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ORIGINAL ARTICLE

12 weeks of Brazilian jiu-jitsu training improves functional fitness in elderly men

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Abstract Worldwide, there are up to 900 million people over 60 years old, of which more than half are physically inactive. Low physical fitness seems to be the major risk factor for cardiovascular diseases and mortality in this population. Alternative methods of exercise, such as martial arts, may be an option to improve physical fitness in the elderly. This study aimed to verify the effects of Brazilian jiu-jitsu (BJJ) training on the functional fitness of elderly men. Sixty-two elderly men were divided in two groups (experimental and control). The experimental group was submitted to a 12-week intervention of BJJ (2 times week^{-1}; 90-min session^{-1}). Physical fitness tests and anthropometric measurements were performed before and after intervention in both groups. No statistical differences were found between groups before and after the intervention. The experimental group improved in all performed physical fitness tests. Effect size showed that intervention had a small effect on upper body flexibility; a moderate effect for upper body strength, lower body flexibility, and motor agility/dynamic balance; and a large effect on lower body strength and aerobic endurance. BJJ seems to improve functional fitness in elderly men and may be an alternative method to enhance this population's health and quality of life.

Keywords Physical fitness · Older men · Martial arts · Fighting sports

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Introduction

Worldwide, there are up to 900 million people over 60 years old [1], of which more than half are physically inactive [2]. This situation may at least partly explain the elevated number of elderly affected by diseases associated with a sedentary lifestyle, such as hypertension [3], type 2 diabetes [4], and osteoporosis [5]. Furthermore, low physical fitness seems to be the major risk factor for cardiovascular diseases and all causes of mortality [6].

Moreover, approximately 30–60 % of community-dwelling older adults fall each year [7], which may be a consequence of low physical fitness [8]. On the other hand, studies have shown that exercise can improve the functional ability of the elderly population, mitigating the deleterious effects of aging [9, 10].

However, formal exercise programs (aerobic and resistance) still have a high frequency of nonadherents (~40 %), and lack of motivation is one of the main reasons [11]. Thus, alternative methods of exercise, such as martial arts (MA), may be an option, since they promote an important social-interaction environment and create a motivating and consistent atmosphere [12, 13]. Nevertheless, many forms of MA may be unfeasible for the elderly, due to MA's elevated technique and physical and physiological demands [14, 15]. Brazilian jiu-jitsu (BJJ)—a short-distance, noncollision combat sport that uses the knowledge of the human body's lever system o make projections,

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immobilizations, and disarticulations and requires high levels of technique rather than physical effort [16]—may be a suitable modality for older people.

In addition, BJJ has over 12 million practitioners worldwide and has become more popular over the past few years [17], which demonstrates the high impact that it can have on public health. Thus, BJJ has proven to increase maximal strength in beginners [18] and may also be effective in improving other physical components and, consequently, functional fitness. The physical profile of BJJ fighters seems to match with other modalities, such as judo and wrestling [19]. However, unlike BJJ, these MA are characterized by physical and ground collisions, which may increase the risk of trauma in its adherents with low physical fitness, such as the elderly.

Nevertheless, to the best of our knowledge, there are no reports in the literature on BJJ training's effects on elderly functional fitness. Therefore, the aim of the present study is to verify the effects of BJJ training on the elderly's functional fitness. It was hypothesized that BJJ training could improve the functional fitness of elderly men.

Materials and methods

Sample

After receiving approval from the Ethics Committee for Human Research and obtaining written informed consent from the volunteers, 62 elderly men participated in the study. All subjects were non-institutionalized, and aged between 60 and 80 years old. Exclusion criteria for participation in this study included: (1) previous diagnosis of cardiometabolic diseases; (2) regular use of drugs that may directly affect the results; (3) bone, muscle, and joint impairments and; (4) less than 80 % attendance at the training sessions. All procedures were carried out according to Resolution 466/2012 of the Brazilian National Health Council and the Declaration of Helsinki for experiments to be conducted on humans.

General procedures

Prior to physical tests, subjects were submitted to anthropometric measurements and were randomly divided in two groups: experimental (EG) and control (CG). Training sessions occurred at least 48 h apart and always during the morning.

Both groups underwent physical tests to assess their levels of functional fitness prior to and 1 day after the last intervention session. The protocol used was developed by Rikli and Jones [20]. A scoring protocol was used on the battery tests, which measured (1) lower body strength (30 s chair stand), (2) upper body strength (arm curl), (3) lower body flexibility (chair sit-and-reach), (4) upper body flexibility (back scratch), (5) aerobic endurance (6 min walk), and (6) motor agility/dynamic balance (8 ft. up-and-go). All procedures were carried out as originally described [20].

The treatment intervention consisted of applying BJJ training for 12 weeks, twice a week. Each 90 min session^{-1} was divided into (a) 5 min of initial stretching, 20 min of warm-up with active stretching, and strength exercises; (b) 3 min of recovery and rehydration (water only); (c) 50 min of BJJ training that included unbalancing (e.g., takedowns and throws), submissions, positions adequate for the skill level of the participants (beginners), and self-defense techniques; and (d) 10 min of stretching for cooldown and relaxation. During the 12-week intervention period, the subjects in the CG were instructed not to perform any type of exercise until the end of the experiment.

Statistical analysis

A priori statistical power >95 % was calculated for the study, considering the statistical model used (split-plot ANOVA), an effect size of $f = 0.25$, two groups, two moments (pre- and postintervention), and $\alpha = 0.05$. After assessing the normality and homogeneity of data through the Shapiro–Wilk and Levene tests, respectively, the data were presented as mean ± standard deviation. In order to compare the characteristics of the groups, the Student's t test for independent samples was applied. Between- and within-group comparisons were carried out using split-plot ANOVA (mixed ANOVA). When any of the dependent variables did not show sphericity in Mauchly's test, the epsilon of Greenhouse–Geisser was used to analyze the F statistic. Since there were only two groups, the post hoc was unable to locate the differences; therefore, it was necessary to apply a parallel test known as pairwise comparisons. The paired Student's t test was used to compare the values at baseline and after the intervention period. The effect size was assessed using Cohen's d [21]. The sample size was $N = 62$. The significance level was set at 5 % ($p < 0.05$), and all procedures were carried out using the Statistical Package for the Social Sciences (SPSS 20.0).

Results

The analysis of the groups' characteristics indicates that the CG concluded with higher body masses and consequently BMIs compared to the EG (Table 1). Nevertheless, both groups presented BMIs below 30 kg m^{-2}, which is a desirable value to reduce chronic-disease risk in people

Table 1 Characteristics of the sample

	CG ($n = 31$)	EG ($n = 31$)	t	p value
Age (years)	69.5 ± 6.1	70.7 ± 6.4	0.81	0.42
Body mass (kg)	72.3 ± 11.3	61.1 ± 10.2	4.09	0.001
Height (m)	1.57 ± 0.1	1.55 ± 0.1	1.25	0.22
BMI (kg m^{-2})	29.2 ± 4.4	25.5 ± 3.1	3.78	0.001

Data expressed as mean (±) standard deviation

CG control group, *EG* experimental group, *BMI* body mass index

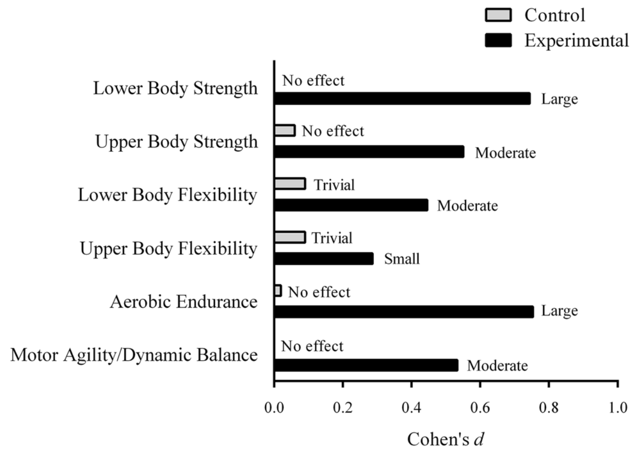

Fig. 1 Effect size and qualitative standard (Cohen's *d*) for the intra-group comparison

over 65 years old [22]. The CG seemed to have maintained the same scores on the tests after the intervention period, since there was no statistical difference between baseline and posttest values. Furthermore, no between-group (EG vs. CG) differences were identified (Table 2).

The intra-group analysis showed an improvement for the EG after BJJ training in all variables ($p < 0.05$). For the lower and upper body strength, we observed an improvement of 18.1 and 11.8 %, respectively, while lower and upper body flexibility increased by 52.7 and 46 %, respectively. Aerobic endurance experienced an enhancement of 11.8 %, and motor agility/dynamic balance improved 15.7 %.

The effect size analysis in the EG showed that the intervention had a small effect on upper body flexibility; a moderate effect on upper body strength, lower body flexibility, and motor agility/dynamic balance; and a large effect on lower body strength and aerobic endurance. The CG, on the other hand, showed trivial or no effects after the intervention (Fig. 1).

Discussion

The aim of the present study was to investigate the effects of 12 weeks of BJJ training on the functional fitness parameters of elderly men. The main findings showed that, in addition to strength, BJJ was also efficient in promoting an increase in flexibility levels, aerobic endurance, and motor agility/dynamic balance.

During BJJ practice, many moves require the use of isometric contraction of lower and upper body muscles, which may lead to neural and somatic adaptations [23], such as increased motor-units recruitment and muscle hypertrophy [24]. This could explain the increase in strength after intervention in the present study. Similarly, Queiroz et al. [18] submitted 19 men (23.2 ± 7.1 years old) to 4 weeks of BJJ training and reported an improvement ($p < 0.05$) in maximal strength of 12.1 and 8.8 % in the bench press and seated-row exercises, respectively. Moreover, muscular strength is a key physical fitness component to increase lifespan, since it is inversely and independently associated with all-cause mortality, even after adjusting for cardiorespiratory fitness and other cofactors, such as age, body fat, smoking, alcohol use, and hypertension [25, 26].

In addition to stretching exercises that were performed before and after the training sessions in the present study, the lever system and disarticulations, such as arm locks and leg locks, performed during a BJJ fight or training

Table 2 Functional fitness tests scores

	Control group ($n = 31$)		Experimental group ($n = 31$)	
	Baseline	Post	Baseline	Post
Lower body strength (score)	12.3 ± 3.6	12.3 ± 3.8	11.3 ± 3.1	13.8 ± 3.6*
Upper body strength (score)	15.3 ± 3.8	15.5 ± 3.0	14.2 ± 3.4	16.1 ± 3.5*
Lower body flexibility (cm)	3.8 ± 10.2	4.7 ± 9.1	2.6 ± 6.6	5.5 ± 6.4*
Upper body flexibility (cm)	−5.5 ± 7.0	−4.9 ± 6.9	−6.3 ± 10.8	−3.4 ± 9.4*
Aerobic endurance (m)	445.3 ± 71.9	444.0 ± 77.6	400.0 ± 67.5	453.4 ± 74.1*
Motor agility/dynamic balance (sec)	5.3 ± 1.0	5.3 ± 1.3	5.9 ± 1.5	5.1 ± 1.5*

Data expressed as mean (±) standard deviation

* $p < 0.05$ in relation to baseline values in the same group

session may be the cause of flexibility improvements in the presented results. These movements require a high range of motion in several joints and thus may compel the fighter to perform eccentric contractions while practicing BJJ. In this scenario, O'Sullivan et al. [27] reported evidence that a training method focused on eccentric contractions can improve flexibility levels in the lower limbs. Literature suggests that the most likely mechanism involved may be the increase of sarcomeres in the involved muscles and consequently the range of motion, which has been tested in animal models [28]. In humans, suitable levels of joint flexibility are suggested to be fundamental to maintain a high level of functional independence and performance in daily living activities for elderly individuals, such as dressing and bathing, thus contributing to a better quality of life for these individuals [29].

It is estimated that 30–60 % of community-dwelling older adults fall each year [7]. Functional impairment and low levels of physical fitness may be the primary factors that contribute to an increased risk of falling. Moreover, studies indicate that increased balance is associated with a decreased risk and fear of falling [30, 31], preserving the autonomy and emotional health of these individuals [32]. Granacher et al. [33] emphasized the importance of testing and training dynamic balance in the elderly and suggested that the increase in muscle power and strength may be the key to developing this physical fitness component. Therefore, the improvement in lower and upper body strength found in the present study could be responsible for higher scores on the motor agility/dynamic balance test. Moreover, Pons van Dijk et al. [34] investigated the effects of 1 year, 1 h week^{-1} taekwondo training on various balance parameters in 24 healthy adults over 40 years old and reported a positive effect of this MA on balance control. However, taekwondo has specific balance demands to perform and stabilize kicks as opposed to BJJ, which suggests that an exercise adaptation in balance parameters in BJJ may be consequence of a general improvement in physical fitness.

Twelve weeks of BJJ training was also effective in promoting a higher performance in the 6-min walk test, which may indicate an improvement in aerobic endurance, which may represent an elevated lifespan, since this physical fitness component is an independent predictor of all-cause mortality [35, 36]. The results of the present investigation corroborate with other scientific reports that used nonspecific aerobic endurance training, such as strength training [37], and improvements in this physical component. However, the increases in flexibility, dynamic balance, and especially muscle strength may be the primary outcomes to improve mobility and functional fitness in general, which may be reflected in the enhanced 6-min walk test after intervention and not necessarily a higher aerobic capacity.

Even though the present study contributes to the literature regarding exercise in the elderly, it is not without limitations. For instance, maximal oxygen consumption was not obtained directly, as well as direct parameters that could explain the possible mechanisms involved in the gains of flexibility, muscle strength, and dynamic balance. Thus, we suggest that the present findings should be analyzed with some caution. Nevertheless, this does not disqualify the practical application of the results.

In conclusion, BJJ training seems to improve functional fitness in elderly men and may be an alternative method to enhance health and quality of life in this population. As a practical application, we suggest that health professionals encourage elderly men to seek MA groups to engage in an exercise program. The motivating environment may be the key to regular practice, health enhancement, and longevity.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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