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Original Article

EFFECT OF 12 WEEKS OF RECREATIONAL SOCCER ON BONE MINERAL DENSITY AND SARCOPENIA IN THE ELDERLY: A RANDOMIZED CLINICAL TRIAL

EFEITO DE 12 SEMANAS DO FUTEBOL RECREATIVO NA DENSIDADE MINERAL ÓSSEA E NA SARCOPENIA EM IDOSOS: UM ENSAIO CLÍNICO RANDOMIZADO

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RESUMO

Objetivo: Verificar o efeito do futebol recreativo na densidade mineral óssea e sarcopenia dos idosos. Métodos: Foram selecionados quatorze idosos com idade de 65,9±3,4 anos. Os indivíduos foram separados em dois grupos: grupo intervenção e grupo controle, o grupo intervenção praticou futebol recreativo durante 12 semanas em dois dias da semana. Foram feitas avaliações para densidade mineral óssea e massa muscular corporal no período anterior e sucessor as intervenções. Para a análise estatística, foi utilizada a anova de medidas repetidas com o post-hoc de Bonferroni. Resultados: Após 12 semanas, ocorreu alteração significativa na densidade mineral óssea na região do fêmur total (p=0,020). Já na análise da sarcopenia dos participantes não houveram resultados significativos após o período de intervenção. Conclusão: Praticar futebol recreativo provoca melhora significativa no fêmur total e manutenção dos sítios ósseos da coluna, corpo inteiro e colo do fêmur. Além disso, promove afastamento da zona limítrofe para rastreio de sarcopenia nos idosos.

Palavras-chave: Exercício. Idosos. Densidade Óssea. Sarcopenia. Futebol.

ABSTRACT

Objective: To verify the effect of recreational soccer on bone mineral density and sarcopenia in the elderly. Methods: Fourteen elderly people aged 65.9 ± 3.4 years were selected. They were separated into two groups: the intervention group and the control group; the intervention group played recreational soccer for 12 weeks on two days of the week. Assessments were performed for bone mineral density and body muscle mass before and after the intervention. For statistical analysis, the repeated measures ANOVA with Bonferroni's *post hoc* test was used. Results: After 12 weeks, there was a significant change in bone mineral density in the region of the total femur (p = 0.020). Analyzing the participants' sarcopenia, no significant results were found after the intervention period. Conclusion: Playing recreational soccer causes a significant improvement in the total femur and maintains bone regions in the spine, whole body, and femoral neck. Also, it promotes a removal from the threshold for sarcopenia screening in the elderly.

Keywords: Exercise. The elderly. Bone Density. Sarcopenia. Soccer.

Introduction

With aging, several changes take place in our body, including decreased bone mineral density (BMD), decreased balance, slower walking, decreased muscle strength, change in adipose tissue, increased fat mass, and loss of muscle mass[1]. Individually, each one of these modifications can lead to major weakness, but they can also interrelate, causing more severe sequels.

Decreased gait speed, for instance, increases the possibility of falls, and when related to decreased strength and increased fat mass, especially in the lower limbs, it can be indicative of severe sarcopenia[2]. Another condition linked to increased fat mass concurrently with decreased BMD is the ability to cause osteoporosis[3]. For the elderly who already have gone through several changes, these situations cause greater damage to their physical health, lowering their functional capacity, impairing their quality of life, generating a greater possibility of fracture and a frailty profile, thus resulting in a higher chance of mortality[4].

In this sense, physiological factors, food consumption and physical inactivity can intensify changes in body composition and degree of sarcopenia[5], which makes engagement in

physical exercises an alternative to bring about changes in both body composition and sarcopenia[6]. Among the types of physical exercise, playing recreational soccer emerges as a possibility of intervention, as it is characterized as an activity of a lower energy expenditure assimilation compared to conventional soccer, promotes intrinsic motivation among members, and is played with a large amount of people and a game size smaller than that of the official one[7].

Recent review studies suggest that recreational soccer has a major positive impact on osteogenesis in premenopausal women[8,9]. Other clinical trials show significant results both in middle-aged adults[10] and in the elderly population, reporting BMD maintenance[11], but with a four-month intervention period. Regarding sarcopenia, despite studies showing that recreational soccer causes hypertrophy and improves muscle strength in the elderly population[12,13], factors that minimize or delay sarcorpenia[2], data on the direct benefit of soccer on sarcopenia are still unknown. Thus, the purpose of the present study is to investigate the effects of playing recreational soccer for twelve weeks on BMD and on the cutoff levels for sarcopenia classification in the elderly.

Methods

Participants and recruitment

This is a non-probabilistic randomized clinical trial approved by the ethics committee of Health Sciences Center of the Federal University of Pernambuco (UFPE) with Opinion Nº. 2.337.267 and registered with the Brazilian Clinical Trials Registry [*Registro Brasileiro de Ensaios Clínicos*] (ReBEC), Nº. U1111-1198-0770. The research was conducted at Department of Physical Education from UFPE between July and December 2018. To select the sample, posts were published on social networks, leaflets were handed out, and advertisements were posted in community centers. Elderly people with the following characteristics were selected for the study: being insufficiently active, in accordance with the GPAQ[14] questionnaire; being aged between 60 to 79 years old, of both sexes; being literate; not having an absolute contraindication to exercising, in accordance with the norms of the American College of Sports Medicine[15]; residing in the community; self-declaring as healthy or having controlled hypertension (with measured and certified systole and diastole values below 130 mmHg and 90 mmHg, respectively), as long as it is not caused by drugs of the beta-blocker group and direct-acting vasodilators, both individually and concomitantly. The exclusion criterion was being on medication for osteoporosis control.

Twenty-four elderly individuals accepted to participate in the research, after signing the Free and Informed Consent Form (FICF); in compliance with the standards of resolution 466/2012, they completed an anamnesis and the PARQ+[16] questionnaire for risk stratification, then had their physical assessment scheduled. Before the tests, they were separated into an intervention group (IG) and a control group (CG), divided by randomization in a 1:1 circumstance through the address www.random.org. The final analysis included those participants who attended the pre- and post-intervention assessment and who reached at least 75% attendance in the IG. Figure 1 summarizes the inclusion and follow-up process of the study.

After the research participants had their assessments performed, the use of the session Rating of Perceived Exertion (RPE) was demonstrated for them to become familiar with the scale.

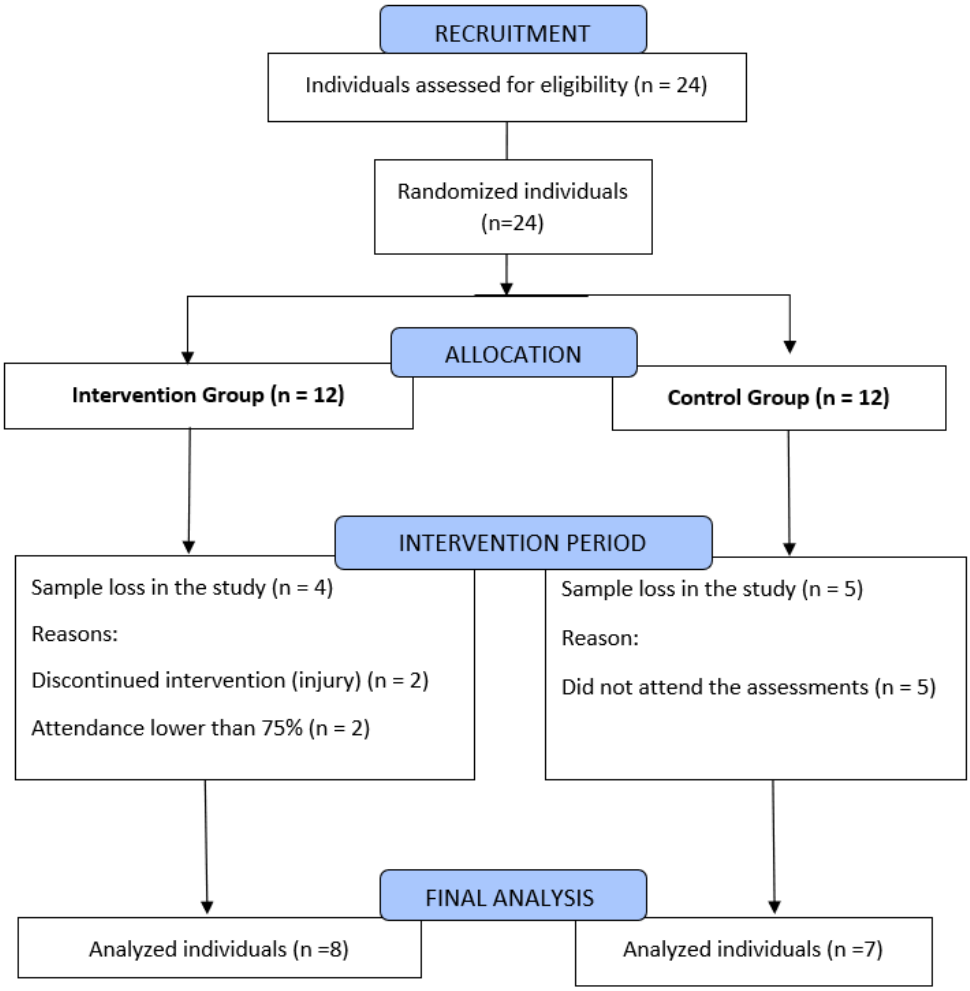

Figure 1. Flowchart of the elderly participating in the study
Source: The authors

Intervention

The Recreational soccer intervention was carried out over twelve weeks, as presented by Reddy et al.[17]. The sessions took place twice (Tuesdays and Fridays) in the morning, in a multi-sports cement court, completing a minimum interval of 48 hours. The sessions were designed with a ten-minute warm-up of the main muscle groups (flexion/extension of the trunk, hip, knee and ankle, arm and forearm; adduction/abduction of the shoulder and hip; circumduction of the hip and shoulder; and alternating running with walking), forty minutes of recreational soccer in reduced size (played in two halves of twenty minutes, with a five-minute break), composed of teams of at least 3x3 and ten minutes of stretching for the same groups worked on at the beginning of the intervention. All sessions were supervised by a physical education professional. The delimited area for the game was defined based on the number of individuals present in the activity, with this being a space of 80m² per individual, that is, 3x3 with a space of 15.5×31m and 20×40m for 5x5, that is, when there were six individuals, a 3x3 game was played, and when there were ten individuals present, soccer was played as 5x5, but when there was an odd number, one of the teams would have one more individual in each period.

For the soccer matches, the teams were selected by the female participant present in the session; when she was absent, the teams would be chosen by two individuals selected by the physical education professional who monitored the activity and played the role of referee. For

the activity, the goal area was delimited by two 50-centimeter cones set 60 centimeters apart. All participants wore appropriate clothing for playing soccer (sneakers, shorts and t-shirt).

Thirty minutes after the end of the activity, the Rating of Perceived Exertion (RPE) was collected as a way to monitor the intensity of the intervention. To determine the RPE, the session RPE[18] was applied. For the CG, throughout the twelve weeks, motivating text messages were sent out weekly to prevent sedentary behavior.

Test procedures

All participants who met the inclusion criteria were assessed, and all analyses complied with the guidelines for handling the equipment used and the tests performed. Measures were collected one week before the first intervention session and, then, one week after the last session. All assessments happened on the same day, after prior scheduling.

The body fat percentage, lean mass percentage, fat mass percentage and BMD of the whole body, total femur, femoral neck and spine were assessed using dual-energy x-ray absorptiometry (DXA)19, Lunar Prodigy – GE.

To assess aerobic capacity, the Senior Fitness Test stationary gait assessment[20] was applied. This evaluation asks the participant to perform a stationary gait for two minutes as fast as possible. The collected measure was obtained from the number of times the individual was able to complete a double stride.

To monitor intensity, the Rating of Perceived Exertion (RPE) was used in each session. To examine the RPE, the session RPE[18] was employed.

To verify the presence of sarcopenia, Baumgartner's formula[21] was used: muscle mass index (MMI) = sum of the lean mass of the lower and upper limbs (in kg) divided by the height squared (in meters), which has as reference values: man = 7.26 Kg/m^2, and woman = 5.45 Kg/m^2.

Statistical analysis

The analyses were run using the Statistical Package for Social Sciences (SPSS), version 25.0. Descriptive statistics were used to characterize the sample, and the results are presented as mean and standard deviation (SD). For data normality assumption, the asymmetry of each group was analyzed separately; subsequently the two-way ANOVA test was applied to assess inter- and intra-group differences. To verify differences between groups, Bonferroni's test was used as a *post hoc* analysis. A p value ≤ 0.05 was accepted as significant.

Results

Twenty-four elderly individuals (18 men and 6 women) started the study, but fourteen (IG: 6 men and 1 women; CG: 4 men and 3 women), with a mean age of 65.9±3.4 years old, completed the research, meeting the inclusion criteria. After the twelve weeks, no significant differences were found as to anthropometric variables and aerobic capacity between or within groups (Table 1).

Table 1. Anthropometric characteristics and aerobic capacity of the sample before and after the 12 weeks of intervention (mean ± standard deviation)

	Control group		Intervention group		
Variable	Pre-test	Post-test	Pre-test	Post-test	*p-value*
Body mass (kg)	75.8±14.5	76.6±15.1	78.7±16.7	78.7±16.8	0.279
BMI#	28.0±3.3	28.3±3.6	25.9±4.1	25.9±4.1	0.232
Height (cm)	164±14.0	164±14.0	173±8.5	173±8.5	0.154
Aerobic Capacity (rep)	98.8±19.9	95.7±20.7	94.3±19.5	99.8±17.3	0.298

Note: #: Body Mass Index; M - Man; W - Woman; (Rep): repetitions
Source: The authors

However, there were significant changes in BMD in the region of the total femur with an effect on the time*group interaction [F(1,12) = 7.252; p = 0.020] together with its respective T-score [F(1,12) = 6.773; p = 0.023], where Bonferroni's post-hoc identified a 1.63% increase in the total femur BMD (p = 0.020) and its T-score (p=0.035) in the IG when the initial values were observed. For the other bone regions analyzed, spine ([F(1,12) = 1.561;p = 0.235], femoral neck [F(1,12) = 1.103; p = 0.314] and whole body [F(1,12) = 1.835; p = 0.20] showed no significant differences.

Analyzing the participants' sarcopenia [F(1,12) = 0.898; p = 0.362], no significant results were found after the intervention period (Table 2). When a descriptive analysis was performed by sex among the sarcopenia levels, both sexes in the IG distanced themselves from the threshold for sarcopenia screening, male = 7.26 kg/m^2 and female = 5.45 kg/m^2.

Table 2. Comparison of results between the intervention and control groups during the intervention period

Variable	Control group			Intervention group		
	Pre-test	Post-test	*ES*	Pre-test	Post-test	*ES*
Bone Mineral Density						
Spine (g/cm^2)	1.199±0.22	1.195±0.22	0.01	1.278±0.26	1.329±0.25	0.19
Femoral neck (g/cm^2)	0.926±0.20	0.933±0.20	0.03	1.102±0.20	1.094±0.19	0.04
Whole body (g/cm^2)	1.183±0.19	1.182±0.19	0.00	1.279±0.13	1.289±0.15	0.07
Total femur (g/cm^2)	1.032±0.21	1.025±0.21	0.03	1.120±0.21	1.138±0.20*#	0.08
Sarcopenia						
Muscle Mass Index (Kg/m^2)	7.95±1.55	7.86±1.60	0.05	7.15±0.98	7.22±0.85	0.07
MMI						
Male	7.33±1.57	7.27±1.81	0.03	7.19±1.07	7.23±0.93	0.03
Female	8.78±1.31	8.66±1.07	0.10	6.96±0.0	7.18±0,0	-$

Note: *: Pre- and post-test difference; #: difference between groups; p ≤ 0.05 ES: Effect size (Cohen's d); $: No result as there is 1 woman in the intervention group.
Source: The authors

The overall mean of the RPE reported by the participants after each intervention session was 4.26±1.17 (rated between moderate and not very difficult), on a scale from 0 to 10.

Discussion

The objective of this study was to analyze the effect of a twelve-week recreational soccer program on BMD and on sarcopenia levels in elderly individuals living in the community.

Regarding the sample's baseline data, no difference was found for age, BMI, height and body mass between the groups. These data are similar to those mentioned in other studies with elderly Brazilians[22,23]. However, for gender, this study was mostly made up of male individuals, unlike what is presented in other studies; this is explained by the fact that this sport is predominantly played by men[24].

As for physical performance, there were no significant differences, either between or within groups, between the pre- and post-intervention period. These results are similar to those of another study[12] with the same protocol and intervention length. On the other hand, Milanovic et al.[25] pointed out, in their review article, that recreational soccer promotes changes in VO_2max, provided that the heart rate reserve is at least 75%, that is, of a moderate to high intensity. Because in the present study the intensity reported by the IG was moderate to low, it is possible that it was not enough to bring about significant changes in VO_2max.

As for bone regions, the femoral neck, lumbar spine and whole body BMD did not show significant differences after the intervention period. In studies that assessed BMD in elderly people playing recreational soccer, only Sousa et al.[26] reported changes in the whole body over twelve weeks, but, in addition to the elderly, the sample was composed of middle-aged adults, as well as a protocol that included a diet prescription. When the sample was made up of elderly people only, the changes in BMD appeared after one year of intervention in the femoral neck, and there were no changes in the whole body[27]. Although there were no significant changes in the BMD of these bone regions, it is possible to highlight that even maintaining BMD after the intervention is an important aspect, as there is an average decrease in bone mass of 0.4% per year after the acquisition of its maximum value[28].

A decrease in BMD can impact the amount of bone fractures; only in the US, about 2 million bone fractures happen every year[29], resulting in negative consequences for the individual's life, since one in three men experiences a new hip fracture, and another dies within a year after a fracture[30]. Thus, BMD maintenance and/or improvement in this age group becomes a protective factor against fractures, osteopenia or osteoporosis.

In the present study, mean values for total femur BMD had a significant increase of 1.63% (1.120±0.21 to 1.138±0.20 g/cm^2) in three months of intervention. Apparently, recreational soccer has a primary osteogenic action on total femur BMD, as Helge et al.[27] also found significant increases of 1%±0.5% and 2.9%±0.7% in total femur BMD after 4 and 12 months of recreational soccer, respectively. It is possible that this result is related to the kinesiology of the kick, which involves movements that use the quadriceps femoris, tensor fascia latae and iliopsoas muscles, which have insertion in the femoral area[31]. Another relevant factor involves the profile of the recreational soccer game because, since the actions performed have an unpredictable character, unlike those of a walk, in which the activity has a relative systematization, the skeletal system does not lose its mechanosensitivity because there are no repeated movements and, when this happens, the bone is desensitized through recurrent stimuli[32].

With regard to sarcopenia, there were no significant changes between the measures before and after the intervention. However, the IG participants distanced themselves from the sarcopenia zone. For men, although they are still in the sarcopenia zone, they were closer to the threshold value of 7.26 kg/m^2 (going from 7.19 to 7.23 kg/m^2, an increase of 0.55%); as for females, the distance from the threshold value rose to 5.45 kg/m^2 (6.96 to 7.18 kg/m^2, an increase of 4.04%). For this variable, resistance physical exercise, except when using elastic bands[33], has better results compared to aerobic physical exercise, but performing the latter can also be effective at reducing oxidative stress and increasing mitochondrial energy[34]. In the studies by Yamada et al.[35] and Brightwell et al.[36], when aerobic physical exercise was used, significant results were found after six months of intervention. Furthermore, in the study by Brighwell et al.[36], an intensity of 70% heart rate reserve (HRR) was used. Because the present

study lasted 3 months and found some distancing from the sarcopenia-risk zones, it is possible that low-intensity recreational soccer can be effective after a longer period of practice (6 months) or, when using an intensity of 70% HRR, can promote changes in a shorter period of time. Thus, further studies in this field are needed to verify the occurrence of these facts.

This study has some limitation, namely, the sample was considered small, but losses were taken into account, as it is has been documented that half of the elderly who engage in a physical exercise program quit in six months[37].

Conclusions

The main finding of this clinical trial with elderly people playing recreational soccer is that there was a significant change in femoral BMD after 12 weeks of training. Additionally, for the analysis of sarcopenia, we observed some distancing from the threshold values for its classification. For this variable, a longer intervention time seems to be necessary to bring about changes. These data can add relevant information to the current body of knowledge.

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