

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

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**Abbreviated title:** Baltic Sea and Mediterranean diets and sarcopenia

**Key words:** Baltic Sea diet; Mediterranean diet; Sarcopenia; Muscle mass; Physical function

## 1 Abstract

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

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

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

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

## 20 INTRODUCTION

21 Sarcopenia, the degenerative and involuntary loss of skeletal lean mass (LM) and physical function (PF),  
22 has been determined as a major cause of mobility disability, and loss of independence. Sarcopenia is  
23 estimated to affect one-quarter of the elderly [1-3]. The pathogenesis of sarcopenia is multifactorial and  
24 is attributed to undernutrition, oxidative stress, inflammation, endocrine changes and physical inactivity  
25 [4]. Studies that assessed the role of nutrition in sarcopenia have focused on specific components of  
26 foods, often single nutrients. Although these studies have consistently provided knowledge for benefits  
27 of nutritional factors such as vitamin D, vitamin E, carotenoids, energy, protein, and whole grains in  
28 ageing sarcopenia [5, 6], this approach has limitations [7]. The role of a single factor is often small and  
29 difficult to capture in observational studies; also, people eat foods, not nutrients. Thus, dietary score  
30 analysis is a sensible approach to understand the role of the whole diet on sarcopenia.

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

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

## 53 **METHODS**

### 54 *Study population*

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

### 69 *Dietary intakes*

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

### 78 *Baltic Sea diet score*

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

### 90 *Mediterranean diet score*

91 MED score is the most widely used diet score [8]. A predefined MED score was selected based on the  
92 existing literature and particularly those studies that have applied the MED score in Nordic cohorts [8,  
93 20, 21], as well as on the suggested positive association of MED score with PF [13]. The score comprised  
94 of six positive components, including 1) high intake of root vegetables, legumes and nuts, mushrooms  
95 and vegetable products (potato excluded), 2) high intake of fruit, 3) high intake of cereals and potatoes,  
96 4) high intake of fish, 5) high PUFA+ monounsaturated fatty acid (MUFA): SFA ratio (as surrogate of  
97 quality of dietary fat), and 6) moderate alcohol intake. Two negative components were included 7) total  
98 meat including sausage and eggs, and 8) total milk and dairy products. Construction of MED score is  
99 described in Table 1. Those who met all of the MED score components received a score of 8, reflecting  
100 maximum adherence.

### 101 *Health examination and measurements*

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

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

#### 110 *Physical function measurements*

111 PF measures were assessed by trained nurses at the baseline and at year 3, consisting of handgrip strength  
112 (kPa), number of chair rises in 30 seconds, ability to squat, knee extension (kPa), maximal walking speed  
113 10 m (m/s), and one leg stance performance for 30 seconds. Handgrip strength was measured in a  
114 controlled sitting position with a pneumatic hand-held dynamometer (Martin Vigorimeter, Germany) by  
115 calculating the mean of three successive measurements from the dominant hand [18]. The chair rise test  
116 was conducted if participant was able to stand at least once without using arms from a straight-backed,  
117 non-padded, armless chair. Maximal walking speed was calculated by the time of walking the 10 m. Any  
118 measurement errors were excluded from the statistical analysis [22]. The follow-up variable of knee  
119 extension was excluded from analysis due to unexpected increase in measured extension force and/or  
120 possible data entry errors. Absolute changes in PF measures were calculated by subtracting the baseline  
121 measures from those measured at year 3. PF assessment methodology have been described and applied  
122 earlier in this data set [18, 22].

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

134 *Diagnosis of sarcopenia*

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

146 *Statistical analysis*

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

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

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

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

## 175 **RESULTS**

### 176 *Characteristics of the study population at baseline*

177 The BSD score ranged from 1 to 25 in our population, and the mean was 13 points. In the model adjusted  
178 for age and energy intake the consumption of positive BSD score components (fruits, berries, vegetables,  
179 fiber from cereals, fish, milk with fat content  $< 2\%$ , and PUFA to SFA ratio) were substantially higher,  
180 and intakes of negative BSD score components (sausage and total fat energy %) were lower in higher  
181 score quartiles. At the baseline, women with higher adherence to BSD were more likely to be nonsmokers  
182 and engage more in physical activity (Table 2). The mean for MED score was 4.7 and ranged from 0 to  
183 8. Energy intake was significantly higher in the higher quartile of MED score (Table 3). Consumptions  
184 of fruits, vegetables, potato, legumes and nuts, milk and dairy products were significantly higher in higher  
185 MED score quartiles. Sarcopenic women ( $n = 127$ ) had significantly lower mean weight ( $-13.2\%$ ), BMI  
186 ( $-12.7\%$ ), FM ( $-16.0\%$ ) and LM ( $-12.0\%$ ) as compared to non-sarcopenic group ( $n = 398$ ) (supplementary  
187 table 1). Sarcopenic women had also higher protein intake (g/kg BW), higher PUFA to SAFA ratio and  
188 higher MUFA+ PUFA to SAFA ratio. At the 3 year of follow-up 386 women were non-sarcopenic and  
189 139 were sarcopenic, whereas in the control group 216 women were classified as non-sarcopenic and 66  
190 as sarcopenic. There were no significant differences in baseline characteristics between intervention and  
191 control groups (data not shown).

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

193 At the baseline, in model 2 women in the higher quartiles of BSD score had significantly greater LM ( $P$   
194  $trend = 0.044$ ), faster walking speed 10m ( $P_{trend} = 0.006$ ), and longer one leg stance performance ( $P_{trend} =$   
195  $0.050$ ). Those women had higher SPPB score ( $P_{trend} = 0.034$ ) and better LBMQ ( $P_{trend} = 0.017$ ) (Table  
196 4). BSD score was non-significantly associated also with lower mobility disability ( $P_{trend} = 0.051$ ). In  
197 prospective analysis, women in the highest quartile of BSD score lost less RSMI ( $P_{trend} = 0.022$ ) and  
198 total body LM ( $P_{trend} = 0.015$ ) as compared to those in lower quartiles (Figure 1). Further, in the analyses  
199 using BSD score as continuous variable, a positive cross-sectional association with total body LM,  
200 walking speed, LBMQ and SPPB was observed, whereas BSD score as a continuous variable was  
201 positively associated with proportional changes of RSMI and total body LM over the 3-year follow-up  
202 (supplementary table 2). The interaction of BSD with interventional vitamin D and calcium  
203 supplementation was not significant ( $P \geq 0.180$ ). In the stratified prospective analysis in the control  
204 group, women in lowest quartile of BSD score lost more RSMI ( $P_{trend} = 0.018$ ), and total body LM ( $P$   
205  $trend = 0.004$ ). Women in the highest BSD score quartile, showed the highest SPPB improvement ( $P_{trend}$   
206  $= 0.041$ ), had a 55% higher squat test completion (OR: 0.45; 95% CI: 0.11-0.98) and 67% lower risk of  
207 sarcopenia (OR: 0.33; 95% CI: 0.13, 0.79) as compared to the lowest quartile, over 3 year of follow-up  
208 (supplementary table 3). Similar results were observed using the BSD score as continuous variable (data  
209 not shown).

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

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

217 The interaction of MED score with vitamin D and calcium supplementation was not significant ( $P \geq$   
218  $0.730$ ). In the stratified analysis using only the control group, women in the lowest quartile of MED score  
219 had higher loss of RSMI ( $P_{trend} = 0.007$ ) and total body LM ( $P_{trend} = 0.001$ ) over the 3-year follow-up

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

### 222 *Association of BSD and MED score components with sarcopenia indices*

223 We assessed further the associations of the BSD and MED score components with total body LM and PF  
224 at the baseline and over the 3-year follow-up with same adjustment as in model 2 (age, energy intake,  
225 smoking, total physical activity, hormone therapy, osteoporosis, rheumatoid arthritis, income per month,  
226 and fat mass percentage). Results showed no significant associations except that higher total fruit and  
227 vegetable (excluding potato) consumptions were positively associated ( $\beta \geq 0.08$  and  $P \leq 0.049$ ) with  
228 walking speed 10 m, while higher alcohol consumption was negatively associated with walking speed  
229 10 m at the baseline ( $\beta = -0.30$  and  $P = 0.034$ ) (data not shown).

## 230 **DISCUSSION**

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

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

249 had better SPPB, better results in squat test and lower risk of sarcopenia over the 3-year follow-up. Lower  
250 adherence to MED was associated also with greater loss of RSMI and total body LM. Further analysis in  
251 the present data showed no significant effect of vitamin D and calcium supplementation on muscle mass  
252 and PF measures (M.I, A.E and J.S, unpublished results), which was also explained elsewhere [18, 33].  
253 Therefore, the possibility of vitamin D and calcium supplementation modification on the muscle mass  
254 and PF measures is not likely in this study. However, previous findings regarding the effect of vitamin  
255 D supplementation on sarcopenia are inconclusive [34, 35]. A recent meta-analysis suggested that  
256 vitamin D has no significant effect on muscle mass [34]. However, in a cross-sectional study that included  
257 2258 men and 3005 women aged  $\geq 50$  years, sarcopenia (defined as appendicular skeletal muscle  
258 mass/body weight  $< 2$  standard deviations below gender-specific means for young adults) was inversely  
259 associated with serum vitamin D levels in women, but not in men [36]. In another cohort study vitamin  
260 D status was associated with functional limitations cross-sectionally and longitudinally in individuals  
261 aged 55 to 65 years and those 65 years and older [37].

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

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

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

297 Compared to younger adults, older adults have lower rates of protein synthesis and propensity to eat less,  
298 leading to lower protein intake [50]. We have previously shown that dietary protein intake was positively  
299 associated with LM, appendicular LM and trunk LM [33]. Moreover, in this data those women with  
300 protein intake higher than 0.8 g/kg body weight/day had less decline in handgrip strength/ body weight,  
301 one leg stance and walking 6 m over 3 years (significances were attenuated after controlling for FM)  
302 [18]. The overall dietary protein intake was higher in the highest BSD score quartile (1.10 g/kg BW) than  
303 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  
304 lowest quartile (0.93 g/kg BW) (Tables 2 and 3). Difference in protein intake can partially explain the  
305 mechanism by which women with lower adherence to BSD and MED had greater decline in total body  
306 LM and RSML.

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

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

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

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

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

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

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

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

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

#### 363 **Conflict of interest**

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

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