Nutrition assistance improves skeletal muscle function and performance in community-dwelling older women

Assistência nutricional melhora o desempenho muscular esquelético de mulheres idosas residentes na comunidade

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ABSTRACT

Including older women in nutrition intervention studies is restricted because muscle strength and performance are often compromised in old age, and physical activity is affected by neurodegenerative processes. The aim of this study was to evaluate the effects of nutritional assistance focusing on protein intake (in the individual's usual diet) on muscle mass, strength, and performance in community-dwelling older women. Methods: This is a non-randomized controlled clinical trial. Forty-three community-dwelling older women were allocated to the Control Group (CG; n = 20) or the Nutrition Group (NG; n = 23). The NG received individualized nutrition assistance and participated in group activities that focused on dietary protein intake once a week for 12 weeks. Main outcome measures: protein and energy intake; handgrip strength (HGS); gait speed (GS); quadriceps cross-sectional area (CSA); and intramuscular non-contractile tissue (IMNCT). The Student's t-test for independent samples, the Mann-Whitney U test, and a mixed model ANOVA with two factors (group and time) were adopted, followed by a post hoc Bonferroni test. A Spearman's correlation test was performed for HGS; GS; CSA; and protein intake adjusted for weight (g/kg) (p \leq 0.050). Results: Participants in the NG showed higher CSA values than those in the CG (p < 0.001). NG participants also had higher HGS (p < 0.001) and GS (p = 0.037) when compared to pre-intervention. Correlations were observed between IMNCT and protein intake adjusted for weight (g/kg) (r = -0.517; p = 0.020); HGS, and CSA (r = 0.827; p = 0.000); and CSA and age (r = -0.520, p = 0.009). Conclusions: A nutrition assistance program focusing on protein intake resulted in enhanced muscle function and physical performance.

Keywords: muscle mass; aged; protein intake; nutrition assistance program; strength.

RESUMO

Objetivo: Analisar os efeitos da assistência nutricional com foco na ingestão proteica (na dieta habitual do indivíduo) em relação a massa muscular, força muscular e desempenho funcional de idosas de uma comunidade. Métodos: Trata-se um ensaio clínico controlado não randomizado. Quarenta e três idosas da comunidade foram alocadas no Grupo Controle (GC; n = 20) ou no Grupo Nutrição (GN; n = 23). O GN recebeu atendimento nutricional individualizado e participou de atividades grupais com foco na ingestão proteica da dieta uma vez por semana, durante 12 semanas. Principais medidas de resultado: ingestão de proteína e energia; força de preensão palmar (FPP); teste de velocidade da marcha (TVM); área de secção transversa do quadríceps (ASTq); e tecido intramuscular não contrátil (TIMNC). Utilizou-se o teste t de Student para amostras independentes, o teste U de Mann-Whitney e um modelo misto de análise de variância (ANOVA) com dois fatores (grupo e tempo), seguido de teste post hoc de Bonferroni. Um teste de correlação de Spearman foi realizado para FPP; TVM; ASTq; TIMNC; idade; e ingestão proteica ajustada para peso (g/kg) (p \leq 0.050). Resultados: Os participantes do GN apresentaram valores de ASTq superiores aos do GC (p < 0.001). Os participantes do GN também exibiram maior FPP (p < 0.001) e GS (p = 0.037) quando comparados à pré-intervenção. Foram observadas correlações entre TIMNC e ingestão proteica ajustada para peso (g/kg) (r = -0.517; p = 0.020); HGS e ASTq (r = 0.827; p = 0.000); e ASTq e idade (r = -0.520, p = 0.009). Conclusões: Um programa de assistência nutricional com foco na ingestão de proteínas resultou em melhora da função muscular e desempenho físico.

Palavras-chave: massa muscular; idoso; ingestão proteica; programa de assistência nutricional; força.
INTRODUCTION

The aging process can be accompanied by a reduction in muscle mass and increased intramuscular fat; the latter is associated with a decline in muscle function (strength and functional performance), impairing the mobility and independence of older adults.\(^1\)\(^,\)\(^2\)

Dietary protein plays an important role in the maintenance of physical performance in older adults;\(^3\) it is used to prevent the weakening of skeletal muscle function. Adequate nutrition, particularly sufficient protein intake, can limit and treat the age-related decline in muscle mass, strength, and functional abilities.\(^4\)

The recommended protein intake for older people used to be the same as that prescribed for adults: 0.8 g/kg/d.\(^5\) However, older people have more tendency to undergo muscle breakdown, do not have as many freely circulating amino acids, and have reduced muscle cell perfusion; these factors lead to an anabolic resistance that inhibits or decreases the positive effects of dietary proteins on muscle protein synthesis, thereby limiting muscle maintenance and size.\(^3\)\(^,\)\(^6\)

New recommendations have been published suggesting an intake of 1.0 to 1.2 g/kg/d of protein for healthy people aged 65 or older.\(^7\)\(^,\)\(^8\) This adapted recommendation was expected to be enough to increase muscle mass and preserve functional capacity.\(^7\)\(^,\)\(^8\) Nevertheless, the amount of protein intake can vary according to local habits and place of residence. An example is older women living in southern Brazil, who consume on average 0.9 g/kg/d of protein.\(^9\)

Dietary counseling is an educational strategy that can contribute to changes in nutritional behavior\(^10\) and promote the maintenance of obtained outcomes.\(^11\) A systematic review and meta-analysis reported that older adults at nutritional risk who received dietary counseling from dietitians following their hospital discharge from previously acute conditions had improved energy intake, protein intake, and body weight, although there was no clear evidence of improved physical function. Regarding impaired physical function in older adults, the authors suggested that future studies on post-medical care dietary counseling should be properly outlined.\(^12\) The effects of protein intake should also be investigated as these seem to have a positive impact on promoting anabolism in older patients.\(^13\)

Nutrition groups and nutrition education are important strategies for changing habits,\(^14\) mainly due to the interaction between participants, which can motivate them towards the same goal. This is true especially when interventions occur weekly or more frequently, thereby limiting the chances of participants failing to enact the suggested practices. Indeed, these strategies can be useful when associated with individual nutrition counseling for improving older adults’ eating habits.\(^15\)\(^,\)\(^16\)

Taken together with individualized dietary counseling, nutrition education sessions could contribute to a better understanding of different food categories such as forms of food preparation and nutritional specificities of foods. To our knowledge, no previous study has assessed the effects of dietary changes on the muscle mass and muscle function of healthy (without diseases or with controlled diabetes and hypertension) older women using a nutrition program associated with dietary and nutrition education for promoting an increase in protein intake through food. Therefore, the present study aimed to analyze the effects of a nutrition assistance program (comprising individual dietary counseling and nutrition education activities) focusing on protein intake (in the individual’s usual diet), muscle mass, muscle strength, and functional performance of community-dwelling older women.

METHODS

Design and participants

This was a longitudinal, non-randomized controlled clinical trial. All participants signed an informed consent form. Leaflets explaining the study and inviting older women to participate were distributed in many places of the city such as churches, universities, hospitals, and public health care centers. Older women who were interested in participating underwent screening assessments by a nutritionist, physical therapists, a physical trainer, and a geriatrician; data were collected in the first half of 2016. The study was in accordance with the Consolidated Standards of Reporting Trials (CONSORT) statement.\(^17\)

The following individuals were included in the study: women aged 65 years or older, with controlled systemic arterial hypertension (SAH) and controlled serum glucose levels, who did not use nutritional supplements for energy and protein replacement, and who did not present cognitive decline according to a Mini Mental State Examination. The following patients were excluded from the study: patients with rheumatic diseases, fractures, metallic or non-metallic fixation, or prosthetic implants; oncological patients; patients with kidney and liver disorders or neurological disorders; and participants who did not attend meetings during the evaluation period and/or missed four or more consecutive meetings and/or dropped out of the study. Data on CSA, IMNCT,
energy intake and protein g/d and g/Kg, which were not very consistent in the initial evaluation, were eliminated.

Outcomes
The primary outcomes were judged by using handgrip strength (HGS), anthropometry, and food intake. HGS was assessed using a calibrated and certified manual dynamometer (SHS001, Saehan Corp®), preferably in the dominant hand, three times with one minute rest between each repetition, and with the mean peak force values used to characterize upper extremity strength.18

Body weight was assessed using a mechanical scale manufactured by Filizola®. Stature was measured using a stadiometer manufactured by Tonelli Gomes®. Body mass index (BMI) was calculated by dividing the weight values by stature squared.19

Protein and energy intakes were evaluated through a three-day dietary record taken before and after the 12-week period for both groups. Trained nutritionists instructed participants on how to fill in their forms correctly; to not change their usual diet from what they had recorded; to record the different foods immediately after intake; and to describe the kind of food, method of preparation, quantity consumed (using home measurements), and commercial brand20 (in the case of processed foods).

Food quantities were listed in grams or milliliters, based on the table of reference measures for food consumed in Brazil.21 These quantities were converted into kilocalories and grams of protein based on the table of food composition for foods consumed in Brazil.22

Our secondary outcomes were functional performance, muscle mass, and intramuscular non-contractile tissue (IMNCT). Functional performance was assessed by a 10-meter walk test performed on a straight walkway and timed with a stopwatch.23,24 The initial and final two meters were excluded due to the acceleration and deceleration phases of gait. Customary gait speed (GS) was used to represent functional performance in this study, with GS values ≤ 0.8 m/s denoting poor physical performance.1

Muscle mass was estimated by calculating the quadriceps cross-sectional area (CSA) from axial images of the dominant leg; images were obtained by magnetic resonance imaging (MRI) using Siemens Magneton Avanto 1.5T equipment. CSA and IMNCT were both measured in cm² and considered the image obtained at the midpoint between the femoral condyle and the trochanter.25,26 The area was delimited using the “Irregular AOI” Image-Pro Plus tool. Muscle tissue was represented by a dark gray scale and further intramuscular non-contractile structures, by a light gray scale. In order to prevent the software from identifying dark pixels and consequently not calculating IMNCT and bone values, a color mask was used on the images. The procedure to calculate CSA and IMNCT was performed three times and the mean result was used in our analysis.27

CSA and IMNCT were measured by a single evaluator. For CSA, the intraclass correlation coefficient (ICC) was 0.998 and the standard error of measurement (SEM) was 0.50; for IMNCT, these values were 0.997 for ICC and 0.45 for SEM.

Nutrition assistance program
The NG participated in the nutrition assistance program once a week for 12 weeks. Each week, the program alternated between individual dietary counseling (five meetings) and group sessions (seven meetings), which comprised educational activities.

Dietary counseling
Each participant received a printed and personalized dietary plan based on a previous evaluation by a nutritionist, as well as a list based on information from the American Diabetes Association,28 which included different possibilities in each food category that could be used to formulate the dietary plan. For example, if a participant is going to eat a portion of protein and a portion of carbohydrate at breakfast, he or she should use the list of options to choose which food to eat from the list on that day (milk, eggs, cheese, bread).

Energy requirements were calculated based on Dietary Reference Intakes (DRIs) for women, according to their BMI classification.29 The energy intake followed recommendations proposed by the DRIs according to the activity factor (AF), as follows: an AF of 1.0 for older women who were considered sedentary; an AF of 1.12 for older women considered not very active; and an AF equal to 1.27 for those considered active. The AF was determined by the Human Activity Profile (HAP), which categorizes participants as active (score > 74); moderately active (score between 54 and 74); or inactive (score < 53).30

Macronutrients were distributed as follows: protein, 1.2 g/kg of weight; carbohydrates, 45% – 65% of the total energy value (TEV); and lipids, 10% – 35% of the TEV.29

Individual meetings were organized for dietary counseling and monitoring of adherence to the dietary plan. Nitrogen balance, which corresponds to the difference between nitrogen intake and its output by urine,31 was assessed before and after the intervention period. This was performed through
24 h urine analyses, where each woman received a 2-l vial containing 2 ml of 50% hydrochloric acid. The participants collected their urine for 24 h starting with the second morning urine until the first urine on the following day.

**Group activities**
During the 12 weeks of the experiment, the NG had seven meetings of nutrition education activities, with different themes. Each session lasted 40 – 50 min and was performed dynamically. The nutritionist presented the content that would be addressed on that day, while proposing activities in which participants needed to interact by answering questions or self-reporting a situation. Table 1 presents the topics covered in each meeting. After the experimental period, a nutrition assistance program was offered to participants in the CG.

**Statistical analysis**
A posteriori power analysis (G*Power 3.1.9 software) revealed a power of 0.978 for the sample size of 43 participants in this study. An α-level of 0.05 and an effect size set at 0.62 (calculated from partial squared) were considered. The normality of data distribution was assessed using the Shapiro-Wilk test. Parametric data were presented as means and standard deviations, and non-parametric data were presented as medians and amplitude values (minimum and maximum).

For the baseline analysis of characteristics, an independent Student’s t-test was used for height and HAP, and the Mann-Whitney U test was used for the non-parametric baseline variables (age, weight, and BMI). To analyze differences within and between groups, a mixed model analysis of variance (ANOVA) with two factors (group [CG and NG] and time [pre and post]) was adopted, followed by a post hoc Bonferroni test. As CSA values were significantly different between groups at baseline, these were analyzed using an analysis of covariance (ANCOVA), with values referring to the pre-experimental period serving as covariables.

Spearman's correlation tests were performed between HGS and the following variables: HAP; CSA; IMNCT; age; protein intake by weight (g/kg); total energy intake; and energy intake by weight (kcal/kg). The same correlation test and variables were applied to the 10-meter walk test. The correlation coefficients were interpreted as follows: 0.0 to 0.25, no correlation; 0.25 to 0.50, weak correlation; 0.50 to 0.75, moderate correlation; and > 0.75, strong correlation. When the correlation was moderate to strong (r > 0.50), a linear univariate regression was performed.

The ICC and SEM were calculated for the analysis of CSA and IMNCT. The SEM was estimated by the following equation: SEM = standard deviation*√(1-ICC). The analysis was performed using SPSS® software version 22, and a 95% significance level (p < 0.05) was considered.

**RESULTS**
A total of 67 eligible participants were recruited; 43 of them completed the follow-up and were subsequently analyzed. Participant screening, enrollment, assignment, and attrition are summarized in Figure 1. Approximately 60% of the participants had more than eight years of academic study.

The nutrition assistance program had a high participation rate (83.3%). On average, the participants took part in 10 of the 12 meetings. Among the baseline characteristics, CSA values for the NG were higher than those in the CG (p < 0.001). The sample characteristics are presented in Table 2.

The effects of the intervention on strength, functional performance, muscle mass, and protein and energy intake are presented in Table 3. NG participants showed greater CSA values than the CG volunteers (p < 0.001), even when considering the initial differences, and NG participants also had greater HGS (p < 0.001) and walking speed (p = 0.037) after the nutrition assistance program. There were no significant differences in the other variables.

A strong and positive correlation was observed between HGS and CSA (r = 0.827, p < 0.001) in the NG. Considering HGS as a dependent variable and CSA as an independent variable in the simple linear regression, CSA accounted for...
FIGURE 1. Flowchart showing participant screening, enrollment, assignment, and attrition (CONSORT).

TABLE 2. Characteristics of participants at baseline.

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>CG</th>
<th>n</th>
<th>NG</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>20</td>
<td>68.04 (65.03 – 83.05)</td>
<td>23</td>
<td>70.01 (65.03 – 79.04)</td>
<td>0.304</td>
</tr>
<tr>
<td>Height (m)</td>
<td>20</td>
<td>1.57 ± 0.05</td>
<td>23</td>
<td>1.57 ± 0.05</td>
<td>0.855</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>20</td>
<td>69.23 (50.31 – 89.07)</td>
<td>23</td>
<td>70.76 (59.21 – 93.92)</td>
<td>0.394</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20</td>
<td>27.35 (22 – 38.55)</td>
<td>23</td>
<td>28.34 (23.97 – 38.85)</td>
<td>0.312</td>
</tr>
<tr>
<td>HAP (score)</td>
<td>20</td>
<td>49.92 ± 13.43</td>
<td>23</td>
<td>49.12 ± 16.57</td>
<td>0.861</td>
</tr>
<tr>
<td>HGS (kgf)</td>
<td>20</td>
<td>22.51 ± 4.56</td>
<td>23</td>
<td>21 ± 5.45</td>
<td>0.350</td>
</tr>
<tr>
<td>GS (m/s)</td>
<td>20</td>
<td>1.38 ± 0.24</td>
<td>23</td>
<td>1.27 ± 0.18</td>
<td>0.094</td>
</tr>
<tr>
<td>CSA (cm²)</td>
<td>19</td>
<td>36.26 ± 6.44</td>
<td>21</td>
<td>48.91 ± 7.47</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>IMNCT (cm²)</td>
<td>19</td>
<td>2.15 ± 1.63</td>
<td>21</td>
<td>2.21 ± 1.70</td>
<td>0.843</td>
</tr>
<tr>
<td>Energy intake (kcal/d)</td>
<td>19</td>
<td>1,597.5 ± 457.12</td>
<td>20</td>
<td>1,815 ± 451.31</td>
<td>0.143</td>
</tr>
<tr>
<td>Protein intake (g/d)</td>
<td>19</td>
<td>68.31 ± 17.67</td>
<td>20</td>
<td>78.92 ± 20.21</td>
<td>0.091</td>
</tr>
<tr>
<td>Protein intake (g/kg body weight)</td>
<td>19</td>
<td>1 ± 0.24</td>
<td>20</td>
<td>1.10 ± 0.32</td>
<td>0.133</td>
</tr>
</tbody>
</table>

Data with normal distributions were described as means ± standard deviations and analyzed with independent t-tests. Non-normal data were described as medians (minimum-maximum values) and analyzed with the Mann-Whitney U test. *p ≤ 0.05 between groups. CG: control group; NG: nutritional intervention group; BMI: body mass index; HAP: human activity profile; HGS: handgrip strength; GS: gait speed; CSA: cross-sectional area; IMNCT: intramuscular non-contractile tissue.
TABLE 3. Effect of nutritional assistance, with emphasis on protein intake through diet, on muscle mass, muscle strength, and functional performance.

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>CG Pre</th>
<th>CG Post</th>
<th>p-value (within group)</th>
<th>n</th>
<th>NG Pre</th>
<th>NG Post</th>
<th>p-value (within group)</th>
<th>p-value (between group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HGS (kgf)</td>
<td>20</td>
<td>22.52 ± 4.54</td>
<td>22.73 ± 5.09</td>
<td>0.604</td>
<td>23</td>
<td>21.03 ± 5.45</td>
<td>22.62 ± 6.21</td>
<td>0.001*</td>
<td>0.051</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>0.48 ± 2.45</td>
<td></td>
<td></td>
<td></td>
<td>1.4 ± 1.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GS (m/s)</td>
<td>20</td>
<td>1.38 ± 0.233</td>
<td>1.39 ± 0.16</td>
<td>0.710</td>
<td>23</td>
<td>1.27 ± 0.18</td>
<td>1.34 ± 0.20</td>
<td>0.037*</td>
<td>0.239</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>0.02 ± 0.15</td>
<td></td>
<td></td>
<td></td>
<td>0.6 ± 0.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSA (cm²)</td>
<td>19</td>
<td>36.2 ± 6.40</td>
<td>35.0 ± 4.84</td>
<td>0.148</td>
<td>21</td>
<td>48.9 ± 7.41</td>
<td>48.7 ± 6.40</td>
<td>0.789</td>
<td>0.001†</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>-1.13 ± 4.06</td>
<td></td>
<td></td>
<td></td>
<td>-0.22 ± 2.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMNCT (cm²)</td>
<td>19</td>
<td>2.17 ± 1.65</td>
<td>1.94 ± 1.23</td>
<td>0.610</td>
<td>21</td>
<td>2.25 ± 1.76</td>
<td>2.03 ± 1.54</td>
<td>0.462</td>
<td>0.889</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>-0.16 ± 1.07</td>
<td></td>
<td></td>
<td></td>
<td>-0.33 ± 2.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy intake (kcal/d)</td>
<td>19</td>
<td>1597.5 ± 457.12</td>
<td>1642.3 ± 373</td>
<td>0.670</td>
<td>20</td>
<td>1815 ± 451.33</td>
<td>1732.7 ± 468.60</td>
<td>0.423</td>
<td>0.388</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>10.67 ± 418.37</td>
<td></td>
<td></td>
<td></td>
<td>-53.08 ± 496.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein intake (g/d)</td>
<td>19</td>
<td>68.31 ± 17.64</td>
<td>74.59 ± 19.16</td>
<td>0.164</td>
<td>20</td>
<td>78.98 ± 20.22</td>
<td>80.12 ± 18</td>
<td>0.779</td>
<td>0.419</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>5.63 ± 17.01</td>
<td></td>
<td></td>
<td></td>
<td>1.46 ± 20.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein intake (g/kg body weight)</td>
<td>19</td>
<td>0.99 ± 0.24</td>
<td>1.15± 0.26</td>
<td>0.171</td>
<td>20</td>
<td>1.18 ± 0.32</td>
<td>1.26 ± 0.30</td>
<td>0.665</td>
<td>0.492</td>
</tr>
<tr>
<td>Δ</td>
<td></td>
<td>0.08 ± 0.26</td>
<td></td>
<td></td>
<td></td>
<td>0.03 ± 0.29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data with normal distributions were described as means ± standard deviations. A mixed model analysis of variance (ANOVA) was used for comparisons within and between groups; Δ, the delta score is the post-test value minus the pre-test value. *p < 0.05 within group; †p < 0.05 between groups. CG: control group; NG: nutritional intervention group; HGS: handgrip strength; GS: gait speed; CSA: cross-sectional area; IMNCT: intramuscular non-contractile tissue.

61% of the HGS (r² = 0.607, p = 0.000). For every 1 cm² increase in CSA, a 0.758 kgf increase was detected in HGS.

A moderate and negative correlation was seen between IMNCT and protein consumption adjusted for weight (g/kg) (r = -0.517, p = 0.020), showing that older women with more IMNCT presented a lower protein consumption per kg. IMNCT was considered a dependent variable, and protein consumption was adjusted for weight as an independent variable in the simple linear regression. The adjusted protein consumption accounted for 23% of the IMNCT (r² = 0.231, p = 0.032). An increase in protein intake of 1 g/kg body weight (BW) resulted in a 2.50 cm² reduction in IMNCT.

A moderate and negative correlation was observed between CSA and age (r = -0.520, p = 0.009). Considering CSA as a dependent variable and age as an independent variable in the simple linear regression, age accounted for 31% of the reduction in CSA (r² = 0.311, p = 0.007). Each additional year brought a reduction of 0.87 cm² in CSA. There were no significant differences in nitrogen balance in the NG.

DISCUSSION

The community-dwelling older women who took part in the nutrition assistance program showed less muscle mass loss, which was assessed by the gold standard method: magnetic resonance imaging. Higher HGS and better GS were found when comparing NG participants to their pre-intervention examinations. Therefore, a nutrition assistance program focusing on protein intake (within the individual's usual diet) might be considered a tool to reduce negative changes in muscle mass, muscle function, and performance in independent older women. Although there was no significant improvement in protein consumption in the NG, higher HGS and better GS were found when comparing NG participants to their pre-intervention examinations.

The primary (non-pharmacological) therapeutic intervention thought to increase muscle mass, strength, and consequently functional capacity is correct dietary practice for a healthy lifestyle. Recommendations by the European Union Geriatric Medicine Society PROT-AGE study group,7,8 the European Society for Clinical Nutrition and Metabolism,4 and the Protein Summit 2.03 emphasize the importance of...
maintaining muscle function in older adults, including not only protein quantity but also protein distribution (intake pattern throughout the day) and the amount of protein ingested per eating occasion, in combination with regular physical activity and exercise.

A protein intake > 1.0 g/kg BW/d and the ingestion of at least 25 – 30 g of protein in each of the three main meals may be needed to optimally stimulate muscle protein synthesis in older adults. These arguments are based on evidence showing that muscle composition changes in older people, and this population can develop physiological anabolic resistance that inhibits or decreases the positive effects of dietary proteins in relation to muscle protein synthesis, limiting the maintenance and increase of muscle mass. Studies published in 2019 demonstrated that the protein quantity required for preventing functional decline during aging should be a mean intake of 1.0 to 1.2 g/kg/d; the recommendation of 0.8 g/kg/d thus seems to have been underestimated.

In the Women's Health Initiative (a large, prospective study of postmenopausal women [~140 000 participants] aged 50 to 79 years), higher protein intake (1.18 g/kg BW/d) was associated with greater HGS at baseline, as well as reduced rates of decline in GS and chair stands over a mean follow-up of 11.5 years. Lima et al. concluded that age was inversely associated with HGS, indicating that women and older people had lower HGS. Higher intakes of total and animal protein (≥ 1.0 g/kg BW/d) were protective against GS decline in adults aged ≥ 60 years in the Framingham Offspring Cohort (20% postmenopausal women) over six years, independently of lean mass. Protein intake ≥ 1.2 g/kg BW/d was associated with better performance in several measures of muscle strength and physical performance at baseline and over a three-year follow-up in women (aged 65 – 72 years) but was dependent on fat mass.

No significant increase was seen in protein consumption in our study. However, both groups attained the new protein recommendations for older adults. The mean daily protein intake among women aged 60 years or older in the Brazilian Family Budgets Survey was 62.9 g; in the southern region of Brazil, the mean was 56.2 g. The protein intake found in our study was thus higher than the national average, and the highest mean value observed in Brazil, which shows a group with good previous nutrition education. A hypothesis for this higher level of protein consumption might be the high level of schooling of the study participants.

Although there was no increase in protein intake, the participants undergoing the nutrition assistance program (NG) presented a lower rate of CSA decline than the CG volunteers; NG participants improved their muscle strength by 7.6% and their functional performance by 4.5%. These results can be compared with a clinical trial with head and neck cancer patients where nutrition counseling was the only dietary intervention able to improve nutritional outcomes such as protein-calorie intake. The individualized, applied intervention model of nutrition counseling, associated with nutrition education sessions in groups, may have contributed to a better understanding of different food categories, food preparation, nutritional characteristics of foods, protein distribution (intake pattern throughout the day), etc. Furthermore, the interaction between participants might have motivated them to reach their goal and continue to adhere to the suggested practices.

Previous studies have suggested that age affects muscle mass. Significant losses in CSA can be observed over time, with a 12.5% to 16.1% variation among older people aged up to 65.4 ± 4.2 years monitored over 12 years. In our study, we observed moderate and negative correlations between CSA and age, demonstrating less muscle mass in the oldest participants; in other words, every additional year of life can result in a 0.87 cm² reduction in CSA. After 12 weeks, muscle mass loss was observed in both groups. However, this reduction was smaller in the group receiving nutritional follow-up. While the control group lost 1.13 ± 4.06 cm², representing a rate of less than 2.36% in muscle mass decline, the NG participants lost 0.22 ± 2.85 cm², representing a rate of decline in muscle mass of less than 0.62%. These outcomes suggest that specialized nutrition care can contribute to reduced muscle loss in older people. Although the counseling performed with the NG focused on increasing protein intake, the food-based orientation may have contributed to altering the consumption of other nutrients involved in muscle physiology. Consequently, complementary intake assessments should be considered in further studies. Literature reports are still scarce and unstandardized when it comes to nutrition counseling programs. In addition, the groups could have differences in physical activity levels, even with unscheduled activities (training).

BMI may have been influenced by the small number of participants in the two groups and an area measurement with no adjustments for body or size. Although there was no statistically significant difference, BMI was 27.3 (22.0 – 38.5) kg/m² in the CG, and CG participants may have had a smaller area for lighter body weight with a difference of about 9 kg between participants with lighter body weight and 1.9 points in minimum BMI compared with NG participants (BMI 28.3 kg/m², range 23.9 – 38.8).

Delmonico et al. reported a 3.2% to 4.9% reduction in quadriceps CSA, as well as a 29% to 48.5% intermuscular...
adipose tissue accumulation in older people aged 70 to 79 years during a five-year period. Muscle mass reduction with aging, as well as increased intermuscular fat, may be associated with reduced strength and functional performance. The fatty infiltration of muscle is a characteristic of aging populations and is associated with mortality, falls, and fractures. Interventions using exercise alone or exercise and nutritional supplementation have proven effective in reducing fatty infiltration in older adults, suggesting that these are modifiable aspects of the muscle.

In our study, we analyzed IMNCT (fat and other tissues) and found no significant reduction after the intervention. However, we observed a moderate and negative correlation between IMNCT and protein intake adjusted for weight (g/kg) in the NG. This outcome demonstrates that older women with greater IMNCT had a lower protein intake. Reduced protein intake thus has a negative impact on muscle quality, reinforcing the importance of adequate protein intake in the older population. IMNCT can influence muscle strength in older people, hence the improved HGS in the NG. To confirm this hypothesis, it would be necessary to measure the IMNCT of the upper limbs. In view of the muscle characteristics, it should be highlighted that the NG participants had higher GS performance than the values published in 2021, which considered a speed ≥ 0.75 m/s as fast.

The 12-week nutrition assistance program was sufficient to reduce the rate of decline in CSA and to improve muscle strength and functional performance. Therefore, we suggest that new randomized controlled studies are conducted, with longer duration of intervention and a focus not only on protein intake, but also on protein distribution (intake pattern throughout the day) and the amount of protein ingested per eating occasion, in combination with usual physical activity and/or exercise. Furthermore, it is important to investigate other factors related to skeletal muscle health, such as biomechanical, neural, genetic, and biochemical characteristics as inflammatory markers, as well as steroids, which may interfere in muscular changes during aging. One of the limitations of this study was the lack of randomization. The proposed intervention depended on the modification of eating habits. The choice of individuals to participate in the NG was intentional, and this might explain the greater care taken with food by this group of women. However, it did not reflect in significant changes in protein consumption between the two studied groups.

CONCLUSION

The 12-week nutrition assistance program, which focused on protein intake in the individual’s usual diet, had a positive impact on skeletal muscle quality, quantity, and function, as well as functional performance. Moreover, we found an association between protein intake and IMNCT in independent older women. We suggest that the nutrition program used in this study be applied as a tool to minimize the loss of muscle mass and improve functional performance and strength in community-dwelling older women.

Conflict of interest

The authors declare no conflicts of interest.

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Authors’ contribution

GJMO: Visualization, Validation, Writing – review & editing. LH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft. EVR: Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft. ARSG: Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft. LH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft. MEMS: Funding acquisition, Methodology, Project administration, Resources, Visualization, Writing – original draft. CTSS: Conceptualization, Data curation, Investigation, Methodology, Validation, Visualization, Writing – original draft. EIR: Funding acquisition, Methodology, Project administration, Resources, Visualization, Writing – original draft.

REFERENCES


