Behavior changes by a buddy-style intervention including physical training, and nutritional and social support

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Introduction

Aging is accompanied by many changes in physiological (e.g. senses, mobility), social (e.g. loneliness) and psychological (e.g. cognitive performance) functioning that can make it more difficult for physical activity and nutritional needs to be met.1,2 Indeed, older adults are more disposed to age-related conditions, including frailty, that might interfere with the maintenance of a good nutritional status.2 Physical activity and nutritional behavior are factors closely related to the frailty syndrome.3 Overall, the population is living longer with more chronic conditions than past generations.4 Therefore, adequate protein intake, in conjunction with regular physical activity, is important to lessen the consequences of aging.

One approach for improving behavior might be through behavioral interventions, focusing on dietary and physical activity habits. In older adults, these interventions have shown improvements in physical activity patterns5 and dietary habits.6 However, these studies focused on one aspect alone, either physical activity or nutritional intervention, although studies combining physical activity and nutritional intervention appear to lead to better outcomes.7,8 Furthermore, behavior interventions can be delivered in group-based or face-to-face settings. Both might be appealing, as they can provide social support in maintaining and/or initiating behavior change.10,11 “Buddy-style” interventions, where persons are encouraged to carry out, for example, strength exercises, have been successful in both the general population12 and in the older generally healthy population living in community centers.13 A literature review reported that social support is a strong driver of health behaviors.14 It is able to function as a pathway by helping individuals to regulate their own behavioral changes, which are derived from their specific chronic conditions; for example, frailty.15

Aim: Previous research suggests that multicomponent interventions including physical training, and nutritional and social support are required to improve a person’s behavior. As a pre-specified secondary outcome, this analysis aimed to ascertain whether a “buddy-style” intervention could produce physical activity and nutritional behavior changes in older adults. Methods: A 12-week, home-based, randomized controlled trial was carried out with 80 older persons, who were randomly assigned to an intervention group (n = 39), including physical training and nutritional support, and a control group (n = 41). Trained non-professional volunteers visited the participants at home twice a week. Physical activity and nutritional behavior were assessed through validated questionnaires.

Results: In total, 36 participants in the intervention group and 26 participants in the control group completed the final questionnaire. The intervention group showed significant improvements in physical activity behavior, such as light sport activity (β = 9.13, 95% CI 0.90–17.37 min/day; P = 0.030), muscle strength exercise (β = 68.18, 95% CI 46.45–89.91 min/week; P < 0.001) and overall activities (β = 0.69, 95% CI 0.21–1.18 h/day; P = 0.006), compared with the control group. Nutritional behavior improvements for the intervention group were observed in the consumption of legumes/nuts (β = 0.18, 95% CI 0.00–0.35 portions/day; P = 0.047) and fluids (β = 0.48, 95% CI 0.01–0.98 portions/day; P = 0.050), relative to controls.

Conclusions: A “buddy-style” program in older adults living at home can produce effective physical activity changes and, to a lesser extent, changes in dietary behavior, and has the potential to be efficient and feasible. Geriatr Gerontol Int 2019; 19: 323–329.

Keywords: health behaviors, non-professional volunteers, nutrition, older persons, physical activity.
We developed a “buddy-style” program with the focus on social support, physical training and nutritional education, especially muscle strength exercises and protein intake. Although there is evidence that our program improves outcomes, such as nutritional and frailty status, handgrip strength, and fear of falling, we also carried out a more detailed analysis in terms of behavioral change, which was a pre-specified secondary outcome. Thus, the aim of the present study was to determine the effectiveness of the combined home-based physical training, nutritional education and social support intervention, carried out by volunteers, on physical activity and nutritional behavior in community-dwelling older adults.

Methods

Study design

The present study was a 12-week randomized controlled trial comparing a physical training, nutritional and social support (PTN) group versus a social support (SoSu) group, carried out by lay non-professional volunteers with older persons at home. The data were collected at two time points.

Participants

Recruitment was undertaken between September 2013 and August 2014; the last follow-up assessment was carried out in February 2015. Participant selection criteria called for persons at risk of malnutrition or malnourished persons, which was assessed by the Mini Nutritional Assessment; prefrail or frail persons, by using the Survey of Health, Aging and Retirement in Europe Frailty Instrument (SHARE-FI); aged >65 years; living in Vienna; and signed informed consent. Persons were excluded for the following reasons: impaired cognitive function; planned admission to a nursing home; undergoing or planned chemo- or radiotherapy; serious comorbidities, for example, insulin-treated diabetes mellitus; and requiring >180 h per month of care. Persons with a medical contra-indication for carrying out strength training were also excluded.

The non-professional volunteers were recruited in cooperation with a non-governmental organization in Vienna (Wiener Hilfswerk). The eligibility criterion for recruitment was persons aged >50 years.

The study was approved by the local ethics committee of the Medical University of Vienna (reference number: 1416/2013) and complied with the Declaration of Helsinki. The study methods were in accordance with the CONSORT guidelines for reporting randomized trials.

Sample size and randomization of groups

On the basis of an assumed 20% dropout rate, we estimated that a total sample size of 80 persons (40 in each group) was required for 80% statistical power to detect a clinically relevant difference of 2 kg (standard deviation: 3) in handgrip strength between the PTN and SoSu groups at 12 weeks. In the present, we focused on changes in physical activity and nutritional behavior, which were prospectively defined as a secondary outcome.

Intervention

The buddies were encouraged to carry out the physical activity and nutritional intervention with the prefrail or frail persons at home twice a week.

The main material of the intervention was a guidebook, which provided standardized physical activity exercises and nutritional recommendations, and encouraged goal setting to reinforce the self-efficacy. A warm-up with mobilization exercises was followed by six strength exercises carried out in circuit form, with two sets and 15 repetitions, until muscular exhaustion. The nutritional intervention focused on three main nutritional aspects: fluid intake, animal and plant protein intake, and energy intake. In addition to the guidebook, participants were provided with a Dyna-Band and recipes for protein- and energy-rich dishes. Details of the intervention have been previously published.

The older persons were also instructed to carry out the strength exercises and the nutritional intervention on their own.

The SoSu group was designed as an active control group, but received no physical activity or nutritional intervention, to examine whether the additional physical training and nutritional intervention was more effective than social support alone.

Instrument

The interview-assisted questionnaire consisted of validated instruments on physical activity and nutritional behavior, along with the main sociodemographic characteristics, including sex, age, education level and living arrangement. The interviewers were not blinded to the group. Cognitive function was assessed by the German version of the Mini-Mental State Examination. The number of oral medications taken was assessed by participant self-reporting, and was verified by prescription forms, drug packages and medical records. The prevalence of comorbidities was determined by self-reporting. Body mass index was calculated from measured height and weight, as weight (kg) divided by height squared (m²).

Physical activity and nutritional behavior outcomes

Physical activity behavior was assessed through the validated Physical Activity Scale for the Elderly questionnaire to measure self-reported physical activity in individuals aged >65 years as overall activities, walking time outside home, sitting, muscle strength, and balance exercises, light, moderate and strenuous sports.

Nutritional behavior was assessed by the modified version of the European Prospective Investigation into Cancer and Nutrition Study Food-Frequency Questionnaire, using only the food groups containing proteins. The participants indicated the number of times a given food item was consumed. One portion size corresponded to the size of one palm of the hand, for example, which was presented as an image on the questionnaire. A total of 21 food items corresponding to five food groups as “meat and meat products, fish and eggs” (five items), “legumes and nuts” (four items), “milk and dairy products” (four items), “grains” (five items) and “bread” (three items) were assessed. Each food item of the Food-Frequency Questionnaire represented an individual food; for example, “salmon”. Extra questions were added to assess the frequency of fluid, vegetable and fruit intake. The frequency of food items enabled quantification of regular consumption of recommended portions, which was based on the Healthy-for-Life Plate guide. This is a modification of the Healthy Eating Plate of Harvard University. Furthermore, the frequencies of food items were calculated as daily intake (portions per day).

Overall adherence rate

The adherence to the intervention was assessed by analyzing the documentation forms completed by the buddies. The number of home visits, number of exercise circuits carried out and number of nutrition-related messages per home visit were also assessed.

Statistical analysis

The results are expressed as mean (standard deviation) or median (minimum–maximum) for continuous variables, according to the distribution, and as percentages for categorical variables. Comparisons between the PTN and the SoSu groups at baseline were made using t-tests, Mann–Whitney U-tests or χ²-tests. All the results were analyzed according to the per-protocol principle.

The intervention effects on physical activity and nutritional behavior outcomes were determined using analysis of covariance (ANCOVA) to assess the effect of the between-subject factor (PTN and SoSu groups). We tested the outcome variables for socioeconomic status variables, such as age, sex, income, education level, living
arrangement and marital status, with the purposeful selection algorithm. Consequently, the models were adjusted for sex and baseline measures to provide an unbiased estimate of the mean group difference. Paired t-tests or Wilcoxon tests were used to assess the effect of the within-subject factor (from baseline to 12 weeks). All physical activity and nutritional behavior variables were recoded in binary form, indicating physical activity participation status (yes or no), for example, lack of physical activity participation means <10 min duration, and adherence to daily intake recommendations (yes or no), for example, consuming less of the recommended portion of legumes or nuts per day. The estimates of the prevalence of physical activity participation and adherence to daily intake recommendations for the PTN and SoSu groups over time were calculated using generalized estimating equations (GEE), with a logit link function for binary outcomes. Unstructured covariance matrices were used within the models. The GEE were used to examine the effects with time (from baseline to 12 weeks) and per group (PTN and SoSu group), with the prevalence of the outcome variable (yes, no) as the dependent variable. Therefore, the GEE were calculated to determine which of the physical activity and nutritional behavior outcomes were positively affected by the study intervention. Significance tests were carried out with Wald $\chi^2$ ($\alpha = 0.05$). These models were also adjusted for sex and baseline value. The within-group effect size was calculated as $d = (\text{post intervention mean} – \text{baseline mean}) / \text{baseline standard deviation}$. The between-group effect size was calculated as $d = (\text{post intervention mean} – \text{baseline mean for the PTN group}) – (\text{post intervention mean} – \text{baseline mean for the SoSu group}) / \text{pooled baseline standard deviation}$. Using Cohen’s effect sizes, $d = 0.2$ was considered a small effect, $d = 0.5$ a medium effect and $d = 0.8$ a large effect. All the statistical analyses were carried out with IBM SPSS Statistics for Windows version 23 software (IBM Corporation, Armonk, NY, USA). $P$-values of <0.05 were considered statistically significant, and all the tests were two-sided.

Results

Study population

Participants ($n = 285$) were assessed for eligibility by three hospitals in Vienna (Austria), and 73% did not meet the inclusion criteria, 19% declined to participate and 6% were excluded for other reasons. Eligible participants were also recruited through the media (newspaper article and television; $n = 197$), and 24% did not meet the inclusion criteria, 18% declined to participate and 19% were excluded for other reasons. Out of the 77 eligible patients recruited via the hospitals, four (2%) persons participated. In total, the dropout rate was 18% ($n = 14$), with 13% ($n = 5$) dropping out in the PTN group and 22% ($n = 9$) dropping out in the SoSu group. The reasons for discontinued intervention were death (PTN $n = 1$, SoSu $n = 2$), medical decision (PTN $n = 2$, SoSu $n = 2$), no time (PTN $n = 2$, SoSu $n = 2$), and the participant’s statements “no longer interested” (PTN $n = 1$) and “did not want to be in the SoSu group” (SoSu $n = 2$). Of the 42 participants in the PTN group and the 38 in the SoSu group who completed the baseline questionnaire, 36 and 26 older adults, respectively, with complete data were available for analysis. The final response rate was 78%.

The characteristics of the study sample are summarized in Table 1.

Physical activity and nutritional behavior outcomes

Table 2 summarizes the changes in physical activity outcomes between the PTN and SoSu groups across the two time points. There was no difference between the two groups at baseline in terms of physical activity variables. The PTN group showed a significant increase from baseline to 12 weeks in mean overall activity, walking time outside home, muscle strength exercises, and light and moderate sports, relative to the SoSu group. Within-subject effect sizes for the PTN group ranged from $d = 0.5$ to 2.1, which represents a moderate-to-large effect size in this physical activity outcome, whereas there were no or small effect sizes for the SoSu group, except for muscle strength exercises. Between-subject effect sizes were medium-to-large ($d = 0.4$–1.2) in the physical activity outcomes of overall activities, muscle strength exercises and light sports. Table 3 shows the participation in physical activity variables between the two groups across the two time points. Significant improvements were evident in the variables of walking time outside home, muscle strength and balance exercises, and light and moderate sports. The PTN group showed a significantly higher odds ratio in the physical activity participation outcome of muscle strength exercises, compared with the SoSu group.

In Table 4, the nutritional behavior outcomes between the PTN and SoSu groups across the two time points are compared. There were significant differences between the two groups at baseline.

Table 1: Baseline characteristics of the study population

| Characteristic | Total ($n = 80$) | PTN group ($n = 39$) | SoSu group ($n = 41$) |
|---------------|-----------------|---------------------|---------------------|
| Sex: female (%) | 84 | 85 | 83 |
| Age (years) | 82.8 (8) | 83.0 (8.1) | 82.5 (8.0) |
| Education level | | | |
| Primary school (%) | 54 | 62 | 46 |
| Secondary school (%) | 34 | 28 | 39 |
| Tertiary (%) | 13 | 10 | 15 |
| Living arrangement: living alone (%) | 84 | 82 | 85 |
| Cognitive status (MMSE score) | 26.5 (2.9) | 26.7 (3) | 26.2 (2.7) |
| No cognitive impairment (%) | 78 | 80 | 76 |
| Mild cognitive impairment (%) | 23 | 21 | 24 |
| No. drugs | 7.7 (4.2) | 7.5 (3.9) | 7.9 (4.4) |
| Polypharmacy ≥4 drugs (%) | 86 | 85 | 88 |
| Comorbidity: yes (%) | 99 | 100 | 98 |
| BMI (kg/m²) | 27.2 (4.3) | 26.9 (4.5) | 27.4 (4.3) |
| Underweight (%) | 10 | 8 | 13 |
| Normal weight (%) | 22 | 31 | 13 |
| Overweight (%) | 47 | 41 | 53 |
| Obese (%) | 22 | 21 | 23 |
| Frailty status (SHARE-FI) | | | |
| Robust (%) | 1 | 3 | 0 |
| Prefrail (%) | 35 | 36 | 34 |
| Frail (%) | 64 | 62 | 66 |
| Nutritional status (MNA-LF) | | | |
| Normal nourished (%) | 51 | 49 | 54 |
| At risk of malnutrition (%) | 45 | 46 | 44 |
| Malnourished (%) | 4 | 5 | 2 |

1Underweight: <20 kg/m² for <70 years or <22 kg/m² for >70 years; normal weight: 20 or 22–24.9 kg/m²; overweight: 25–29.9 kg/m²; obese: ≥30 kg/m². Data are presented as mean (standard deviation) for continuous variables and percentages for categorical variables. BMI, body mass index; MMSE, Mini-Mental State Examination; MNA-LF: Mini Nutritional Assessment long form; Primary school, elementary school/no degree or first to fourth grade of school level; PTN, physical training and nutritional intervention group; Secondary school, secondary school or fifth to eighth grade of school level; SHARE-FI, Frailty Instrument for Primary Care of the Survey of Health, Aging and Retirement in Europe; SoSu, social support group; Tertiary, university level/higher degree or over ninth grade of school level.
| Outcome                                  | Group    | Baseline Mean (95% CI) | Baseline P-value | 12 weeks Mean (95% CI) | 12 weeks P-value | Change Absolute | Within-subject effect Mean (95% CI) | Within-subject effect P-value | d | Between-subject effect β (95% CI) | Between-subject effect P-value |
|------------------------------------------|----------|------------------------|------------------|------------------------|------------------|----------------|-------------------------------------|--------------------------------|---|-----------------------------------|-------------------------------|
| Overall activities (h per day)           | PTN      | 1.3 (0.9, 1.7)         | 0.714            | 2.3 (1.8, 2.7)         | 0.023            | 1.0            | 0.87 (0.42, 1.32)                   | **0.001**                        | 0.7 | 0.69 (0.21, 1.18)                  | 0.006                          |
|                                          | SoSu     | 1.4 (0.9, 1.8)         | 0.235            | 1.6 (1.1, 2)           | 0.2              | 0.2            | 0.16 (0.03, 0.55)                   | 0.16                           | 0.1 | 0.69 (0.21, 1.18)                  | 0.006                          |
| Walking time outside home (min per day)  | PTN      | 31.7 (13.4, 50)        | 0.235            | 59.2 (36.7, 81.6)      | 0.625            | 27.5           | 27.10 (3.43, 50.77)                 | *0.039                          | 0.5 | 23.30 (−2.46, 49.07)              | 0.075                          |
|                                          | SoSu     | 44.6 (21.6, 68.2)      | 0.235            | 47.2 (27.2, 67.2)      | 2.6              | −8.77          | −27.61 (10.07)                     | 0.001                          | 0.0 | 1                                 |                               |
| Sitting activities (h per day)           | PTN      | 10.4 (9.3, 11.4)       | 0.467            | 10.6 (10, 11.2)        | 0.233            | 0.2            | −0.03 (−1.22, 1.17)                 | 0.118                          | 0.1 | −0.69 (−1.59, 0.21)               | 0.131                          |
|                                          | SoSu     | 11.7 (11, 12.3)        | 0.167            | 11.4 (10.7, 12.1)      | −0.3             | −0.33          | −1.22 (0.56)                      | 0.0                             | 1   | 1                                 |                               |
| Muscle strength exercise (min per week)  | PTN      | 12.9 (−7.6, 33.3)      | <0.001           | 75 (57.9, 92.1)        | <0.001           | 62.1           | 60.00 (30.08, 89.92)               | <0.001                          | 1.0 | 68.18 (46.45, 89.91)              | <0.001                          |
|                                          | SoSu     | 1.6 (−1.6, 4.8)        | 0.323            | 6.9 (−3, 16.8)         | 0.5              | 5.3            | −2.96 (16.80)                     | 0.0                             | 1   | 0.5                               |                               |
| Balance exercises (min per week)         | PTN      | 5.4 (−0.7, 11.5)       | 0.522            | 11.4 (6.1, 16.7)       | 0.007            | 6.0            | 5.54 (−0.72, 11.79)                | *0.107                         | 0.3 | 4.39 (−7.72, 16.50)               | 0.471                          |
|                                          | SoSu     | 9.5 (2.3, 16.7)        | 0.966            | 9.6 (−5.3, 24.5)       | 0.1              | −1.20          | −14.82 (12.42)                    | 0.0                             | 1   | 0.0                               |                               |
| Light sports (min per day)               | PTN      | 6.1 (0.5, 11.6)        | 0.946            | 14.5 (6.3, 22.7)       | 0.067            | 8.4            | 10.78 (2.28, 19.28)                | *0.015                          | 0.5 | 9.13 (0.90, 17.37)                | 0.030                          |
|                                          | SoSu     | 4.3 (0.2, 8.5)         | 0.946            | 6.1 (1.6, 10.6)        | 1.8              | 0.92           | −6.63 (8.48)                      | 0.0                             | 0.1 | 0.1                               |                               |
| Moderate sports (min per week)           | PTN      | 1.9 (−1.1, 4.8)        | 0.841            | 21.5 (7.8, 35.1)       | 0.396            | 19.6           | 19.10 (6.48, 31.71)                | *0.007                          | 2.1 | −10.35 (−41.42, 20.71)            | 0.507                          |
|                                          | SoSu     | 12.6 (−6.9, 32.2)      | 0.841            | 31.2 (−6, 68.4)        | 18.6             | 12.00         | −30.30 (54.30)                    | 0.3                             | 0.3 | 1                                 |                               |
| Strenuous sports (min per week)          | PTN      | 5.7 (−3.3, 14.8)       | 0.939            | 8.2 (−1.9, 18.2)       | 0.315            | 2.5            | 0.91 (−12.52, 14.33)               | 0.581                          | 0.1 | 1.46 (−12.28, 15.20)              | 0.832                          |
|                                          | SoSu     | 3.9 (−2.6, 10.5)       | 0.939            | 4.4 (−4.7, 13.4)       | 0.5              | 4.38           | −4.68 (13.43)                     | 0.0                             | 0.1 | 1                                 |                               |

*P < 0.05, **P < 0.001. P-values are based on Mann-Whitney U-tests. P-values are based on Wilcoxon tests as within-subject factor (from baseline to 12 weeks). P-values are based on analysis of covariance (ANCOVA) as between-subject factor (physical training and nutritional intervention group [PTN] and social support group [SoSu] groups). SoSu group as the reference group. Models are adjusted for sex and baseline value. Mean (95% confidence interval) for continuous variables at baseline and after 12 weeks. 95% CI, 95% confidence interval; d, Cohen’s effect size; β, standardized coefficient.
| Participation of at least 10 min | Group   | Baseline | 12 weeks | Change | Within-subject effect | Between-subject effect |
|--------------------------------|---------|----------|----------|--------|-----------------------|-----------------------|
|                                |         | n (%)    | P-value  | n (%)  | P-value               | OR (95% CI)           | P-value |
| Walking time outside home      | PTN     | 15 (19.2)| 0.365    | 26 (33.3)| 0.915 | 4.18 (2.28, 7.67) | <0.001 | 1.58 (0.47, 5.29) | 0.456 |
|                                | SoSu    | 18 (23.1)|          | 19 (24.4)|          |                      |                     |
| Muscle strength exercise       | PTN     | 3 (7.9)  | 0.617    | 31 (81.6)| <0.001 | 55.60 (12.56, 246.12) | <0.001 | 31.66 (6.55, 153.06) | 0.001 |
|                                | SoSu    | 1 (2.6)  |          | 3 (7.9) |          |                      |                     |
| Balance exercises              | PTN     | 6 (16.7) | 0.558    | 18 (50) | 0.008 | 2.63 (1.28, 5.40) | 0.009 | 1.82 (0.72, 4.60) | 0.208 |
|                                | SoSu    | 8 (22.2) |          | 4 (11.1) |          |                      |                     |
| Light sports                   | PTN     | 5 (17.2) | 0.866    | 13 (44.8)| 0.403 | 3.05 (1.35, 6.92) | 0.007 | 1.50 (0.61, 3.65) | 0.376 |
|                                | SoSu    | 5 (17.2) |          | 6 (20.7) |          |                      |                     |
| Moderate sports                | PTN     | 2 (9.5)  | 0.664    | 11 (52.4)| 0.375 | 7.48 (3.07, 18.19) | <0.001 | 1.46 (0.40, 5.36) | 0.565 |
|                                | SoSu    | 3 (14.3) |          | 5 (23.8) |          |                      |                     |
| Strenuous sports               | PTN     | 2 (22.2) | 0.918    | 4 (44.4) | 0.385 | 1.78 (0.65, 4.89) | 0.263 | 1.75 (0.65, 4.97) | 0.257 |
|                                | SoSu    | 2 (22.2) |          | 1 (11.1) |          |                      |                     |

P-values are based on χ²-tests. **P-values are based on generalized estimating equations to examine effects with time (from baseline to 12 weeks) as repeated factor and group (physical training and nutritional intervention group [PTN] and social support group [SoSu] groups) as between-subject factor, with prevalence of outcome parameters (yes, no) as dependent variable. Logit link function and an unstructured correlation matrix were used. Significance tests were carried out with Wald χ² (α = 0.05). The models are adjusted for baseline value and sex. Baseline data and SoSu group as reference. Number and percentages (n, %) are reported for categorical variables at baseline and after 12 weeks. 95% CI, 95% confidence interval; OR, odds ratio.

| Nutritional behavior outcomes in both groups at baseline and 12 weeks |
|---------------------------------------------------------------|
| Portions of (per day) | Group   | Baseline | 12 weeks | Change | Within-subject effect | Between-subject effect |
|                    |         | Mean (95% CI) | P-value | Mean (95% CI) | P-value | Absolute | Mean (95%-CI) | P-value | d | β (95% CI) | P-value |
| Meat and meat products, fish or eggs                         | PTN     | 1.2 (1.1, 1.4) | 0.262 | 1.2 (1.1, 1.4) | 0.880 | 0.0 | 0.07 (−0.07, 0.22) | 0.675 | 0.0 | 0.09 (−0.14, 0.32) | 0.443 |
| Milk or dairy products                                       | PTN     | 2.2 (1.9, 2.5) | 0.017 | 2.2 (1.8, 2.6) | 0.024 | 0.0 | −0.09 (−0.50, 0.33) | 0.331 | 0.0 | 0.38 (−0.14, 0.90) | 0.146 |
| Legumes or nuts                                              | PTN     | 0.4 (0.2, 0.6) | 0.717 | 0.6 (0.4, 0.8) | 0.345 | 0.2 | 0.27 (0.10, 0.43)** | 0.001 | 0.4 | 0.18 (0.00, 0.35) | 0.047 |
| Grains                                                       | PTN     | 0.9 (0.7, 1) | 0.587 | 0.9 (0.8, 1) | 0.635 | 0.0 | 0.04 (−0.11, 0.18) | 0.187 | 0.0 | 0.01 (−0.16, 0.15) | 0.969 |
| Bread                                                        | PTN     | 1.7 (1.5, 1.9) | 0.455 | 1.7 (1.4, 1.9) | 0.867 | 0.0 | 0.01 (−0.35, 0.38) | 0.655 | 0.0 | 0.03 (−0.32, 0.38) | 0.867 |
| Fluids                                                       | PTN     | 5.3 (5, 5.7) | 0.709 | 5.3 (5, 5.7) | 0.075 | 0.2 | 0.44 (−0.07, 0.96) | 0.240 | 0.2 | 0.48 (0.01, 0.98) | 0.050 |

**P < 0.001. *P*-values are based on independent t-tests. †P-values are based on paired t-tests as within-subject factor (from baseline to 12 weeks). ‡P-values are based on analysis of covariance (ANCOVA) as between-subject factor (physical training and nutritional intervention group [PTN] and social support group [SoSu] groups). SoSu group as the reference group. Models are adjusted for sex and baseline value. Mean (95% confidence interval) are reported for continuous variables at baseline and after 12 weeks. 95% CI, 95% confidence interval; d, Cohen’s effect size; β, standardized coefficient.
The present randomized controlled trial evaluated the effects of a home-based physical training and nutritional intervention compared with a social support program on physical activity and nutritional behavior in older persons. Such a "buddy-style" intervention was able to improve physical activity behavior and, to a lesser extent, nutritional behavior after 12 weeks in older persons living at home.

The present results indicate that the PTN group showed significant increases in the physical activity behaviors of light sport activity, muscle strength exercises and overall activities, compared with the SoSu group. It is not surprising that muscle strength exercises improved in the PTN group after 12 weeks, because carrying out strength exercises was a major part of the physical activity intervention. Nevertheless, the participants also improved other physical activity behavior, such as light sport activity and overall activities, which was not obvious and not expected.

The intervention also led to statistically significant increases in the consumption of legumes or nuts, compared with the SoSu group. The nutritional intervention encompassed a "food first" approach, which meant that the intervention focused on foods that are naturally high in protein; that is, animal- and plant-based protein-rich foods. However, the participants in the PTN group did not improve their consumption of animal-based protein-rich foods; that is, meat, fish and dairy products. Possible reasons for this could be, for example, a decrease in oral health, which makes eating meat difficult because of its texture, not enjoying the taste, issues of cost or affordability, or participants did not agree that animal-based foods are healthy. Furthermore, for very old persons, it is challenging to improve their nutritional behavior, as aging is associated with altered sensations of thirst, hunger and satiety. This might also be a possible reason why nutritional behavior outcomes improved to a lesser extent.

In previously published studies, combined home-based volunteer-led physical activity and nutrition programs have been shown to be effective in terms of changing physical activity and nutrition-based behavior. These studies reported a significant increase in carrying out strength exercises and moderate intensity sport participation. It is, however, noteworthy that these studies focused on nutritional behavior as consumption of fruit and vegetables, fat avoidance, fiber intake, and adherence to fruit and vegetable intake recommendations. In the present study, we did not see a significant improvement in the consumption of fruit and vegetables or the adherence to the recommendations. A reason for this could be that the nutritional intervention in our study focused more on consumption of protein and fluid intake, as well as adherence to them.

The strength of the present study was the implementation of this "buddy-style" program, which might be a low-cost and practical way to increase physical activity and to stabilize or improve dietary behaviors among older adults living at home. This intervention also had in mind that the volunteers who delivered the program might also benefit in the near future, as they themselves were in retirement transition. Another strength of the study is that the outcomes were pre-specified.

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**Table 5** Adherence to daily intake recommendation variables in both groups at baseline and 12 weeks

| Adherence to recommended daily intake of | Group   | Baseline | 12 weeks | Change | Within-subject effect | Between-subject effect |
|-----------------------------------------|---------|----------|----------|--------|------------------------|------------------------|
|                                         | n (%)   | P-value⁠ | n (%)    | P-value| OR (95% CI)            | OR (95% CI)            | P-value⁠               |
| 1 portion of meat and meat products, fish or eggs | PTN 28 (19.7) | 0.810 | 25 (17.6) | 0.575 | −2 | 1.23 (0.69, 2.20) | 0.485 | 0.76 (0.28, 2.08) | 0.599 |
|                                         | SoSu 27 (19) |        | 20 (14.1) |        | −5 |                      |                        |                       |
| 2 portions of milk or dairy products | PTN 27 (19) | 0.043 | 20 (14.1) | 0.072 | −5 | 0.69 (0.39, 1.23) | 0.209 | 1.98 (0.85, 4.60) | 0.112 |
|                                         | SoSu 15 (10.6) |        | 8 (5.6)    |        | −5 |                      |                        |                       |
| 1 portion of legumes or nuts | PTN 5 (3.5)  | 0.866 | 6 (4.2)    | 0.794 | 1 | 1.62 (0.93, 2.85) | 0.090 | 0.81 (0.21, 3.09) | 0.759 |
|                                         | SoSu 5 (3.5) |        | 5 (3.5)    |        | 0 |                      |                        |                       |
| 2 portions of bread | PTN 19 (13.4) | 0.602 | 19 (13.4) | 0.416 | 0 | 1.25 (0.64, 2.44) | 0.512 | 1.28 (0.64, 2.55) | 0.483 |
|                                         | SoSu 15 (10.6) |        | 11 (7.7)   |        | 3 |                      |                        |                       |
| 6 portions of fruits | PTN 25 (17.6) | 0.370 | 25 (17.6) | 0.040 | 0 | 1.18 (0.62, 2.25) | 0.616 | 3.47 (1.38, 8.75) | 0.008 |
|                                         | SoSu 18 (12.7) |        | 11 (7.7)  |        | 0 |                      |                        |                       |
| 3 portions of vegetables | PTN 6 (4.2)  | 0.269 | 5 (3.5)    | 0.689 | −1 | 1.08 (0.40, 2.93) | 0.879 | 1.32 (0.39, 4.49) | 0.661 |
|                                         | SoSu 2 (1.4) |        | 2 (1.4)    |        | 0 |                      |                        |                       |
| 2 portions of fruits | PTN 8 (5.6)  | 0.357 | 4 (2.8)    | 0.653 | −3 | 0.58 (0.23, 1.47) | 0.249 | 1.43 (0.46, 4.49) | 0.538 |
|                                         | SoSu 4 (2.8) |        | 2 (1.4)    |        | −1 |                      |                        |                       |

⁠P-values are based on χ²-tests. P-values are based on generalized estimating equations to examine effects with time (from baseline to 12 weeks) as repeated factor and group (PTN, physical training and nutritional intervention group [PTN] and social support group [SoSu] group) as between-subject factor, with prevalence of outcome parameters (yes, no) as dependent variable. Logit link function and an unstructured correlation matrix were used. Significance tests were performed with Wald χ² (α = 0.05). The models are adjusted for baseline value and sex. Baseline data and SoSu group as reference. Number and percentages (n, %) for categorical variables at baseline and after 12 weeks. 95% CI, 95% confidence interval; OR, odds ratio.
The study did have some limitations. First, because of the study design, recruitment process and the eligibility criteria, our sample size was relatively small and was relatively homogeneous. However, the results do indicate that such a "buddy-style" intervention can improve physical activity and nutritional behavior. Second, our attrition rate was 23% in total and is another limitation; however, this compares well with other studies. Third, the study follow-up after just 12 weeks was a relatively short period. Fourth, the data collected from the questionnaires were based on self-reporting, although similar inaccuracies could be expected between the PTN and SoSu groups. Fifth, trials of this type do not allow a blind approach, making participation bias a possibility and lead to inflation of type I error. However, the data management and statistical analysis were blind. Furthermore, residual confounding could not be ruled out, even though demographic and other factors were controlled for in the ANCOVA and GEE regression analyses.

In conclusion, the present findings indicate that a 12-week "buddy-style" program with the focus on physical training, nutritional education and social support can result in effective physical activity and, to a lesser extent, dietary behaviors changes towards higher vegetable protein consumption, but not animal protein, in older adults living at home. Such a program has the potential to be efficient and feasible, and could be used in addition to the services provided by health professionals.

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Disclosure statement

The authors declare no conflict of interest.

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