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Original Article

Impact of dietary composition and resistance training on cardiovascular risk indicators and abdominal fat in older adult women

Impacto da composição dietética e do treinamento resistido sobre indicadores de risco cardiovascular e o tecido adiposo abdominal em idosas

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ABSTRACT

Introduction: Senescence occurs as a natural organic aging process which brings changes in body composition and quality of life. These conditions result in an increased risk to develop cardiovascular diseases, making it necessary to eat properly and to exercise. **Objective:** To evaluate the effects of two dietary patterns (high-protein, 1.8 g proteins/kg/day; normoproteic, 1.0 g proteins/kg/day) with a 300 kcal reduction associated with resistance training on cardiovascular risk indicators and android adipose tissue in overweight and/or obese older adult women. **Methods:** The sample consisted of 25 older adult women aged ≥ 60 years and body mass index ≥ 25 kg/m². Participants were allocated into three separate groups by randomization and submitted to a resistance training program for eight weeks. Anthropometric and dietary data were collected. **Results:** A significant effect of time (Pre vs. Post) was found regarding anthropometric variables and cardiovascular risks indicators in the control group with an increase in waist circumference (p = 0.0001) and waist-to-height ratio (p = 0.002). There was a significant effect of the time for body mass index and fat percentage in the high-protein group (p = 0.039; p = 0.002) and normoproteic group (p = 0.001; p = 0.012), respectively, while the normoproteic group had a significant decrease of the time effect (p = 0.001) for body mass index, although there was no significance (p = 0.088) for this parameter in the high-protein group. **Conclusion:** This study demonstrated that a prescriptive diet with different protein intake and caloric restriction patterns associated with resistance training for eight weeks seems to be ineffective in decreasing cardiovascular risk factors or android adipose tissue in older adult women.

Key-words: Aging, Body composition, Resistance training, Diet, Obesity.

RESUMO

Introdução: Senescência se dá como um processo orgânico natural de envelhecimento que traz consigo alterações na composição corporal e na qualidade de vida. Essas condições trazem como consequência o aumento do risco para o desenvolvimento das doenças cardiovasculares, tornando imprescindível uma alimentação adequada bem como a prática de exercícios físicos. **Objetivo:** Avaliar os efeitos de dois padrões de dieta (hiperproteica 1,8g proteínas/kg/dia; normoproteica, 1,0 g de proteína/kg/dia) com redução de 300 kcal associada ao treinamento resistido sobre indicadores de risco cardiovascular e o tecido adiposo androide em idosas com sobrepeso e/ou obesidade. **Métodos:** A amostra foi composta por 25 mulheres idosas, com idade ≥60 anos e índice de massa corporal ≥ 25 kg/m². As participantes foram alocadas em três grupos distintos por randomização e submetidas a um programa de treinamento resistido por oito semanas. Dados antropométricos e dietéticos foram coletados. **Resultados:** Em relação às variáveis antropométricas e os indicadores de risco cardiovascular, foi encontrado efeito significativo para o tempo (Pré vs. Pós) no grupo controle com elevação nos índices de circunferência de cintura (p = 0,0001) e razão cintura-estatura (p = 0,002). Para índice de massa corporal e porcentagem de gordura houve efeito significativo para o tempo no grupo hiperproteico (p = 0,039; p = 0,002) e no grupo normoproteico (p = 0,001; p = 0,012), respectivamente, enquanto que para a MC o grupo normoproteico teve diminuição significativa, efeito do tempo (p = 0,001) embora no grupo hiperproteico não obteve significância (p = 0,088) neste parâmetro. **Conclusão:** Este estudo demonstrou que dieta prescritiva com padrões diferentes de ingestão de proteínas e restrição calórica associada ao treinamento resistido por oito semanas parece não ser eficiente em diminuir tantos fatores de risco cardiovascular como o tecido adiposo androide em idosas.

Palavras-chave: Envelhecimento, Composição corporal, Treinamento de resistência, Dieta, Obesidade.

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Introduction

Senescence occurs as a natural organic aging process which brings changes in body composition and quality of life [1]. Thus, a greater tendency to fat accumulation is observed with advancing age [2]. Obesity is defined as excess weight expressed by a Body Mass Index (BMI) ≥ 30 kg/m² [3]. In Brazil, obesity affects approximately 27.7% of women and 20.4% of men in the capitals of the Brazilian states and the Federal District, aged 55 to 64 years [4].

External factors influence the current obesity scenario, with the main factors being sedentary behavior and inadequate eating, reaching all socioeconomic levels; just as physiological factors also exert their influences [5]. There is a redistribution of fat mass in the natural process of aging, with decreased fat in the appendicular (upper and lower limbs) and a higher concentration in the abdominal region being observed in men and women [6].

These conditions result in increased risk for developing cardiovascular diseases. Visceral adiposity is related to the development of insulin resistance [7], as well as to dyslipidemias (deregulation of serum total cholesterol levels and their fractions, increase in total lipids, among others) and hypertension, while these factors occurring concomitantly is characterized as metabolic syndrome [8].

Energy deficit and exercise are known to induce improvements in health, body composition, cardiovascular risk parameters (CVR) and visceral obesity [9]. It is seen in the literature that a high protein intake seems to be effective in promoting greater retention of lean mass as well as greater fat loss in older individuals during the weight loss process [10]. Similarly, resistance training (RT), which in addition to promoting lean mass increase, is also an effective intervention in improving health parameters, as it is capable of reducing both abdominal and visceral fat content, as well as to increase insulin sensitivity [11]. Together with RT, a higher protein intake seems to potentiate the effects of RT on lean mass increase, since several studies corroborate this statement [12]. Therefore, these interventions can be applied together in aiming toward an improvement in the abovementioned health parameters.

Thus, the present study aimed to evaluate the effects of two dietary patterns (high-protein 1.8 gPTN/kg/day; Normoproteic 1.0gPTN/kg/day) with a reduction of 300 kcal associated with resistance training on cardiovascular risk indicators and android adipose tissue in overweight and/or obese older adult women.

Methods

Subjects

This was a randomized and controlled clinical trial composed of 25 older adult women, aged ≥ 60 years and BMI ≥ 25kg/m². The eligibility criteria included those who were restricted to high-protein diets (patients with chronic kidney disease), without physical and/or mental limitations which would prevent the evaluation and practice of physical exercises, as well as understanding of nutritional guidelines. After signing the Free and Informed Consent Form (ICF), the participants were allocated by simple randomization (computer generated list, used to prepare sealed envelopes, following a ratio of 1:1:1) in three different groups: the control group (CG), the high-protein group (HPG) and the normoproteic group (NPG). All groups underwent a RT program for eight weeks. The study was approved by the Research Ethics Committee of the Health Sciences Center of the Federal University of Pernambuco

(Opinion No. 3,410,439) and was conducted in accordance with the ethical principles contained in the 2008 Declaration of Helsinki.

Anthropometry

Participants had their height measured using a millimetered Stanley® tape measure, with 1mm accuracy and 0.5cm accuracy. Body mass was measured using a 0.1kg precision electronic scale (Filizola®). Waist circumference was measured by a non-flexible measuring tape (accuracy 0.1 cm) placed directly on the skin, with the individual standing, relaxed abdomen, arms along their body and feet joined at the level of the umbilical scar at the end of an expiration. A cut-off point > 80cm was used, being indicative of increased CVR [13].

BMI was calculated according to mass and height (kg mass/height m^2), according to the original technique recommended by Lohman *et al*. [14]. The World Health Organization parameters were adopted for overweight or obesity classification [15].

Waist-to-height ratio (WHtR) values were obtained through the ratio of waist circumference (cm) and height (cm), adopting a cut-off point of 0.55 for greater CVR associated with central adiposity [16].

Body composition

Body composition was measured by dual energy X-ray absorptiometry (DXA, GE, Lunar, Prodigy, GE Health). Changes in fat mass of the android region were analyzed - which concerns the region between the last rib and the iliac crest [17].

Training protocol

All groups performed RT with 80% intensity of 1RM for the vertical bench press and horizontal leg press, articulated row and extensor chair exercises, with a margin of 8 to 12 repetitions. Loads were determined from a relative load test, and participants performed two sets to failure with at least 2 repetitions and not exceeding 10 repetitions. The calculation proposed by Wathen was used to estimate the maximum loads (1RM) [18].

Diet

In order to plan the dietary intervention as close as possible to the dietary reality of the older adults, the 24-hour recall (R24) was applied at the data collection time as well as the Food Frequency Questionnaire (FFQ), which was answered by the selected subjects on three alternate days, being two days on weekdays and one on the weekend. Diets had a reduction of 300 kcal and equivalent amounts of fiber and lipids. The HPG intake was 1.8 g protein/kg current weight/day and 2.0 g carbohydrate/kg/day, and the NPG intake 1.0 g protein/kg current weight/day and 3.0 g carbohydrate/kg/day, while the CG maintained their routine eating habits. Pre-intervention nutritional orientations were conducted on portions, home measures and the benefits of healthy eating habits in order to make adherence to the diet easier. The nutritional intervention lasted eight weeks, with weekly follow-up. Adherence to the food plan was evaluated, the nutritional guidelines were reinforced and the food consumption was monitored in these meetings.

Statistical analysis

Descriptive analysis was presented as mean ± standard error. Data normality was verified with the Shapiro-Wilk test, and the Quasi-Likelihood under the Independence Model Criterion (QIC) was used to evaluate which model is the best according to the data distribution. Generalized Estimating Equations (GEE) were used to verify the interaction between time (pre vs. post) and interventions (CG vs. NPG vs. HPG) for the dependent variables. The LSD post hoc was used to identify differences between conditions. Data were analyzed using SPSS 23.0 software and the alpha value was set at 5%.

Results

Table I presents the characterization data of the sample composed by age, body mass, height, body mass index (BMI), waist circumference (WC), waist-height ratio (WHtR), body fat percentage (FAT%), total caloric intake and macronutrients (Carbohydrates, Proteins and Lipids). No statistically significant differences were observed between control (CG), high-protein (HPG) or normoproteic (NPG) groups in the pre-experimental condition.

Table I - Baseline characteristics of 25 overweight older adult women who completed two months of intervention with strength training and dietary manipulation. Recife, Brazil, 2019.

	CG (n = 7) Mean (SE)	HPG (n = 9) Mean (SE)	NPG (n = 9) Mean (SE)
Age (years)	64(0.81)	66.22(1.72)	64(1.66)
Body mass (kg)	75.82(5.24)	68.43(3.33)	84.06(7.03)
Height (cm)	152.71(1.44)	153.33(1.15)	153.66(1.84)
BMI	32.42(1.93)	29.04(1.19)	35.77(3.21)
WC (cm)	101.5(4.39)	95.27(3.48)	109.21(6.40)
WHtR	0.66(0.02)	0.62(0.02)	0.71(0.04)
FAT%	45,61(1.96)	43.70(1.60)	49.27(1.83)
Total ingestion (Kcal)	1230.23(280.14)	1587.43(247.06)	1306,34(247,06)
CHO (g)	227.46(27.08)	179.40(22.11)	229.36(25.07)
PTN (g)	56.24(7.68)	75.58(6.27)	69.68(7.11)
LIP (g)	35.48(9.86)	59.26(8.05)	64.46(9.13)

IBMI = body mass index; WC = waist circumference; WHtR = waist-to-height ratio; FAT% = body fat percentage; CG = control group; HPG = high-protein group; NPG = normoproteic group; SE = standard error.

Regarding anthropometric variables and CVR indicators (Table II), a significant effect of time (Pre vs. Post) was found in the CG, with an increase in WC ($p = 0.0001$) and WHtR ($p = 0.002$). There was a significant effect of time for BMI and FAT% in the HPG ($p = 0.039$; $p = 0.002$) and NPG ($p = 0.001$; $p = 0.012$), respectively, while the NPG had a significant decrease of the time effect ($p = 0.001$) for BMI, although there was no significance ($p = 0.088$) for this parameter in the HPG.

Table II - Anthropometric and body composition data before and after the 8-week intervention period.

	CG (n = 7)		HPG (n = 9)		NPG (n = 9)	
	Pre	Post	Pre	Post	Pre	Post
BM (kg)	75.82(4.85)	75.42(5.20)	68.43(3.14)	67.02(3.32)	84.06(6.63)	81.61(6.20)*
BMI	32.42(1.79)	32.37(1.94)	29.04(1.12)	28.33(1.23)*	35.77(3.02)	34.76(2.84)*
WC (cm)	101.5(4.06)	105.97(3.61)*	95.27(3.28)	95.74(4.30)	109.21(5.98)	109.24(5.47)
WHtR	0.66(0.02)	0.69(0.02)*	0.62(0.02)	0.62(0.02)	0.71(0.04)	0.71(0.04)
FAT%	45.61(1.81)	44.71(1.87)	43.70(1.51)	42.05(1.78)*	49.27(1.72)	48.18(1.93)*

BM = body mass; BMI = body mass index; WC = waist circumference; WHtR = waist-to-height ratio; CG = control group; HPG = high-protein group; NPG = normoproteic group. Results expressed as mean (standard error). *P <0.05, significant difference Pre vs. Post (Generalized Estimation Equations).

Table III presents the results based on GEE, in which we can affirm that there was no effect of time or interaction for all variables related to android tissue distribution (Total Android Tissue, TAT; Lean Android Tissue, LAT; Android Adipose Tissue, AAT (Android Adipose Tissue Percentage, AAT%).

Table III - Data on lean and fat distribution in the abdominal region before and after the eight-week intervention period.

	CG (n = 7)		HPG (n = 9)		NPG (n = 9)	
	Pre	Post	Pre	Post	Pre	Post
TTA (kg)	6.30(0.50)	6.04(0.43)	5.63(0.41)	5.41(0.39)	6.92(0.64)	6.77(0.56)
TMA (kg)	3.03(0.13)	2.83(0.11)	2.78(1.11)	2.75(0.08)	2.99(0.17)	2.95(0.14)
TAA (kg)	3.26(0.39)	3.08(0.36)	2.85(0.35)	2.66(0.34)	3.93(0.47)	3.71(0.45)
%TAA	50.79(2.22)	49.99(2.28)	49.55(2.13)	47.83(2.45)	55.78(1.59)	53.53(2.37)

TAT = Total Android Tissue; LAT = Lean Android Tissue; AAT = Android Adipose Tissue; TAA% = Android Adipose Tissue Percentage; CG = control group; GHP = high-protein group; GNP = normoproteic group. Results expressed as mean (standard error) (Generalized Estimation Equations).

Discussion

The main finding of this study was that modifying dietary patterns (high-protein or normoproteic) with a restriction of 300 kcal/day and associated with eight weeks of strength training in older adult women who were overweight/obese was not enough to significantly change cardiovascular risk and android adipose tissue indicators. However, a significant decrease in BMI and fat percentage was observed (and not in android adipose tissue) regardless of the dietary pattern, indicating that caloric restriction may be a major factor in changing body composition during the proposed intervention scope.

Studies have long shown that increased visceral adipose tissue (as well as excess body weight) is considered to be a poor health indicator due to its strong association with peripheral insulin resistance, dyslipidemia and cardiometabolic diseases [19]. In fact, a decrease in cardiovascular risk occurs with a reduction of visceral adipose tissue, and its alteration is as important as a reduction in total body weight in the treatment of obesity [20]. One of the methods used to predict cardiovascular risk is anthropometric measurements of waist circumference (WC) and waist-height ratio (WHtR) [16].

The two dietary patterns (high-protein, 1.8 g PTN/kg/day and normoproteic, 1.0 g PTN/kg/day, both with reduction of 300 Kcal) in association with resistance training in the present study did not promote enough alterations for there to be a change in the CVR classification of the older adults, but both WC and WHtR significantly increased their rates in the control group (Table II). Thus, although the two dietary patterns did not improve such indicators, the control group increased the chances of a cardiovascular event even further. Therefore, even though the HPG and NPG older women remained at cardiovascular risk, there was no increase in CVR with the interventions (diet, caloric restriction and RT) compared to the CG.

A study by López-Domenech *et al*. [21] submitted 59 obese individuals to caloric restriction for six months and observed improvement in anthropometric, metabolic parameters and reduction in inflammatory response, therefore showing improvement in atherosclerotic markers, suggesting a reduction in the risk of cardiovascular disease. In a systematic review and meta-analysis, Cioffo *et al*. [22] evaluated 11 studies with a total of 528 participants (most of them women) divided into two groups; one overweight and one obese. In conclusion, it was seen that dietary restriction had a beneficial effect on weight loss and metabolic improvements.

Several previous studies highlight the importance of dietary adherence and its influence on the success of the intervention, and there seems to be a direct relationship between adherence and weight loss [19]. The findings obtained in this intervention suggest a low adherence to diet, since there were individual differences ranging from -7.4 to + 1.2 kg in total mass between the pre and post intervention moments for the HPG and NPG (data not shown), which may represent a greater adherence to the dietary strategy in those who were successful in total body weight loss. This may have been due to the maintenance of a longer caloric deficit by some older women.

In a study conducted by Calugi *et al*. [24], it was observed that individuals aged 18-65 years who showed higher adherence to the diet tended to lose more weight and maintained this loss, while individuals who presented low adherence to the diet showed lower weight loss and a consequent dissatisfaction with this condition. Other studies also corroborate this premise and have shown similar results, which confirms the importance of adhering to the program in order to succeed in achieving its goal [25].

A statistically significant difference ($p = 0.001$) was observed in the normoproteic group regarding body mass, similar to the study by Christensen *et al*. [26] in which the whole population sample had changes in fat-free mass and total body mass, as well as improvement in anthropometric parameters, blood pressure and metabolic profile. However, the authors point out that rapid weight loss (within eight weeks) would be in fact beneficial for maintaining body weight and future cardiovascular health. As previously stated, it is noteworthy that the findings of the present study did not contribute to a decrease in cardiovascular risk of the older adult participants.

Another point which deserves attention concerns the significant decrease in BMI and fat percentage in both groups (HPG and NPG). Even with differences in protein intake, both obtained reductions in these parameters, reflecting that caloric restriction is the predominant body change factor when compared to variations of a macronutrient. The study by Anton *et al*. [27] used fasting as a calorie restriction strategy in overweight sedentary older adults. The participants obtained changes in body mass and waist circumference as a result of the study, among other parameters. However, there is a caveat if the decrease in body mass was due to the loss of fat mass or lean mass. The study by Beavrs *et al*. [28] observed reductions in fat percentage in obese older adults aged 65-79 years undergoing an intervention with calorie restriction and high protein content.

In a study performed by Melanson *et al.* [29], overweight and/or obese sedentary adults were allocated into three groups and submitted to different dietary approaches, all with energy restriction for 12 weeks. The result for weight loss and improvements in body composition was significant for all groups, reinforcing the hypothesis that BMI and body mass reductions are obtained with energy value equity, even with macronutrient variations.

Regarding the effects of resistance training intervention combined with calorie restriction on total mass and body composition behavior, Nicklas *et al.* [30] observed a greater decrease in total mass, fat mass, and fat percentage in individuals who combined both strategies when compared to those who only performed resistance training. These results corroborate those reported by Normandin *et al.* [31], in which a greater weight reduction was observed when resistance training was combined with caloric restriction, and more significant changes in cardiovascular risk parameters were observed when compared to changes observed in the group that did not undergo caloric restriction. Borges *et al.* [9] did not observe differences in the effects of interventions involving physical exercise and/or diet on intra-abdominal adipose tissue when equalizing caloric expenditure [32,33]. These results corroborate the literature, since changes in body mass and its composition are directly related to the daily energy balance [34].

When comparing the pre and post intervention moments, the older adult participants of the high-protein group (HPG) and the normoproteic group (NPG) generally had a greater reduction in body mass index (BMI), body mass (kg) and in fat percentage (FAT%) when compared to the control group (CG). This reflects better quality in body composition with dietary intervention, since all groups underwent strength training. Although the cardiovascular risk was maintained above the cut-off point of the WC and WHtR indicators for the HPG and NPG, there was an increase in the CG, inferring that the intervention time was insufficient and adherence to the diet was compromised.

Conclusion

In conclusion, this study demonstrated that a prescriptive diet with different protein intake patterns and caloric restriction associated with resistance training for eight weeks does not seem to be effective in decreasing many cardiovascular risk factors such as android adipose tissue in older women. Thus, nutritional strategies should be rethought for this population, as well as offering longer intervention periods so that their effects on the analyzed parameters can be effectively verified.

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Potential conflict of interest
No conflicts of interest have been reported for this article.

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Authors' contributions
Conception and design of the research: Costa AS, Souto VF. **Obtaining data:** Souto VF, Silva CA, Lins NCM, Araujo MLD. **Analysis and interpretation of data:** Costa AS, Souto VF. **Statistical analysis:** Costa AS. **Writing of the manuscript:** Souto VF. **Critical review of the manuscript:** Costa AS, Souto VF, Silva CA, Lins NCM, Araujo MLD.

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