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Effects of resistance exercise in postmenopausal women with type 2 diabetes: nonrandomized clinical trial

Efeitos do exercício resistido em mulheres com diabetes tipo 2 na pós-menopausa: ensaio clínico não randomizado

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Abstract

Introduction: *type 2 diabetes is a chronic metabolic disorder characterized by gradual loss of insulin secretion and increased insulin resistance. Due to longevity, women spend more than one-third of their lives in the postmenopausal period, with estrogenic and quality of life reduction, besides several physiological disturbances.* ***Objective:*** *to evaluate the effects of a resistance training protocol on muscle strength, metabolic control, and quality of life in postmenopausal type 2 diabetic women.* ***Methods:*** *this nonrandomized clinical trial studied 34 sedentary or irregularly active women. Participants in the Control Group received routine care. In the Exercise Group, they performed resistance training for 90 minutes twice a week, with moderate intensity (50%-75% 1RM) and a duration of eight weeks.* ***Results:*** *resistance training reduced waist circumference by 2.31cm (p=0.025), increased handgrip strength by 1.08 kg/f (p=0.004), improved physical performance by 1.38 points (p=0.008) in the Short Physical Performance Battery and quality of life, with improvement in six domains of the SF-36: physical functioning 31.67% (p=0.002), physical health 58. 97% (p=0.001), pain 29.21% (p=0.023), general health status 15.81% (p=0.033), social functioning 31.29% (p=0.034) and emotional problems 36.50% (p=0.041), in addition to improving the health change 33.33% (p=0.007).* ***Conclusions:*** *a short-term resistance exercise program in a hospital setting improved handgrip strength, physical performance, quality of life, and reduced waist circumference in postmenopausal type 2 diabetic women.*
Keywords: *Resistance training; Hand grip strength; Waist circumference; Quality of life; Type 2 Diabetes Mellitus.*

Resumo

Introdução: a diabetes tipo 2 é um distúrbio metabólico crônico caracterizado pela perda gradual da secreção de insulina e pelo aumento da resistência à insulina. Devido à longevidade, as mulheres passam mais de um terço de suas vidas na pós-menopausa, com redução estrogênica e da qualidade de vida, além de diversos distúrbios fisiológicos. **Objetivo:** avalia os efeitos de um protocolo de treinamento resistido na força muscular, controle metabólico e qualidade de vida em mulheres diabéticas tipo 2 na pós-menopausa. **Metodologia:** esse ensaio clínico não randomizado estudou 34 mulheres sedentárias ou irregularmente ativas. Participantes do Grupo Controle receberam cuidados de rotina e do Grupo Exercício realizaram treinamento resistido por 90min, duas vezes por semana, com intensidade moderada (50%-75% 1RM) e duração de oito semanas. **Resultados:** o treinamento resistido reduziu a circunferência da cintura em 2,31cm (*p=0,025*), aumentou a força de preensão manual em 1,08 kg/f (*p=0,004*), melhorou o desempenho físico em 1,38 pontos (*p=0,008*) no Short Physical Performance Battery e na qualidade de vida, com melhora em seis domínios do SF-36: capacidade funcional 31,67% (*p=0,002*), aspectos físicos 58, 97% (*p=0,001*), dor 29,21% (*p=0,023*), estado geral de saúde 15,81% (*p=0,033*), aspectos sociais 31,29% (*p=0,034*) e aspectos emocionais 36,50% (*p=0,041*), além de melhorar a percepção da saúde atual comparada a um ano atrás em 33,33% (*p=0,007*). **Conclusões:** um programa de exercício resistido de curta duração, em ambiente hospitalar, melhorou a força de preensão manual, o desempenho físico, a qualidade de vida e reduziu a circunferência da cintura em mulheres diabéticas tipo 2 na pós-menopausa.
Palavras-chave: Treino de resistência; força de preensão manual; perímetro da cintura; qualidade de vida; Diabetes Mellitus tipo 2.

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemia[1]. Currently recognized as one of the most important public health challenges[2]. According to the International Diabetes Federation

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(IDF), in 2019, about 463 million people worldwide had the disease, 90% of whom had type 2 diabetes mellitus. By 2045, this figure is expected to reach 700 million, representing 9% of the world's population between 20 and 79 years of age[3].

Due to the increase in life expectancy of the world population from 70.4 years in 2000 to 81.3 years by 2050, women now spend more than a third of their lives postmenopausal[4]. This period begins one year after the last menstrual cycle. It is characterized by a decreased production of estrogen, a reduction in quality of life, and the presence of various physiological disorders, such as coronary artery disease, osteopenia, sarcopenia, loss of collagen, decreased sexual function, increased visceral adiposity, reduced sensitivity to insulin, metabolic syndrome, and type 2 diabetes[5-7].

Studies have shown that interventions with resistance physical exercises in diabetic individuals result in significant improvements in glycemic control, increased lean mass, reduced abdominal adiposity, improved systolic blood pressure, increased muscle strength and spontaneous physical activity[8]. It also contributes, in the cases of postmenopausal women, to the promotion of strength gain, muscle mass, improvement in bone mineral density and quality of life[9,10].

Although resistance exercise has the potential to improve metabolic control and physical performance in type 2 diabetes, data on controlled or randomized studies in individuals with type 2 diabetes are scarce, especially in postmenopausal women who would be at increased risk for metabolic and muscle-skeletal complications.

This study aimed to evaluate the effects of a hospital-based supervised resistance training protocol on muscle strength, metabolic control, and quality of life in type 2 diabetic women in the postmenopausal period.

METHODS

Trial Design

This was a nonrandomized clinical trial involving 34 women allocated to the Control Group (CG) and Exercise Group (EG) based on participant availability and interest.

The study received approval from the Research Ethics Committee of Agamenon Magalhães Hospital (AMH) – CAAE: 54325516.0.0000.5197 and is registered in the Brazilian Registry of Clinical Trials (ReBEC): RBR-72sc84. Written informed consent was obtained from all participants.

Participants

Postmenopausal women with type 2 diabetes, with glycosylated hemoglobin levels ≤ 11% and classified as sedentary or irregularly active according to the International Physical Activity Questionnaire (IPAQ)[11] were included in this study. Women with the following characteristics were excluded from the study: past coronary or cerebrovascular event; chronic renal disease with estimated glomerular filtration rate ≤ 30 ml/min; orthopedic limitations for physical training; proliferative diabetic retinopathy; disabling diabetic neuropathy; heart failure classified by the New York Heart Association functional classification as class III or IV; liver disease established by the Child-Pugh classification for the severity of liver disease as B or C; decompensated thyroid disease; malignant neoplasia, except basal cell carcinoma; a history of coronary, carotid or peripheral artery bypass grafting; documented myocardial ischemia; classified as active or very active by the IPAQ; participated in the last six months in any training program using weights; and participated in fewer than 80% of the resistance training sessions.

Individuals from the AMH, the "Diabetes and Climacteric Group" of the Albert Sabin Polyclinic, and the Women's Specialized Outpatient Clinic (WSOC), all located in the city of Recife, state of Pernambuco, participated in the study.

Interventions

The CG participants received the AMH's standard of care and nutritional education. Participants of the EG received the standard of care of the AMH and nutritional education. They underwent a systematic and supervised protocol of hospital-based resistance training (Table 1), with a duration of 90 minutes of training twice a week, moderate intensity (50%–70% of 1RM), for eight weeks, based on the guidelines of the American College of Sports Medicine and American Diabetes Association[12].

Outcomes

All participants were initially screened to verify eligibility criteria. After being considered eligible and signing a consent form, participants had the following data collected: personal information; anthropometric data; blood pressure measurements; comorbidities; serum dosage of glucose, glycosylated hemoglobin (HbA1c), triglycerides, and cholesterol fractions; lean body mass measurement by dual-energy X-ray absorptiometry (DXA)[13]; short physical performance battery (SPPB) for the assessment of balance, gait, strength, and Endurance[14]; assessment of hand grip strength using a Saehan® Dynamometer[15]; and assessment of participants' quality of life using the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36)[16]. Eight weeks later, the CG and EG participants were assessed again for comparison with the initial data.

During the training, blood pressure (BP), heart rate (HR), peripheral oxygen saturation (SpO2) and the Subjective Effort Perception by Borg's scale were recorded. The training protocol was interrupted when participants had an HR above 85% of HRmax, estimated by the equation (220 – Age), SpO2 < 90%, BP variation > ± 20 mmHg, Borg > 7 (very tiring) or signs of malaise.

Table 1 *– Systematized resistance exercise protocol.*

STEPS	EXERCISE TYPE	TIME	FREQUENCY	INTENSITY	PERIOD
Warm up	Dumbbell squats (quadriceps, hamstrings, glutes) Alternating Dumbbell Shoulder Press (deltoids, triceps brachii, trapezius) Dumbbell curl (biceps brachii)	10 minutes	1 set of 10 repetitions	25% of 1-repetition maximum (1RM)	2 days per week - 1–8 weeks
Flexibility	Stretching neck, arms, back, and legs	5 minutes	15-second stretch per body segment	-	
Resistance Training	Dumbbell squats (quadriceps, hamstrings, glutes) Dumbbells calf raise (gastrocnemius, soleus) Dumbbell Side Bend – obliques (oblique and rectus abdominis) Alternating Dumbbell Shoulder Press (deltoids, triceps brachii, trapezius) Dumbbell curl (biceps brachii) Dumbbell French Press (triceps brachii) modified crucifix shoulder dumbbells (pectoralis major, deltoid)	60 minutes	3 sets of 10 repetitions resting 2 minutes between sets	50% of 1-repetition maximum (1RM) (1–2 week) 50%–75% of 1-repetition maximum (1RM) (3–8 week)	
Cool down	Dumbbell-free squats (quadriceps, hamstrings, glutes) Alternating Dumbbell-free Shoulder Press (deltoids, triceps brachii, trapezius) Dumbbell-free Curl (biceps brachii)	10 minutes	1 set of 10 repetitions	Weightless	
Flexibility	Stretching neck, arms, back, and legs	5 minutes	15-second stretch per body segment	-	

Abbreviations: 1RM, one-repetition maximum.

Sample Size

The mean and variance expected for the event of interest in the evaluated groups were obtained from the reference work: "Effects of regular supervised resistance training on muscle strength and metabolic control in postmenopausal type 2 diabetic women". Considering the above parameters and 20% for loss correction, the sample size for each study group was estimated at 33 participants.

Because of the SARS-Cov-2 pandemic and because the study participants were considered at high risk, data collection was stopped before reaching the minimum sample size. However, we achieved statistically significant results even with the small sample size.

Statistical Methods

Descriptive analysis, analysis of variance and mean tests were performed. Student's t-tests were used when the data presented a normal distribution, and the Mann-Whitney and Wilcoxon tests were paired in cases of rejection of normality. The verification of normality was done by the Shapiro-Wilk test, and the equality of variances was done by the Levene F test[17,18]. The margin of error considered in the statistical testing decision was 5%. IBM SPSS Statistics®23 and GraphPad Prism®8 were used for data analysis.

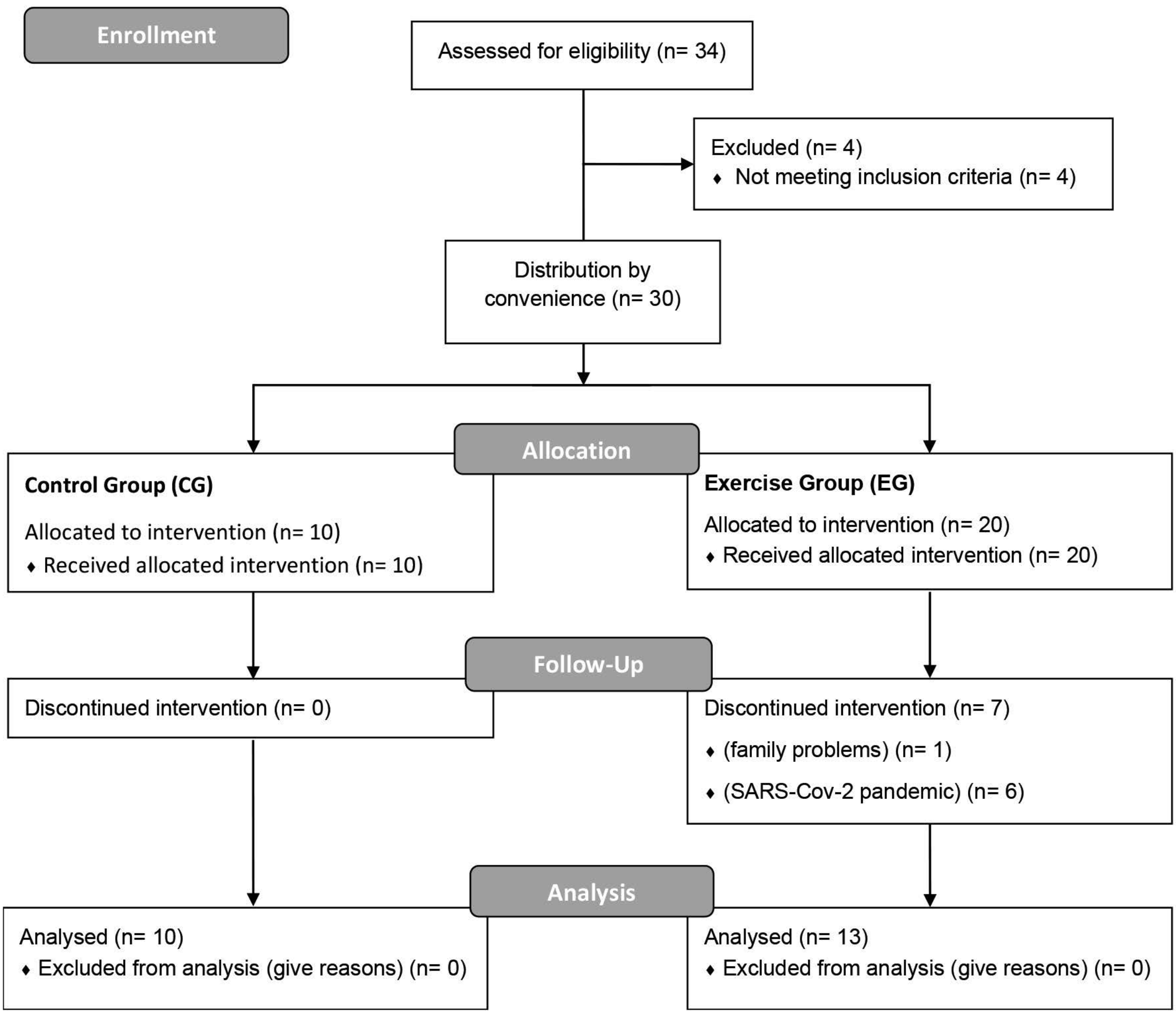
RESULTS

According to the study flow diagram (Figure 1), 34 participants were evaluated. Four did not meet the inclusion criteria, one withdrew after starting the exercise protocol, and six had the exercise protocol discontinued due to the SARS-Cov-2 pandemic. This study analyzed 23 participants, ten from CG and 13 from the EG.

Participants were recruited between July and November 2019. They were followed for four months when new participants entered the study. The EG was followed *until March 2020, when activities were suspended and restrictive measures imposed to contain the SARS-Cov-2 pandemic in Brazil.*

The baseline characteristics and homogeneity of the participants are shown in Table 2. The mean age in the EG was 65.69 ± 7.69 years, and in the CG, it was 61.50 ± 8.33 years (p=0.225). Most of the participants who did not use insulin (69.57%) were classified as irregularly active (95.65%) and presented with dyslipidemia (86.95%), followed by systemic arterial hypertension (82.61%) as the most prevalent comorbidities. The mean duration of type 2 diabetes was 10.31 ± 7.13 years rin the EG and 11.40 ± 8.59 years in the CG.

***Figure 1** – CONSORT diagram of participant flow.*



Mean body weight increased in the CG from 74.80 ± 16.76 kg to 77.10 ± 18.46 kg (p=0.027) and decreased marginally in the EG from 70.62 ± 14.71 kg to 70.54 ± 15.37 kg (p=0.851) (Figure 2-A). In the comparisons for the mean per cent differences, there were significant differences between the groups (p=0.006), where the EG reduced their body weight by 0.24%, while the CG increased by 2.74%.

***Table 2** – Baseline characteristics and homogeneity of the study participants by group.*

Variable	*Group*		*p-value*
	Exercise – EG (n= 13)	*Control – CG (n= 10)*	
	Mean ± SD (Median)	*Mean ± SD (Median)*	
Age	*65.69 ± 7.69 (68.00)*	*61.50 ± 8.33 (63.50)*	$p^{(a)} = 0.225$
Time of 2DM (years)	*10.31 ± 7.13 (11.00)*	*11.40 ± 8.59 (7.00)*	$p^{(a)} = 0.742$
Weight (kg)	*70.62 ± 14.71 (67.00)*	*74.80 ± 16.76 (70.00)*	$p^{(b)} = 0.473$
AC (cm)	*99.08 ± 10.62 (96.00)*	*102.90 ± 12.33 (100.50)*	$p^{(a)} = 0.434$
IPAQ	*3.38 ± 0.51 (3.00)*	*3.60 ± 0.70 (3.50)*	$p^{(a)} = 0.392$
Insufficiently active A1	*8 (61.5%)*	*5 (50.0%)*	
Insufficiently active B2	*5 (38.5%)*	*4 (40.0%)*	
Inactive 3	*0 (00.0%)*	*1 (10.0%)*	
Insulin	*1.69 ± 0.48 (2.00)*	*1.70 ± 0.48 (2.00)*	$p^{(a)} = 0.961$
Yes	*4 (30.8%)*	*3 (30.0%)*	
No	*9 (69.2%)*	*7 (70.0%)*	
Nephropathy	*1.31 ± 0.48 (1.00)*	*1.50 ± 0.53 (1.50)*	$p^{(a)} = 0.378$
G1 (CKD-EPI > 90)	*9 (69.2%)*	*5 (50.0%)*	
G2 (CKD-EPI 60-89)	*4 (30.8%)*	*5 (50.0%)*	
Neuropathy	*1.46 ± 0.52 (1.00)*	*1.60 ± 0.52 (2.00)*	$p^{(a)} = 0.529$
Yes	*7 (53.8%)*	*4 (40.0%)*	
No	*6 (46.2%)*	*6 (60.0%)*	
Smoking	*1.92 ± 0.28 (2.00)*	*1.80 ± 0.42 (2.00)*	$p^{(a)} = 0.420$
Yes	*1 (7.7%)*	*2 (20.0%)*	
No	*12 (92.3%)*	*8 (80.0%)*	
Dyslipidemia	*1.15 ± 0.38 (1.00)*	*1.10 ± 0.32 (1.00)*	$p^{(a)} = 0.741$
Yes	*11 (84.6%)*	*9 (90.0%)*	
No	*2 (15.4%)*	*1 (10.0%)*	
Diabetic kidney disease	*1.77 ± 0.44 (2.00)*	*1.90 ± 0.32 (2.00)*	$p^{(a)} = 0.440$
Yes	*3 (23.1%)*	*1 (10.0%)*	
No	*10 (76.9%)*	*9 (90.0%)*	
Hypertension	*1.23 ± 0.44 (1.00)*	*1.10 ± 0.32 (1.00)*	$p^{(a)} = 0.440$
Yes	*10 (76.9%)*	*9 (90.0%)*	
No	*3 (23.1%)*	*1 (10.0%)*	
Fasting Glucose (mg/dL)	*137.15 ± 35.47 (120.00)*	*121.70 ± 49.83 (108.00)*	$p^{(b)} = 0.213$
HbA1c (%)	*7.85 ± 1.68 (7.00)*	*7.20 ± 0.92 (7.00)*	$p^{(a)} = 0.286$
LDL (mg/dL)	*109.15 ± 42.96 (99.00)*	*92.70 ± 56.31 (82.50)*	$p^{(a)} = 0.435$
HDL (mg/dL)	*47.15 ± 10.24 (50.00)*	*51.30 ± 16.12 (48.00)*	$p^{(b)} = 0.828$
Triglycerides (mg/dL)	*200.38 ± 175.30 (164.00)*	*129.90 ± 74.49 (105.50)*	$p^{(b)} = 0.264$
AMM (g)	*17.25 ± 2.83 (16.46)*	*18.37 ± 4.83 (16.51)*	$p^{(b)} = 0.915$
Baumgartner (Kg/m2)	*7.25 ± 0.78 (7.00)*	*7.52 ± 1.68 (6.80)*	$p^{(b)} = 0.637$
Handgrip strength (kg/f)	*10.54 ± 2.70 (11.00)*	*10.40 ± 2.12 (10.50)*	$p^{(a)} = 0.895$
Total SPPB	*8.08 ± 1.71 (8.00)*	*7.60 ± 1.43 (7.50)*	$p^{(b)} = 0.549$
SF-36 (score/domains)			
D1-Physical functioning	*57.31 ± 28.33 (65.00)*	*50.50 ± 31.92 (62.50)*	$p^{(a)} = 0.594$
D2-Physical health	*38.46 ± 41.60 (25.00)*	*64.50 ± 43.36 (87.50)*	$p^{(b)} = 0.192$
D3-Pain	*57.00 ± 39.33 (68.00)*	*49.90 ± 18.73 (46.50)*	$p^{(b)} = 0.703$
D4-General health	*56.15 ± 25.91 (60.00)*	*54.40 ± 26.55 (46.00)*	$p^{(a)} = 0.875$
D5-Energy/fatigue	*57.31 ± 32.38 (60.00)*	*54.50 ± 24.20 (45.00)*	$p^{(a)} = 0.821$
D6-Social functioning	*54.92 ± 35.61 (50.00)*	*62.40 ± 38.30 (62.50)*	$p^{(a)} = 0.634$
D7-Emotional problems	*56.38 ± 45.95 (67.00)*	*62.70 ± 40.47 (66.50)*	$p^{(b)} = 0.769$
D8-Emotional well-being	*55.69 ± 39.07 (64.00)*	*58.80 ± 25.58 (64.00)*	$p^{(a)} = 0.830$
Health change	*53.85 ± 28.59 (50.00)*	*59.50 ± 23.62 (57.50)*	$p^{(a)} = 0.618$

***Abbreviations:** SD, standard deviation; 2DM, type 2 diabetes mellitus; IPAQ, International Physical Activity Questionnaire; CKD-EPI, estimate of the glomerular filtration rate by the Chronic Kidney Disease Epidemiology Collaboration; AC, abdominal circumference; HbA1c, glycated hemoglobin; LDL, low-density lipoprotein; HDL, high-density lipoprotein; AMM, appendicular muscle mass; Total SPPB, total short physical performance battery score; SF-36, quality of life questionnaire; D1 – D8, SF-36 domains.*
(a) Pelo teste t-Student com variâncias iguais.
(b) Pelo teste Mann-Whitney

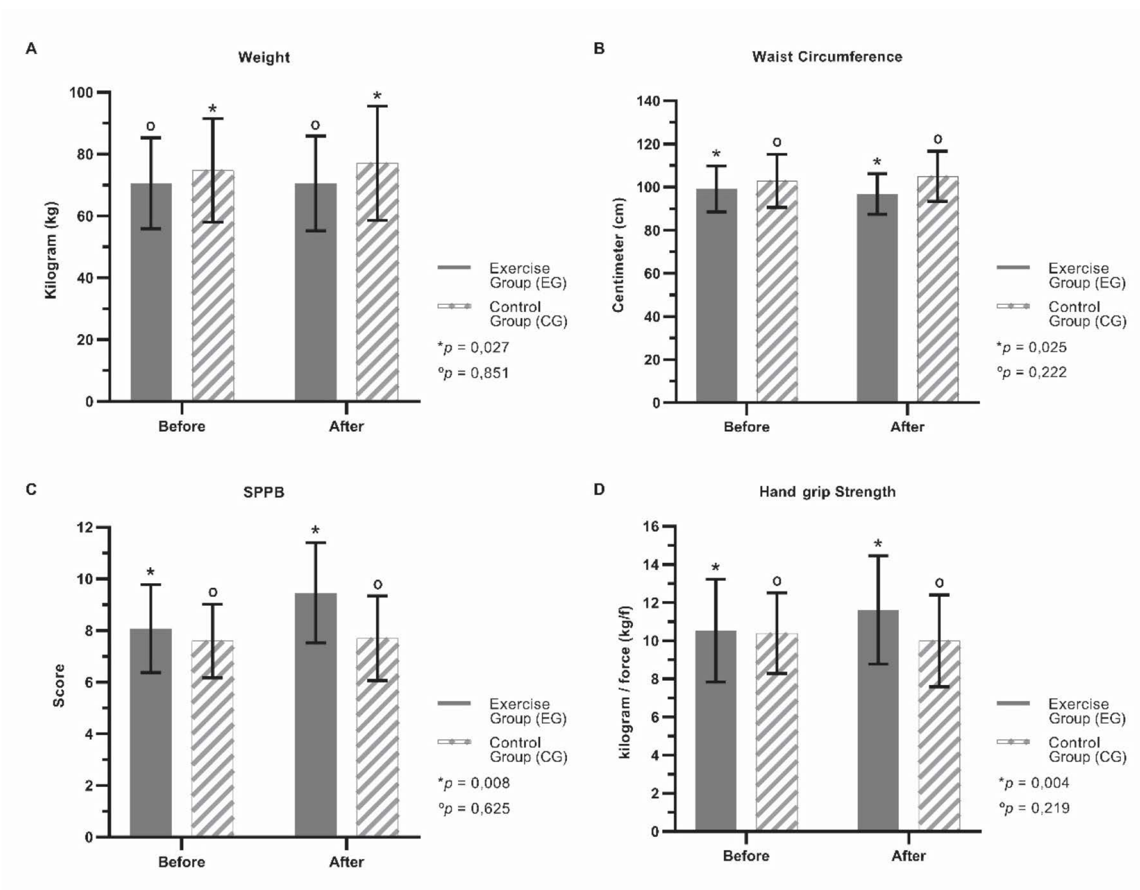
The EG showed significant differences in the waist circumference, with a reduction of 2.31 cm (p=0.025) in the comparison between the means before (99.08 ± 10.62) and áster (96.77 ± 9.43) (Figure 2-B); in the total score of the SPPB, increasing from 8.08 ± 2.70 points to 9.46 ± 1.94 points (p=0.008) (Figure 2-C); and in the hand grip strength, with an increase of 1.08 kg/f (p=0.004) in relation to the mean before (10.54 ± 2.70) and after (11.62 ± 2.84) the resistance exercise protocol (Figure 2-D).

The average percentage differences between the EG and CG hand grip strength were also significant (p=0.035), with an increase of 8.12% in the EG strength and a reduction of 4.81% in the CG strength.

The were no significant differences in biochemical parameters between the groups, with the values before and after for fasting plasma glucose of 137.15 ± 35.47 vs. 147.85 ± 44.28 mg/dL (p=0.078) in the EG and 121.70 ± 49.83 vs. 128.40 ± 44.90 mg/dL (p=0.725) in CG; glycated hemoglobin: 7.85 ± 1.68 vs. 7.62 ± 1.76 % (p=0.188) in EG and 7.20 ± 0.92 vs. 7.50 ± 1.08 % (p=0.500) in CG; LDL-C: 109.15 ± 42.96 vs. 91.92 ± 26.24 mg/dL (p=0.262) in the EG and 92.70 ± 56.31 vs. 86.30 ± 34.30 mg/dL (p=0.768) in the CG; HDL-C: 47.15 ± 10.24 vs. 45.31 ± 10.13 mg/dL (p=0.209) in the EG and 51.30 ± 16.12 vs. 50.40 ± 12.38 mg/dL (p=0.782) in CG; and triglycerides: 200.38 ± 175.30 vs. 176.46 ± 107 mg/dL (p=0.721) in EG and 129.90 ± 74.49 vs. 151.30 ± 59.22 mg/dL (p=0.221) in CG.

Body composition analysis did not differ between groups, even though there were higher values after the intervention. The appendicular lean mass was 17.25 ± 2.83 vs. 18.30 ± 4.07 kg (p=0.054) with a Baumgartner Index of 7.25 ± 0.78 vs. 7.66 ± 1.26 kg/m2 (p=0.063) in the EG in comparison with 18.37 ± 4.83 vs. 18.70 ± 5.17 kg (p=0.711) with Baumgartner of 7.52 ± 1.68 vs. 7.66 ± 1.95kg/m2 (p=0.688) for the CG.

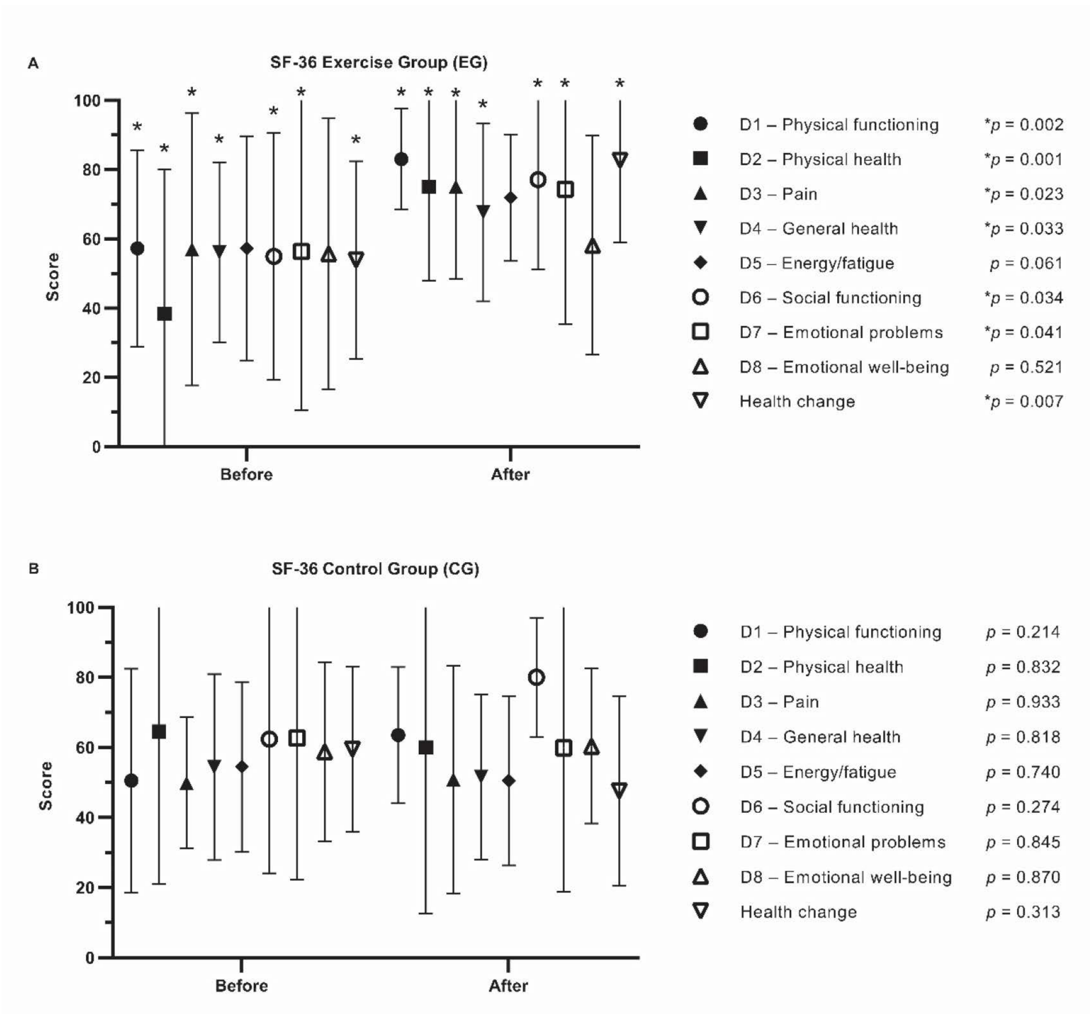
***Figure 2** – Differences in anthropometric data and physical function by exercise group (EG) and control group (CG) before and after eight weeks. Weight in kilograms per group (A). Abdominal circumference in centimeters per group (B). SPPB score per group (C). Handgrip strength in kilogram/force per group (D). Abbreviations: SPPB, short physical performance battery.*



EG showed improvement in scores for all SF-36 domains and in a comparison of current health from one year ago (health change). However, these values were only different from the mean in the before and after the variables: physical functioning (D1), from 57.31 ± 28.33 to 83.08 ± 14.51 (p=0.002); physical health (D2), from 38.46 ± 41.60 to 75.00 ± 26.59 (p=0.001); pain (D3), from 57.00 ± 39.33 to 75.15 ± 26.59 (p=0.023); general health (D4), from 56.15 ± 25.91 to 67.69 ± 25.63 (p=0.033); social functioning (D6), from 54.92 ± 35.61 to 77.15 ± 25.89 *(p=0.034); emotional problems (D7), from 56.38 ± 45.95 to 74.38 ± 38.88 (p=0.041); and in the comparison of the current health with one year ago (health change), from 53.85 ± 28.59 to 82.69 ± 23.68 (p=0.007) (Figure 3).*

The average percentage differences indicate improvement by domains: physical functioning 31.67%, physical health 58.97%, pain 29.21%, general health 15.81%, social functioning 31.29%, emotional problems 36.50% and health change 33.33%.

***Figure 3** – The quality of life domains (SF-36 questionnaire) before and after eight weeks per group. Score of the eight SF-36 domains and health change (comparison of current health to one year before) in the exercise group – EG (A). Score of the eight SF-36 domains and health change (comparison of current health to one year before) in the control group – CG (B).*



DISCUSSION

In the present study, we demonstrated significant improvements in physical performance and quality of life parameters after a short-term, hospital-based resistance exercise (REs) program in postmenopausal women with type 2 diabetes, with no significant differences in metabolic control.

In this regard, a systematic review, followed by a meta-analysis, was performed by Liu et al.[19] to investigate the influence of REs with different intensities on HbA1c, insulin and glycemia levels in individuals with type 2 diabetes. They selected 24 clinical trials with 962 individuals for analysis. They were grouped into exercise (n = 491) and control (n = 471). Meta-regression analysis showed a decrease in HbA1c (p=0.006) and insulin (p=0.015) that correlated with high-intensity REs. However, Cruz et al.[20] found different results in a study that evaluated the effects of RE at different intensities on glucose response 24 hours after REs in 12 women. They concluded that an REs of lower intensity (40% of 1RM) caused a higher glucose reduction compared with the group of higher intensity (80% of 1RM) and the CG without exercise. In another study, Tomeleri et al.[21] reported significant improvements in total LDL (−36%), HDL (+13.2%) and glucose (−5.9%) levels after eight weeks of REs by 38 obese elderly women (66.8 ± 3.2 years).

Even though type 2 diabetes and being postmenopausal are often associated with sarcopenia and fragility, our study found no differences in appendicular muscle mass between the groups; however, there was a significant improvement in physical performance and hand grip strength in the EG.

Macdonald et al.[22] assessed the effectiveness of primary care interventions for physical fragility in adults over 60. They analyzed 31 studies with a total of 4.794. The results suggested that REs improved measures related to physical fragility (walking speed, lower limb strength and hand grip strength) and promoted functional and cognitive benefits for older individuals, even in the presence of comorbidities.

According to our results, the REs significantly improved six of the eight domains of the SF-36 Quality of Life Questionnaire (physical functioning, physical health, pain, general health, social functioning and emotional problems), in addition to improving participants' perception of their current health compared to one year ago (health change).

Guedes et al.[23] also reported the effects of a training program on the quality of life. They included 35 women (65.7 ± 6.68 years) divided into three groups: combined training (CT, n = 15), strength training (ST, n = 10) and aerobic training (AT, n = 10). Each group trained twice a week for eight weeks and was evaluated using the SF-36. They found significant improvements for the domains Physical Aspects, Pain and Emotional Aspects for the TF group and the AT group, Social Aspects, Pain and Emotional Aspects. The study showed no significant differences in any domain of the SF-36 questionnaire for the CT.

CONCLUSION

We found that a short-term, hospital-based resistance exercise program improved hand grip strength, physical performance, and quality of life and, in addition, decreased waist circumference in postmenopausal women with type 2 diabetes.

Although the small sample size is a limitation of our study, there are still few studies evaluating REs in postmenopausal women with type 2 diabetes, which are also limited by the small sample sizes. In our study, the small number of participants was largely influenced by age-related limitations. However, the short protocol time and its performance in a hospital-based setting contributed positively to the participants' adherence, making them see this approach as an important adjuvant strategy to clinical care.

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