Rev Andal Med Deporte. 2019; 12(4): 363-367

Revista Andaluza de
Medicina del Deporte

https://ws072.juntadeandalucia.es/ojs

Original

Evaluation of a program of physical exercise on blood markers and sleep quality in elderly

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ARTICLE INFORMATION: Received 12 July 2018, Accepted 16 May 2019, Online 23 July 2019

ABSTRACT

Objective: Analyze the effects of a physical exercise program on blood markers and sleep quality in the elderly.
Method: A total of 112 elderly people with metabolic diseases controlled by hypocholesterolemic and hypoglycemic medications participated in the study. The participants were divided into two groups, an exercise group composed of 54 individuals with a mean age of 62 years and control group of 58 individuals with a mean age of 63 years.
Results: Blood glucose, total cholesterol, and triglyceride levels showed a mean reduction of 27.47, 18.13, and 23.48 mg/dl, respectively, and an increase of 8.98 mg/dl in the high-density lipoprotein level was seen. A significant change was seen in the low-density lipoprotein, very-low-density lipoprotein, and calcium levels on comparing the exercise group post-test values with that of the control group pre-test. The Pittsburgh Sleep Quality Index score showed a significant reduction of 3.15 ($p < 0.001$, $\mu p2=0.78$) on comparing the exercise group with the control group.
Conclusion: It can be concluded that the physical exercise program, consisting of supervised walking and gymnastics with localized quadriceps muscle strengthening exercises, performed for 16 weeks at a frequency of three times a week for 60 min, was effective in improving the low-density lipoprotein and very-low-density lipoprotein levels and sleep quality of the elderly.
Keywords: Physical exercise; Blood markers; Sleep quality.

Evaluación de un programa de ejercicio físico sobre los marcadores de sangre y la calidad del sueño en mayores

RESUMEN

Objetivo: Analizar los efectos de un programa de ejercicio físico sobre los marcadores sanguíneos y la calidad del sueño en ancianos.
Método: Un total de 112 personas mayores con enfermedades metabólicas controladas por medicamentos hipocolesterolémicos e hipoglucemiantes participaron en el estudio. Los participantes se dividieron en dos grupos, un grupo de ejercicio compuesto por 54 individuos, con una edad media de 62 años y un grupo control de 58 individuos, con una edad media de 63 años.
Resultados: Los niveles de glucosa en sangre, colesterol total y triglicéridos mostraron una reducción media de 27.47, 18.13 y 23.48 mg/dl, respectivamente, y se observó un aumento de 8.98 mg/dl en el nivel de lipoproteínas de alta densidad. Se observó un cambio significativo en los niveles de lipoproteínas de baja densidad, lipoproteínas de muy baja densidad y calcio al comparar los valores de grupo de ejercicio post-test con los del grupo control pre-test. La puntuación del Pittsburgh Sleep Quality Index mostró una reducción significativa de 3.15 ($p <0.001$, $\mu p2=0.78$) al comparar el grupo de ejercicio con el grupo control.
Conclusiones: Se puede concluir que el programa de ejercicio físico supervisado, consistente en caminar y realizar ejercicios de fortalecimiento muscular de cuádriceps, durante 16 semanas con una frecuencia de tres veces por semana durante 60 minutos, fue eficaz para mejorar los niveles de lipoproteínas de baja densidad, lipoproteínas de muy baja densidad y la calidad del sueño de las personas mayores.
Palabras clave: Ejercicio físico; Marcadores sanguíneos; Calidad del sueño.

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https://doi.org/10.33155/j.ramd.2019.05.009

Avaliação de um programa de exercício físico sobre marcadores de sangue e qualidade do sono em idosos

RESUMO

Objetivo: Analisar os efeitos de um programa de exercício físico sobre marcadores sanguíneos e qualidade do sono em idosos.
Método: Um total de 112 idosos com doenças metabólicas controladas por medicações hipocolesterolêmicas e hipoglicemiantes participaram do estudo. Os participantes foram divididos em dois grupos, um grupo exercício composto por 54 indivíduos com idade média de 62 anos e grupo controle de 58 indivíduos com média de idade de 63 anos.
Resultados: Os níveis de glicose no sangue, colesterol total e triglicerídeos mostraram uma redução média de 27.47; 18.13 e 23.48 mg/dl, respectivamente, e um aumento de 8.98 mg/dl no nível de lipoproteínas de alta densidade foi observado. Uma mudança significativa foi observada nos níveis de lipoproteínas de baixa densidade, lipoproteínas de muito baixa densidade e Cálcio na comparação dos valores do pós-teste do grupo exercício com o pré-teste do grupo controle. O escore do *Pittsburgh Sleep Quality Index* mostrou uma redução significativa de 3.15 ($p < 0.001$, $\mu p2 = 0.78$) na comparação do grupo exercício com o grupo controle.
Conclusão: Pode-se concluir que o programa de exercícios físicos, consistindo em caminhada supervisionada e ginástica com exercícios de fortalecimento muscular do quadríceps localizados, realizado por 16 semanas na freqüência de três vezes por semana durante 60 min, foi efetivo na melhora dos níveis de lipoproteínas de baixa densidade e lipoproteínas de muito baixa densidade e da qualidade do sono dos idosos.
Palavras-chave: Exercício físico; Marcadores de sangue; Qualidade do sono.

Introduction

The population of elderly individuals has been increasing in the developing countries over the last few decades. Brazil is among those countries that will contribute a substantial portion to this increase. According to the statistics of the World Health Organization (WHO)[1] as well as the Brazilian Institute of Geography and Statistics,[2] estimates are that between 1950 and 2030, the population of the elderly will grow by approximately 7.5% to around 15%, the same as in European countries. By 2050, the estimate is that there will be more elderly than children under the age of 15 years, ranking Brazil sixth in the world.

Aging is associated with a nonlinear decline in the osseous and muscular system due to osteopenia and sarcopenia, which will probably lead to a decrease in functional autonomy.[3] This will impact directly on the cardiovascular system, being one of the several factors that predispose to chronic no communicable diseases (CNCD) associated with smoking, excessive alcohol consumption, physical inactivity, unhealthy diet, and social determinants such as; schooling, income, food and employment.[4]

The WHO estimates indicate that CNCDs are one of the greatest public health problems today, accounting for 63% of the 36 million deaths worldwide in 2008.[5] In Brazil also, CNCDs are prevalent, accounting for 72% of all deaths in 2007, mainly circulatory diseases (31.3% of deaths), neoplasias (16.3%), and diabetes (5.2%).[6]

The aging process causes a decrease and fractionation of sleeping hours, impacting the sleep quality of the elderly and generating chronic health sequel, thereby, becoming an endemic condition in the modern society. Research has indicated that poor quality and duration of sleep are associated with worsening of cardiovascular diseases (CVD), and are related to a number of independent risk factors such as systemic arterial hypertension, diabetes mellitus, and obesity.[7] Insomnia exerts deleterious effects on sleep modulating function, impacting on glucose metabolism, molecular mechanisms, physiological stress, immunity, and the interaction between sleep and eating.[8] The regular practice of physical activity of mild to moderate intensity has been shown to be an important regulator of the quantity and quality of sleep, mainly in the elderly.[9]

Thus, the objective of the present study was to analyze the effects of a physical exercise program on blood markers and sleep quality in the elderly attending the health service of an Elderly clinic.

Methods

Sample

The sample consisted of 112 elderly patients with hypercholesterolemia and diabetes mellitus diagnosed clinically and controlled by hypocholesterolemic and hypoglycemic medications. All the volunteers were enrolled into the program of physical activity called “Elderly in Movement”, an institutionalized project of the clinic of the elderly of the single health service, of the city of Lauro de Freitas, Bahia, Brazil. The exclusion criteria were: a) presence of severe congestive heart or respiratory insufficiency; b) those who would attend less than 75% of the program; c) those participating in another physical activity program; and d) those less than 55 years of age.

All the subjects were informed about the study, and they provided their signed written informed consent in accordance with the resolution 466/2012 of the National Commission of Ethics in Research of the National Health Council in agreement with the ethical principles expressed in the Declaration of Helsinki (1964, restated in 1975, 1983, 1989, 1996, 2000, 2008, and 2013) of the World Medical Association. Approved by ethics committee with number partnership 69319717.0.0000.5546.

Experimental design

After the steps mentioned (figure 1), the subjects were randomly divided (by lot) into two groups: 54 subjects in the exercise group (EG) and 58 in the control group (CG). Their characteristics are described in table 1.

A digital scale of the Toledo® brand (Toledo, Brazil) was used to determine the body mass measurements with a coupled stadiometer with a capacity of 0–150 kg and an accuracy of 0.05 kg. The body mass index (BMI) (Quételet, 1835, adopted by World Health Organization (WHO), was calculated by the mathematical relation body mass (Kg)/height (m^2).[10]

The metabolic parameters were requested by the medical professional or nurse of the clinic for the elderly following 12 h of fasting to determine the levels of total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), fasting glucose, and calcium. The blood samples were collected by a laboratory technician from Lauro de Freitas Central Laboratory, Bahia, Brazil, on the scheduled days in the clinic of the Elderly.

Procedures						
Pre test Medical release	→	Familiarization	→	Pre test (blood collection, anthropometry, Sleep Questionnaire)		
Intervention (16 weeks)		(3 x per week) Experimental Group (n = 54) Control group (n = 58)	→	Procedures Warm  Walking, Stretching exercises and balance exercises	→	Recovery
Posttest	→	Experimental Group (n = 54) Control group (n = 58)	→	Pre test (blood collection, anthropometry, Sleep Questionnaire)		

Figure 1. Experimental design - Weekly training schedule

Table 1. Physical characteristics of the sample

	Experimental Group	Control Group
Age	62.11±10.89	63.03±10.78
Weight (kg)	70.73±13.56	70.03±14.12
Height (m)	1.55±0.09	1.57±0.10
Body mass index (kg/m^2)	29.86±5.85	28.43±5.74
Gender ♂(%)/♀(%)	14(26)/40(74)	15(26)/9(74)

The Pittsburgh Sleep Quality Index Questionnaire (PSQI) evaluates sleep quality and disturbances during a period of one month and was developed by Buysse et al.[11] as a standardized questionnaire, simple and well accepted by patients. The instrument consists of 19 self-report questions and five questions directed to the spouse or room companion. The last five questions are only used for clinical practice, not contributing to the overall score of the index. The 19 questions are categorized into seven components, the scores graded from zero (no difficulty) to three (severe difficulty). The components of PSQI are C1, subjective sleep quality; C2, sleep latency; C3, sleep duration; C4, usual sleep efficiency; C5, sleep disturbances; C6, sleep medication; and C7, sleep diurnal dysfunction. The sum of the values assigned to the seven components ranges from 0 to 21, with higher the score, worse the quality of sleep. A total score greater than 5 indicates that the individual is experiencing major dysfunctions in at least two components or moderate dysfunction in at least three components.

The CG performed their normal daily duties throughout the study period. The participants in this study agreed not to make any systematic changes in physical combined activity or work combined activities during the 16 weeks of the experiment until the completion of the post-test. The EG underwent 16 weeks of exercise training consisting of walking, stretching exercises, and balance exercises. The classes were held three times per week on alternate days, always at the same time and lasting 60–70 min. Each session consisted of a 5-min "fun" warm-up with low-intensity activities. The warm-up was followed by a 15-min workout of static and passive stretching, with the stimulus 10–15s at each movement. The stretching consisted of three sets involving alternating half of the body for every movement with an interval of 30 s between movements. The stretching exercise was followed by five minutes of exercises and static balances on the ground. The 15 min of resistance exercise consisted of two sets of 12 repetitions at moderate intensity using dumbbells and resistance bands. The resistance exercise was followed by 25 min of aerobic exercise consisting of a moderate-intensity walk and recovery. To control the intensity of the exercise, the OMNI-RES was used, and all personnel were properly trained and familiar with the goal of 3–5 intensity level for this study. The OMNI-RES scale presents illustrations with weight-lifting for the individual to make associations with ratings of perceived exertion.[12]

Statistical analysis

Descriptive statistics were applied with measures of central tendency (mean ± standard deviation) and the normality of the variables verified through the Shapiro-Wilk test, considering the sample size. Sphericity was ensured by the Mauchly's test. To verify the variations in the domains, ANOVA (two way) with Bonferroni post hoc test was performed. The significance level adopted was $p \leq 0.05$. In order to verify the size of the effect, the values of eta (μp2) were used, adopting low effect values (0.1 and 0.24), mean effect (0.25 and 0.39), and high effect (greater than 0.40). The program used for data processing was SPSS version 20.0.

Results

The results of the exercise and control groups in the period before and after the 16 weeks of intervention are shown in table 2.

Blood glucose, total cholesterol, and triglyceride levels showed a mean reduction of 27.47, 18.13, and 23.48 mg/dl, respectively. On the other hand, there was an increase of 8.98 mg/dl in the HDL levels, representing beneficial changes in the health condition of the studied population. However, the result was not significant, enter groups and moments.

The variables LDL, VLDL, and calcium presented significant changes when comparing the data of the post-test EG and pre-test CG with a significance of $p < 0.004$, $p < 0.016$, and $p < 0.001$ and effect μp2=0.77, 0.49, and 0.35, respectively.

The mean PSQI scores showed a reduction of 3.15 ($p < 0.001$, μp2=0.78) on comparing the post-test EG with post-test CG. The EG reduced its score keeping the same classification, while the CG showed a worsening of the score in the post-test period, and according to the classification, showed the presence of sleep disorder.

The blood kinetics (glycemia, total cholesterol, HDL, LDL, VLDL, triglyceride, calcium and quality of sleep) are shown in figure 2.

Discussion

The objective of the present study was to analyze the effects of a physical exercise program on blood markers and sleep quality in the elderly. It was observed that the EG improved in all variables, glycemia, total cholesterol, triglycerides, HDL, LDL, VLDL, calcium, and sleep, compared with the CG. A significant difference was seen in the LDL, VLDL, and calcium levels and sleep quality pre- and post-intervention.

Table 2. Blood Glucose, Total Cholesterol, High-density lipoprotein, Low-density lipoprotein, Very-low-density lipoprotein, Triglycerides, Calcium and Sleep quality (mean ± standard deviation) $p < 0.05$ and f2 after exercise protocol intervention.

	Pre test EG	Post-test EG	Pre test CG	*Post-test CG*	*P*	*μp2*
Blood Glucose	123.40±38.01	112.22±32.26	139.69±35.03	123.88±31.11	0.177	0.197[a]
Cholesterol	211.56±44.69	195.59±30.43	213.72±37.18	200.57±18.36	0.961	0.020
Triglycerides	132.18±45.05	121.41±26.47	144.89±44.56	127.59±22.67	0.416	0.012
HDL Cholesterol	59.43±17.00	64.72±16.42	55.74±19.06	52.97±11.07	0.664	0.023
LDL Cholesterol	134.08±43.56	106.16±26.50*	137.22±37.61	121.90±30.47	0.004	0.771[c]
VLDL Cholesterol	48.58±14.61	29.24±17.68*	46.20±14.72	39.56±15.02	0.016	0.492[c]
Calcium	14.51±1.81	9.04±0.38*	11.16±1.17	10.91±1.90	0.004	0.352[b]
Sleep quality	8.91±2.29	7.35±1.92*	8.83±1.58	10.50±2.66	<0.001	0.781[c]

HDL: High-density lipoprotein; LDL: Low-density lipoprotein; VLDL:Very-low-density lipoprotein; *= $p < 0.05$ (ANOVA two way, Bonferroni Post Hoc); a: low effect (0.1 and 0.24); b: mean effect (0.25 and 0.39); c: high effect (greater than 0.40); EG: Experimental group; CG: Control group.

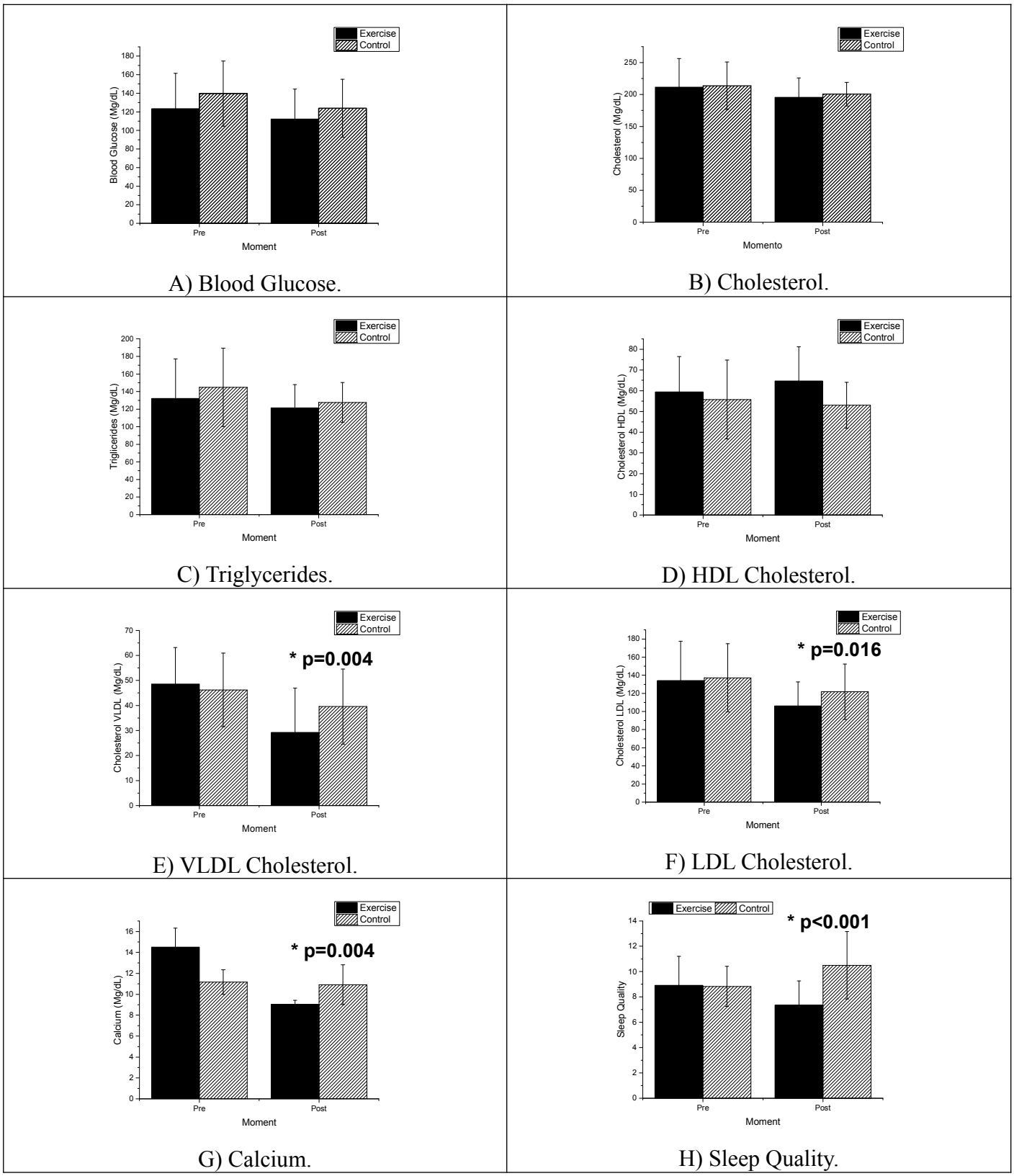

Figure 2. Pre and post-test Blood Glucose (A); Cholesterol (B); Triglycerides (C); HDL Cholesterol (D); VLDL Cholesterol (E); LDL Cholesterol (F); Calcium (G); Sleep quality (H) in both groups.

The blood glucose levels showed a decrease after four months of intervention, although not statistically significant, demonstrating a possible increase in the effect with a longer intervention time. These findings corroborate with[13] in that we found a reduction in the blood glucose levels as reflected by the HbA1c values (p = 0.0001) for the elderly who performed mild intensity physical exercise.

The evaluation time of the elderly (16 weeks) was an important factor in this intervention in the reduction of glycemia, corroborating with an intervention study which showed a monthly decline in HbA1c of 0.7 mmol/mol during the first six months of the intervention.[14] Patients with diabetes were divided into groups that underwent gymnastics and walking for six months. A reduction in the fasting blood glucose was seen in both the groups,

gymnastics (p = 0.01) and walking (p = 0.008). Also, a decrease in the insulin resistance was seen in the gymnastics (p = 0.01) and walking group (p = 0.001).[13]

Those with mean total cholesterol, triglyceride, and HDL levels of 195.59, 121.41, and 64.72 mg/dl, respectively, had the same glycemia behavior, showing a slight decrease after four months of intervention, as has been seen in other similar studies. A six month study involving moderate physical activity showed a significant reduction in the HDL (p = 0.0001), triglycerides (p = 0.49), and total cholesterol levels (p = 0.009).[13] Patients with metabolic syndrome and deranged lipid profile who were divided into groups that performed gymnastics and walking for six months obtained a reduction in the total cholesterol (p = 0.001) and triglycerides (p = 0.001) in the former and only in the total cholesterol levels (p = 0.04) in the latter group.[15] A significant reduction was also seen in the LDL (p < 0.004, μp2=0.77) and VLDL levels (p < 0.016, μp2=0.49) during the intervention period.

Other study with longer intervention time have showed the efficacy of exercise on total cholesterol (−31.86 ± 4.2 mg/dl, p = 0.012), HDL-c (−11.14 ± 0.9 mg/dl, p = 0.008), HDL (8 ± 0.9 mg/dL), triglycerides (−12.3 ± 1.0 mg/dL), and glucose (−6.9 ± 2.9 mg/dL).[16] In the present study, the total and LDL cholesterol levels decreased significantly with physical training (p < 0.01). HDL, an important marker of cardiovascular disease incidence, also significantly reduced (from 3.91 ± 0.91–3.60 ± 0.74, p < 0.01) after the physical exercise program. In menopausal women who performed physical activity for 15 weeks, the triglycerides decreased (7.4%, p < 0.05) and HDL-C increased (4.6%, p < 0.05) significantly in the EG compared with that in the CG.[17]

A reduction was seen in the calcium levels (p < 0.004, μp2=0.35), but this remained within the acceptable values which may be associated with a calcium absorption, important for the population that has a mean age of 62 years, representing a protective effect against osteoporosis. A study in elderly women with low bone mass who performed strength exercise for four months showed a correlation between the manual muscle strength and femoral neck bone mineral density (r = 0.582, p = 0.003) and total femur BMD (r = 0.485, p = 0.01).[18] Resistance training or jumping exercise is also an effective way to increase bone mineral density in men with low bone mass as shown by a randomized 12-month clinical trial.[19]

Regarding sleep quality, the present study showed that the regular practice of exercise by the EG was able to reduce the average PSQI score of the participants by 3.15 compared with the control. The results of the present study corroborate with that of another study[20] which showed that the practice of walking managed to change the classification from bad to good in the EG and observed that increased physical activity time during leisure in the EG produced positive results in relation to subjective quality of sleep (p < 0.001, μp2=0.78), complementing with the findings that the regular practice of physical activity contributes to the improvement of sleep quality.

In view of the results obtained in this study, it can be concluded that the physical exercise program, consisting of supervised walking and gymnastics with localized quadriceps muscle strengthening exercises, performed for 16 weeks at a frequency of three times a week lasting 60 min, was effective in improving the LDL and VLDL levels, and sleep quality. Also, a reduction in the glycemia, total cholesterol, and HDL values in the elderly with dyslipidemias and metabolic diseases who participated in the training was seen.

Authotship. All the authors have intellectually contributed to the development of the study, assume responsibility for its content and also agree with the definitive version of the article. **Conflicts of interest.** The author have no conflicts of interest to declare. **Provenance and peer review.** Not commissioned; externally peer reviewed. **Ethical Responsabilities.** *Protection of individuals and animals:* The authors declare that the conducted procedures met the ethical standards of the responsible committee on human experimentation of the World Medical Association and the Declaration of Helsinki. *Confidentiality:* The authors are responsible for following the protocols established by their respective healthcare centers for accessing data from medical records for performing this type of publication in order to conduct research/dissemination for the community. *Privacy:* The authors declare no patient data appear in this article.

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