistently provided knowledge for benefits of nutritional factors such as vitamin D, vitamin E, carotenoids, energy, protein, and whole grains in ageing sarcopenia [5, 6], this approach has limitations [7]. The role of a single factor is often small and difficult to capture in observational studies; also, people eat foods, not nutrients. Thus, dietary score analysis is a sensible approach to understand the role of the whole diet on sarcopenia.

A dietary score represents a summary value of consumed foods or nutrients and characterizes a measure of adherence to a predefined (healthy) diet [8, 9], in which higher scores indicate diet quality and a higher intake of beneficial foods (such as whole grains, vegetables, fruits, and fish). In the past years, Mediterranean (MED) and Baltic Sea diets (BSD) have been related to positive health outcomes and received growing attention in European and particularly in Nordic settings (Denmark, Finland, Iceland, Norway and Sweden) [8, 10]. The MED is a model of a healthy diet that represents the dietary pattern in population from the Mediterranean area which has also been frequently applied in other populations [8]. However, due to the differences in food culture, applying MED directly to the Nordic population could be challenging [10]. BSD was therefore initially developed in order to present the healthier choices for the diet consumed in the Nordic countries [10, 11]. Many foods cultivated in the Nordic countries, for example, apples and berries, rye, rapeseed oil, salmon and dairy products, are considered to have health-enhancing features [12]. Higher adherence to MED has consistently been associated with lower cognitive functional decline, less dementia and better PF in the elderly [8, 13, 14]. It was shown that higher adherence to MED was associated with better lower body performance [15]. Higher adherence to the MED was associated also with lower odds of sarcopenia among elderly men and women [14]. However, to our knowledge the association of MED with sarcopenia in Nordic countries has not been studied. BSD is likely to be inversely associated with abdominal obesity [11] , and it was associated with better overall physical performance in elderly Finnish women [16].

Studies examining the effect of diet quality on indices of sarcopenia in the elderly are scarce. We hypothesized that higher adherence to BSD and MED provide a wide range of foods and nutrients that can benefit LM and PF. We evaluated and compared the associations of BSD and MED scores with LM, and PF measures in Finnish elderly women in both cross-sectional and prospective settings.

METHODS

Study population

Data of the present study were collected from the Osteoporosis Risk Factor and Prevention - Fracture Prevention Study (OSTPRE-FPS), which was a 3-year intervention to investigate the effect of calcium and vitamin D supplementation on incidence of falls and fractures among elderly women. The subjects were selected from the population-based OSTPRE-cohort [17]. In total 3432 women volunteered to participate in the study, and 750 women were randomly invited into this subsample for participating in detailed examinations including measurement of body composition, clinical, physical and laboratory tests [18]. Of these, 554 returned valid food record at baseline and had valid body composition and PF measurements for both at the baseline and at the 3-year follow-up. The subjects were randomized to intervention group (n=272) receiving daily cholecalciferol 800 IU and calcium 1000 mg for 3 years and control group receiving neither supplementation nor placebo (n=282). All clinical measurements were performed in Kuopio Musculoskeletal Research Unit of the Clinical research center of the University of Kuopio. All participants provided written permission for participation. The study was approved in October 2001 by the ethical committee of Kuopio University Hospital. The study was registered in Clinical trials.gov by the identification NCT00592917.

Dietary intakes

Dietary intake was assessed by using a 3-day food record at the baseline. A questionnaire and the instructions were sent to participants beforehand, and they were returned on the visiting day. Questionnaire included 3 consecutive days, with 2 days during the week and one day in the weekend (Saturday or Sunday). In case of uncertainties in the food record, a nutritionist called the participant for additional information [19]. Assessment of underreporting has previously been described and none of the participants was excluded due to low energy intake [18]. Consumption of foods and the intake of nutrients were calculated using Nutrica program (version 2.5, Finnish social insurance institute, Turku, Finland).

Baltic Sea diet score

We used published definitions of BSD and that have been applied in Nordic settings with slight modifications due to different dietary assessment methods in earlier studies [10]. The final BSD score consisted of nine components, of which five are foods or food groups and four nutrient intakes. The BSD score components included 1) fruits and berries, 2) vegetables (root vegetables, legumes, nuts, mushrooms and vegetable products– potatoes excluded), 3) fiber from cereal products, 4) low-fat milk (skim milk and milk with fat content less than 2 %), and 5) total fish intake as positive components and 6) processed meat products (sausage) as a negative component. 7) Total fat intake was expressed as a percentage of total energy intake (E%). 8) Quality of fat intake was represented by calculating a ratio of polyunsaturated fatty acids (PUFA) to saturated fatty acid (SFA). 9) Frequency of consumption of alcohol portions (1 portion=12 g) was asked in a separate questionnaire. The score construction is presented in Table 1. BSD score ranged from 0–25, higher points indicating higher adherence to BSD.

Mediterranean diet score

MED score is the most widely used diet score [8]. A predefined MED score was selected based on the existing literature and particularly those studies that have applied the MED score in Nordic cohorts [8, 20, 21], as well as on the suggested positive association of MED score with PF [13]. The score comprised of six positive components, including 1) high intake of root vegetables, legumes and nuts, mushrooms and vegetable products (potato excluded), 2) high intake of fruit, 3) high intake of cereals and potatoes, 4) high intake of fish, 5) high PUFA+ monounsaturated fatty acid (MUFA): SFA ratio (as surrogate of quality of dietary fat), and 6) moderate alcohol intake. Two negative components were included 7) total meat including sausage and eggs, and 8) total milk and dairy products. Construction of MED score is described in Table 1. Those who met all of the MED score components received a score of 8, reflecting maximum adherence.

Health examination and measurements

All the information related to lifestyle, income per month, chronic diseases, falls and medications was gathered by using a self-administered questionnaire [22]. Height and weight of participants were measured in light indoor clothing without shoes, and BMI was calculated kg/m^2. Total exercise time/week was based on self-reported amounts and types of exercise/week. To measure body composition whole body dual-energy X-ray absorptiometry (DXA) scans were performed by specially

trained nurses [23]. Relative skeletal muscle index (RSMI) was calculated as the sum of the nonfat, nonbone skeletal muscle in arms and legs divided by the square of height (m^2) which is an indicator of LM in the diagnosis of sarcopenia [3].

Physical function measurements

PF measures were assessed by trained nurses at the baseline and at year 3, consisting of handgrip strength (kPa), number of chair rises in 30 seconds, ability to squat, knee extension (kPa), maximal walking speed 10 m (m/s), and one leg stance performance for 30 seconds. Handgrip strength was measured in a controlled sitting position with a pneumatic hand-held dynamometer (Martin Vigorimeter, Germany) by calculating the mean of three successive measurements from the dominant hand [18] . The chair rise test was conducted if participant was able to stand at least once without using arms from a straight-backed, non-padded, armless chair. Maximal walking speed was calculated by the time of walking the 10 m. Any measurement errors were excluded from the statistical analysis [22]. The follow-up variable of knee extension was excluded from analysis due to unexpected increase in measured extension force and/or possible data entry errors. Absolute changes in PF measures were calculated by subtracting the baseline measures from those measured at year 3. PF assessment methodology have been described and applied earlier in this data set [18, 22].

Short physical performance battery (SPPB) score was calculated based on European working group on sarcopenia (EWGSOP) definition [24]. Three individual measures of physical performance including walking speed 10 m (m/s), chair rises in 30 seconds and one leg stance performance were included [25]. Individuals unable to complete the task received a score of 0, PF tests were further categorized in quartiles and each quartile was scored on scale of 1-4 points. The total SPPB score ranging from 0 to 12; higher scores indicate better performance. Previous studies indicated that an SPPB cut point of less than 10 identifies individuals at increased risk of mobility disability [26] . However, due to the different study setting and that only 8 percent of women had SPPB score over 10, we defined the development of "mobility disability" as an SPPB score belonging to the lowest quartile. The lower body muscle quality (LBMQ) was calculated using walking speed 10 m per leg LM, explained by association between lower leg LM and poorer low extremity performance and walking speed in older men and women [27, 28].

Diagnosis of sarcopenia

We have previously defined sarcopenia based on EWGSOP criteria in this data set [18, 22]. In brief, women were subdivided into quartiles according to their RSMI, handgrip strength and walking speed values (the women who were not able to perform the tests allocated into the group of the lowest quartile). A woman was classified as sarcopenic if she belonged to the lowest quartile of RSMI and the lowest quartile of either handgrip strength or walking speed or both. A non-sarcopenic woman did not belong to the lowest quartile of any measurement, whereas pre-sarcopenic women were in the lowest quartile of RSMI but not in the lowest quartile of any other outcome measure. Non-classified women belonged to the lowest quartile of either handgrip strength or walking speed or both, but not to that of RSMI. To achieve balanced numbers of participants in the stratified analysis, women were classified as sarcopenic if they belonged to pre-sarcopenia, sarcopenia and severe sarcopenia (lowest quartile of RSMI) and non-sarcopenic group was compiled from non-sarcopenic and non-classified groups (normal RSMI).

Statistical analysis

We reported MED and BSD scores in quartiles to enable comparability of their results. We analyzed BSD and MED score also as continuous variables. The agreement between the MED and BSD score was not significant (*kappa* value= 0.020 and *P*= 0.148). We compared the participant characteristics according to BSD and MED score quartiles using chi-square analysis or ANOVA, as appropriate. Independent sample t-test was used to compare the baseline characteristic between sarcopenic and non-sarcopenic groups as well as intervention and control groups.

For the cross-sectional analysis, the baseline values of LM, RSMI and PF measures were tested in total population. In the follow-up analysis, we tested the interaction terms between BSD and MED with vitamin D and calcium intervention. There was no significant interaction by intervention; therefore, data were pooled for total population (intervention and control group) adjusted for the intervention. However, to account for the possible effect of vitamin D and calcium intervention, we tested further the associations only in the control group. In the prospective analysis, we used the absolute changes of PF measures, and the proportional change of LM and RSMI to correct for effect of body size since bigger individuals have greater LM. ANCOVA was used to test the differences among the groups, multiple linear regression models were used to calculate (β) and SE introducing LM, RSMI and PF at the baseline and changes in them as dependent variables with BSD or MED score as independent variable. Logistic regression was used to determine the association of BSD and MED with categorical outcomes (sarcopenia, mobility

disability, and squat test). P-trend was based on a linear trend across BSD and MED score quartiles by using the median value in each category as a continuous variable in the linear regression model as exposure.

We used two models with hierarchical adjustments. Model 1 was adjusted for age and energy intake. Model 2 was adjusted for variables in model 1 and smoking, total physical activity, hormone therapy, osteoporosis, rheumatoid arthritis, income per month, and fat mass percentage. Depression, diabetes, and fall were not included in the models because their associations with the diet scores and outcome measures in the bivariate correlation analysis were $P > 0.10$. Longitudinal analyses were adjusted for the muscle mass and PF baseline measures to account for differential subsequent changes depending on the initial measures. All statistical analysis were executed using SPSS software version 21 for Windows (IBM Corp., Armonk, NY). Result was considered significant if a *P* value was < 0.05.

RESULTS

Characteristics of the study population at baseline

The BSD score ranged from 1 to 25 in our population, and the mean was 13 points. In the model adjusted for age and energy intake the consumption of positive BSD score components (fruits, berries, vegetables, fiber from cereals, fish, milk with fact content <2%, and PUFA to SFA ratio) were substantially higher, and intakes of negative BSD score components (sausage and total fat energy %) were lower in higher score quartiles. At the baseline, women with higher adherence to BSD were more likely to be nonsmokers and engage more in physical activity (Table 2). The mean for MED score was 4.7 and ranged from 0 to 8. Energy intake was significantly higher in the higher quartile of MED score (Table 3). Consumptions of fruits, vegetables, potato, legumes and nuts, milk and dairy products were significantly higher in higher MED score quartiles. Sarcopenic women (n = 127) had significantly lower mean weight (-13.2%), BMI (-12.7%), FM (-16.0%) and LM (-12.0%) as compared to non-sarcopenic group (n =398) (supplementary table 1). Sarcopenic women had also higher protein intake (g/kg BW), higher PUFA to SAFA ratio and higher MUFA+ PUFA to SAFA ratio. At the 3 year of follow-up 386 women were non-sarcopenic and 139 were sarcopenic, whereas in the control group 216 women were classified as non-sarcopenic and 66 as sarcopenic. There were no significant differences in baseline characteristics between intervention and control groups (data not shown).

Association of BSD score and sarcopenia indices at the baseline and over 3-year follow-up

At the baseline, in model 2 women in the higher quartiles of BSD score had significantly greater LM (P_{trend} = 0.044), faster walking speed 10m (P_{trend} = 0.006), and longer one leg stance performance (P_{trend} = 0.050). Those women had higher SPPB score (P_{trend} = 0.034) and better LBMQ (P_{trend} = 0.017) (Table 4). BSD score was non-significantly associated also with lower mobility disability (P_{trend} = 0.051). In prospective analysis, women in the highest quartile of BSD score lost less RSMI (P_{trend} = 0.022) and total body LM (P_{trend} = 0.015) as compared to those in lower quartiles (Figure 1). Further, in the analyses using BSD score as continuous variable, a positive cross-sectional association with total body LM, walking speed, LBMQ and SPPB was observed, whereas BSD score as a continuous variable was positively associated with proportional changes of RSMI and total body LM over the 3-year follow-up (supplementary table 2). The interaction of BSD with interventional vitamin D and calcium supplementation was not significant ($P \geq 0{\cdot}180$). In the stratified prospective analysis in the control group, women in lowest quartile of BSD score lost more RSMI (P_{trend} = 0.018), and total body LM (P_{trend} = 0.004). Women in the highest BSD score quartile, showed the highest SPPB improvement (P_{trend} = 0.041), had a 55% higher squat test completion (OR: 0.45; 95% CI: 0.11-0.98) and 67% lower risk of sarcopenia (OR: 0.33; 95% CI: 0.13, 0.79) as compared to the lowest quartile, over 3 year of follow-up (supplementary table 3). Similar results were observed using the BSD score as continuous variable (data not shown).

Association of MED score and sarcopenia indices at the baseline and over 3-year follow-up

Women in the higher quartiles of MED score had significantly faster walking speed 10m (P_{trend} = 0.041), greater LBMQ (P_{trend} = 0.017) at the baseline (Table 4). In prospective analysis, women in the lowest quartile of MED score lost more RSMI (P_{trend} = 0.001) and total body LM (P_{trend} = 0.008) as compared to those in higher quartiles (Figure 2). When using MED score as a continuous variable, a significant positive association was observed with walking speed and knee extension at the baseline and with proportional changes of RSMI and total body LM over the 3-year follow-up (supplementary table 2).

The interaction of MED score with vitamin D and calcium supplementation was not significant ($P \geq$ 0.730). In the stratified analysis using only the control group, women in the lowest quartile of MED score had higher loss of RSMI (P_{trend} = 0.007) and total body LM (P_{trend} = 0.001) over the 3-year follow-up

(supplementary table 3). We observed the similar results using the MED score as continuous variable (data not shown).

Association of BSD and MED score components with sarcopenia indices

We assessed further the associations of the BSD and MED score components with total body LM and PF at the baseline and over the 3-year follow-up with same adjustment as in model 2 (age, energy intake, smoking, total physical activity, hormone therapy, osteoporosis, rheumatoid arthritis, income per month, and fat mass percentage). Results showed no significant associations except that higher total fruit and vegetable (excluding potato) consumptions were positively associated ($\beta \geq 0.08$ and $P \leq 0.049$) with walking speed 10 m, while higher alcohol consumption was negatively associated with walking speed 10 m at the baseline ($\beta = -0.30$ and $P = 0.034$) (data not shown).

DISCUSSION

This cross-sectional and prospective study addressed the associations of BSD and MED with sarcopenia indices in elderly women. Findings of our study indicated that women with the lower adherence to BSD and MED lost more RSMI and total body LM as compared to those with higher adherence over the 3-year follow-up. The cross-sectional results showed that better adherence to BSD was associated with greater total body LM, faster walking speed 10 m, longer one leg stance performance, higher SPPB score, and greater LBMQ at the baseline. Those with higher adherence to BSD tended to have lower risk of mobility disability. Further, women with higher adherence to MED had faster walking speed 10 m and greater LBMQ at the baseline. One explanation to the attenuation observed in the prospective analysis could be the small changes in PF measures over of the 3-year follow-up. The associations of the components of BSD and MED with muscle and PF measures were not significant; except for the association of fruits and vegetables with walking speed 10 m. Therefore, consistent with previous studies, the overall quality of diet might have more importance than only one food item [11, 29] , and it might not be sufficient to measure only one food item.

Vitamin D supplementation can potentially affect muscle mass and PF in the elderly [30-32]. Given that about half of the subject in this study received calcium and vitamin D supplementation over the 3-year follow-up, we performed stratified analysis to evaluate the association of BSD and MED with sarcopenia indices only in the control group. Among women in the control group, lower adherence to BSD was associated with greater loss of RSMI and total body LM. Those women with higher adherence to BSD

had better SPPB, better results in squat test and lower risk of sarcopenia over the 3-year follow-up. Lower adherence to MED was associated also with greater loss of RSMI and total body LM. Further analysis in the present data showed no significant effect of vitamin D and calcium supplementation on muscle mass and PF measures (M.I, A.E and J.S, unpublished results), which was also explained elsewhere [18, 33]. Therefore, the possibility of vitamin D and calcium supplementation modification on the muscle mass and PF measures is not likely in this study. However, previous findings regarding the effect of vitamin D supplementation on sarcopenia are inconclusive [34, 35]. A recent meta-analysis suggested that vitamin D has no significant effect on muscle mass [34]. However, in a cross-sectional study that included 2258 men and 3005 women aged ≥50 years, sarcopenia (defined as appendicular skeletal muscle mass/body weight <2 standard deviations below gender-specific means for young adults) was inversely associated with serum vitamin D levels in women, but not in men [36]. In another cohort study vitamin D status was associated with functional limitations cross-sectionally and longitudinally in individuals aged 55 to 65 years and those 65 years and older [37].

Our results are consistent with the existing, although limited, literature that supports an association between diet quality and PF in the elderly. In the recent prospective study among ageing women and men, a higher adherence to a healthy Nordic diet (similar to BSD) was associated with better physical performance 10 years later, including the 6-min walk, arm curl and chair stand tests, reflecting better aerobic endurance and upper- and lower-body strength [16]. Results of the InCHIANTI study [15], indicated that higher adherence to MED was associated with better lower body performance. Participants with higher adherence experienced less decline in SPPB score, at the 3, 6 and 9 year follow-up, compared to those with lower adherence. Higher adherence to MED at baseline was also associated with a lower risk of low physical activity and low walking speed but not with feelings of exhaustion and poor muscle strength. In the study by Shahar et al.[13] among 2225 well-functioning men and women aged ≥ 70 years, over 8 years of follow-up, both usual and rapid 20 m walking speed declined in the three MED adherence groups; however, the group with the highest adherence to the MED performed better at all time points.

Multiple mechanisms can explain the effects of BSD and MED on LM and PF in the elderly. Oxidative stress is a major mechanism implicated in the pathogenesis of sarcopenia, and aging muscle shows increased oxidative damage to DNA, protein, and lipids [38, 39]. High intake of fruits and vegetables in MED and BSD could provide antioxidants such as vitamin C, vitamin E and carotenoids. Carotenoids

and antioxidants quench free radicals, reduce damage from reactive oxygen species, and appear to modulate redox-sensitive transcription factors (such as NF-κB, IL-6 and other proinflammatory cytokines) [6, 40, 41]. Recent epidemiological studies in community-dwelling older adults show that low serum/plasma carotenoids and vitamin E are independently associated with low skeletal muscle strength and the development of walking disability [42-44]. There were significantly higher intakes of carotenoids, vitamin E and vitamin C in the highest quartiles of BSD and MED score (Table 2 and 3). In contrast, intakes of fat and processed meat are related to increased oxidation and inflammation [45] . Those in the lowest BSD score quartile had significantly higher fat and sausage intakes. However, fat, total meat and sausage intakes were not significantly different by MED score quartiles. This can be explained by that total fat intake was not included in MED score construction. In addition, dietary fat quality might have more importance than the total fat intake. Both MED and BSD are characterized by high PUFA and MUFA intake to SFA ratio [8, 11]. Intake of n-3 PUFA (EPA, DHA and ALA) which are known for their anti-inflammatory properties were related to leg strength and chair-rise capacity [46], and similarly consumption of fatty fish (as enriched source of PUFAs) to grip strength [47]. In addition, n-3 PUFAs have potential to stimulate the muscle protein synthesis and subsequently muscle mass production [48]. In the InCHIANTI study, serum levels of n-3 PUFA were related to physical performance [49]. This suggests that the anti-inflammatory actions of n-3 PUFA may play a role in the prevention of sarcopenia.

Compared to younger adults, older adults have lower rates of protein synthesis and propensity to eat less, leading to lower protein intake [50]. We have previously shown that dietary protein intake was positively associated with LM, appendicular LM and trunk LM [33]. Moreover, in this data those women with protein intake higher than 0.8 g/kg body weight/day had less decline in handgrip strength/ body weight, one leg stance and walking 6 m over 3 years (significances were attenuated after controlling for FM) [18]. The overall dietary protein intake was higher in the highest BSD score quartile (1.10 g/kg BW) than in the lowest (0.87 g/kg BW); as well as in the highest MED score quartile (1.05 g/kg BW) than in the lowest quartile (0.93 g/kg BW) (Tables 2 and 3). Difference in protein intake can partially explain the mechanism by which women with lower adherence to BSD and MED had greater decline in total body LM and RSMI.

In our study, associations of MED and BSD with muscle strength measures (handgrip strength and chair rises) were not significant. Thus, it might be that higher adherence to MED and BSD can be more related

to preserving lower extremity muscle strength (walking speed and one leg stance) rather than upper extremity muscle strength [16]. Women with higher adherence to BSD tended to have lower mobility disability as compared to those with lower adherence. It has been shown that intake of dietary long-chain n-3 PUFAs was associated with decreased risk of developing rheumatoid arthritis as chronic inflammatory disease of joints that can affect the walking speed in the elderly [51], which may partially explain the MED and mobility disability association [52].

There were general similarities between the components of BSD and MED in our study as they are rich in fruits, vegetables, and fiber. Findings of our study in a non-Mediterranean country (Finland) suggested that either BSD or MED (adapted to Nordic foods consumption) could be beneficial to prevent sarcopenia in Finnish elderly women. However, we observed stronger associations in the analysis using BSD as compared to MED. Thus, due to the diversity in construction of MED and difficulty of its application in Nordic countries alongside with food culture differences; BSD could facilitate recommending a healthy diet for elderly Nordic populations.

Current study has important strengths including the use of dual-energy X-ray absorptiometry to obtain total and regional body composition measures, use of extensive indices of sarcopenia, including LM, RSMI and PF measures as well as reporting both cross-sectional and prospective results. The PF measures and their changes have been applied and explained in this data set previously [18]. We have used categories based on distribution for BSD and MED rather than cut-off points based on recommendation.

There are some potential limitations that need to be considered while interpreting the results. First, the dietary intake assessment was obtained only at the baseline, which may be insufficient to capture long-term dietary exposures. The imprecision of the dietary data may have reduced the ability to detect more robust associations between dietary scores and changes in PF. Second, lower adherence to BSD and MED might be linked to the inferior health of a participant and since we do not have information on the participants' earlier health status and eating patterns, reverse causality is possible. For instance, those with higher BSD score were more physically active than those with lower BSD score. Third, even though we were able to adjust for a wide range of potential confounders, the possibility of other residual confounding cannot be excluded. The study included relatively healthy elderly women from a rather homogenous Finnish population, so caution should be taken in generalization of the results to the entire elderly population. Fourth, we used income per month as a proxy of socioeconomic status. However,

association of income and dietary scores were not significant. Finally, the observational nature of our study did not allow us to evaluate a causal association between dietary scores and changes in RSMI and LM.

This study have encouraging public health message that adherence to healthy BSD and MED could prevent sarcopenia with preserving LM. It is well documented that the loss of LM is associated with critical illnesses and sarcopenia. Further, although only at cross-sectional setting, a healthy diet was associated with better PF measures in elderly women. Previous studies have shown positive relation of BSD and MED with better physical performance, lower abdominal obesity, cognitive function and lower risk of metabolic syndrome [8, 10, 11, 16]. Thus, healthy MED or BSD seem to enhance overall health, physical performance as well as preventing sarcopenia in the elderly.

In conclusion, a higher adherence to BSD and MED might be beneficial in prevention of sarcopenia, since women with lower adherence to BSD and MED lost more RSMI and total body LM compared to others. However, associations of BSD and MED with PF measures were more pronounced in cross-sectional setting. This highlights the importance of a whole diet, not only single foods or nutrients. Further longitudinal studies are warranted to substantiate these recommendations.

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Author contributions are as follows, H. K and M. T designed the original OSTPRE-FPS study. M. I, A. E, planned the present analysis together and collaborated on drafting the manuscript. M. I carried out the statistical analysis, and summarized the results in tables and figures. J.S, J. M, T. R, H. K, M. T critically revised the manuscript for important intellectual content.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest

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