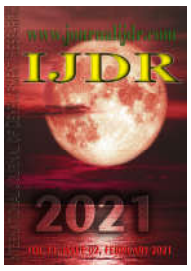
ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 11, Issue, 02, pp. 44824-44828, February, 2021
https://doi.org/10.37118/ijdr.21226.02.2021



RESEARCH ARTICLE OPEN ACCESS

EFFECTS OF THE HOME-BASED OLDER PEOPLE'S EXERCISE (HOPE) PROTOCOL ON BODY COMPOSITION AND FUNCTIONAL CAPACITY OF OLDER BRAZILIANS WITH SARCOPENIA: A RANDOMIZED CLINICAL TRIAL

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ARTICLE INFO

Article History:
Received 17th December, 2020
Received in revised form
20th December, 2020
Accepted 11th January, 2021
Published online 28th February, 2021

Key Words:

Sarcopenia, Older Person, Physical Exercise, Body Composition, Functional Capacity, Clinical Trial.

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ABSTRACT

The objective of this study was to examine the effectiveness of the Home-based Older People's Exercise (HOPE) protocol in terms of body composition and functional capacity of sarcopenic older people living in the Federal District. **Method**: this was a randomized clinical trial with a convenience sample composed of elderly people with sarcopenia based on the criteria of the European Work Group of Sarcopenia on Older People (EWGSOP2). The sample was divided into two different groups: group 1 (G1) which did the HOPE protocol twice a week and the control group (G2) that received health education through weekly talks; both groups were monitored for 12 weeks. Body composition was measured using DXA (LUNAR®) and functional capacity was determined by measuring calf circumference, grip strength, gait speed, timed sit-to-stand and SPPB. **Results:** after the intervention, there was increased muscle mass mainly in the lower limbs in the HOPE group, with statistically significant intra- and inter-group values. With respect to functional capacity, the HOPE yielded significant scores when compared to the control group and before the intervention. **Conclusion:** The HOPE protocol was a low-cost functional training strategy that improved muscle mass and functional capacity in older people with sarcopenia.

Citation: ***Hudson Azevedo Pinheiro, Vera Regina Cerceau, Leonardo Costa Pereira, Silvana Schwerz Funghetto et al. 2021.*** **"**Effects of the Home-based Older People's Exercise (HOPE) protocol on body composition and functional capacity of older Brazilians with sarcopenia: a randomized clinical trial*", International Journal of Development Research*, 11, (02), 44824-44828.

INTRODUCTION

The aging process causes various physiological changes primarily associated with change in body composition (reduction of lean mass and increased amount of body fat) which can lead to loss of muscle strength and/or functional performance, defined as sarcopenia, a geriatric syndrome which can culminate in a state of vulnerability associated with fall risk, loss of autonomy, hospitalization and death (Silva *et al*., 2013)(Alfonso J Cruz-Jentoft *et al*., 2010)(Muscaritoli *et al*., 2010)(Alfonso Jose Cruz-Jentoft *et al*., 2018). The literature shows that resistance training is a non-pharmacological intervention for treating sarcopenic older people. However, access to fitness centers and professionals, such as physical therapists and physical education teachers, is restricted, especially for the most needy population segments. These people often rely solely on services offered by primary health care, where care and instructions for doing exercises at home have yielded weak results (Landi *et al*., 2014) (Galvão & Taaffe, 2005)(Ogawa *et al*., 2010)(Facchini & Tomasi, 2010). Exercise protocols aimed at maintaining mobility and functional capacity are a care alternative for older people, particularly the more elderly, whether in clinics, long-term care facilities or even in home environments, through stretching techniques, strengthening and aerobic exercises. However, when they are based on daily living activities (DLA), this type of approach generally results in greater adherence to the proposed treatment (Landi *et al*., 2017)(Maruya *et al*., n.d.) (Forster *et al*., 2010) (Sa *et al*., 2012). The Home-based Older People's Exercise (HOPE) is an exercise protocol that was developed by Clegg *et al.* (2011) for treating fragile older people through functional exercises done at home five times a week for a minimum period of 12 weeks, where the older people are monitored by telephone and/or home visits by the researchers. The results on functional capacity have been significant. However, body composition has still not been investigated as an outcome after application of this protocol (Clegg *et al*., 2011) (Clegg *et al*., 2014).

In view of the need for low-cost strategies, prevention and health promotion among sarcopenic older people, the objective of this study was to verify the effectiveness of the HOPE protocol in relation to body composition and functional capacity of sarcopenic older people residing in the Federal District.

METHODS

A randomized, clinical trial was carried out with a convenience sample selected from a reference outpatient clinic in geriatrics and gerontology, located in the Taguatinga Polyclinic, which is part of the Unified Health System (SUS). The inclusion criteria were: be sarcopenic according to the revised criteria of the European Work Group of Sarcopenia on Older People (EWGSOP2): low muscle mass, initially measured by calf circumference (CC), where values below 31 cm indicate reduced muscle mass; reduced muscle strength measured by the grip strength test (GST) using a Jamar® brand dynamometer, with the older person seated in a chair without support in the lumbar region, shoulder in a neutral position, elbow flexed at 90º and wrist slightly extended, where three measurements, using the dominant hand, were taken in 1-minute intervals, with cutoff values under 30 kg/F for men and 20 kg/F for women; and last, reduced functional performance was measured by normal gait speed (GS), with the older person walking on a flat surface, discarding the acceleration and deceleration stages, and calculating average speed by dividing the distance covered in meters (three meters) by time in seconds, with cutoff values below 0.8m/s (Alfonso Jose Cruz-Jentoft *et al*., 2018). Another inclusion criterion was independence in daily living activities, verified through the Barthel index, with cutoff scores exceeding 60 points indicating independence in these activities(Minosso *et al*., 2010). Older people were excluded who had sequela from neurological diseases (cerebrovascular disease and parkinsonism, among others), moderate to severe cognitive deficit assessed through the Mini–Mental State Examination (MMSE), and amputations or who were bedridden. Older people who regularly engaged in physical activities were also excluded from the present study, as determined by the International Physical Activity Questionnaires (IPAQ)(Matsudo *et al*., 2012).

Initially, 112 older people who met the sarcopenia criteria in accordance with EWGSOP2 were selected: 90 women (80.3%) and 22 men (19.7%) were invited to participate in the present study. EpiInfo software version 7.2 was used for the sample calculation, with each group needing to be composed of at least 17 individuals. It was decided to exclude the men to make the sample more homogeneous. Therefore, the study started off with 25 individuals in each group, divided randomly into two groups that were monitored for 12 weeks. Group 1 (G1) followed the HOPE protocol presented in the study by Clegg *et al*. (2010) with some adaptations: the exercises were carried out in an outpatient setting and in groups of up to five individuals, in order to improve adherence and better control the execution of the exercises. Each session lasted 50 minutes on average. From among the 19 functional exercises, the ones that best fit the functional condition of the older person were chosen, based on the times from the Timed up and Go Test (TUG). In this mobility and dynamic balance test, times of over 30 seconds are an indication of more fragile and/or weaker individuals, who should do level 1 exercises. Times between 20 and 29 seconds indicate level 2 individuals and those with times under 20 seconds are level 3 (Clegg *et al*., 2014)(Clegg *et al*., 2011). The exercises were performed twice a week, with three series of 10 repetitions each, and every two weeks the TUG was conducted to determine the possibility of progression in the exercises (Sc *et al*., 2018). Group 2 (G2) had activities involving guidance through informational talks on healthy eating, maintenance of DLA, fall prevention, self-esteem and avoiding social isolation. No types of physical activity or regular exercises were carried out during these times, in accordance with the protocol of Cilento *et al*. (2010). The aforementioned activities were led by a health professional (MBR Cilento, ACL Nóbrega, 2005). There were two outcome variables in this study: body composition and functional capacity, which were evaluated in different ways.

Dual X-ray absorptometry (DXA) was used for body composition, and timed sit-to-stand (SS) and short physical performance battery (SPPB), as well as TUG, GST, GS and CC (described earlier), were used for functional capacity. For DXA, the volunteers were placed in a supine position on the table of the previously calibrated equipment (LUNAR® brand) and then carefully positioned in order to be totally centered in relation to the sides of the table. The anthropometric height and weight measurements were entered in the software and an examination was conducted afterwards to collect body composition and bone mineral density (Neto *et al*., 2012). The SPPB protocol was used to assess functional performance, which is comprised of three tests that evaluate, in sequence, static standing balance, gait speed at a normal pace (three meters) and, indirectly, lower limb muscle strength (LLMS) through the movement of standing up from a chair and sitting back down five consecutive times, without using the upper limbs. The scores for each test ranged from zero (worst performance) to 12 points (best performance) (Nakano, 2007).

The SS test, which is a sub-domain of the SPPD, was used in isolation to estimate lower limb muscle strength. The statistical package SPSS version 22 was used for the statistical calculations. The results of the continuous variables were expressed through the mean and standard deviation; the Kolmogorov-Smirnov test was used for testing normality; and the level of significance adopted was $p<0.05$. Due to sample loss, G*Power software version 3.1 was used, with a resultant size effect of 0.8. The study was approved by the ethics and research committee of the Foundation for Teaching and Research in Health (Federal District, Brazil), under Opinion No. 1.128.355/2015, The experimental protocol was filed with the Brazilian clinical trials registry under Opinion REQ 3.616.

RESULTS

The study was launched with 50 older people divided into two equally sized groups. However, over the course of the 12 weeks of the intervention, there were sample losses for various reasons, as outlined in Figure 1.

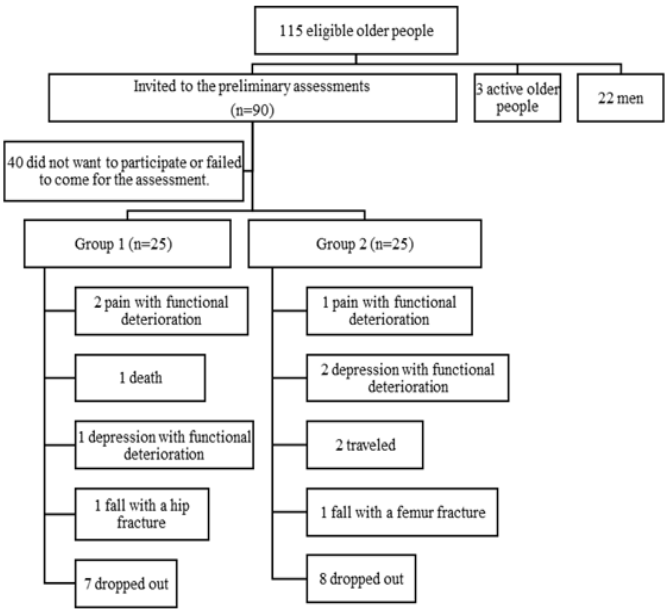

Figure 1. Flowchart of the sample description, ranging from the selection of eligible participants to finalization of the intervention groups, including sample losses

With respect to the older people who completed the intervention, the mean age was 80.3±6.8; all had up to five years of formal study; and all were independent in daily life activities. No differences were noted between the groups, indicating that they were homogeneous (Table 1).

Table 1. Characterization of the study participant sample

Variable		G1	G2	p
Completed high school		11	11	0.98[£]
EWGSOP2	Sarcopenia	5	8	0.26[£]
	Severe sarcopenia	5	3	
Fall history (yes)		2	6	0.11[£]
Has a spouse?	Yes	3	1	0.25[£]
	No	7	10	
Household income	≤ 2 minimum wages	6	4	0.14[£]
	> 3 minimum wages	3	8	
Age		81.7±7.9	79.1±7.6	0.36[£]
BMI (cm/kg²)		23.1±4.1	21.9±2.9	0.47[£]
Barthel index (points)		95.5±3.7	96.4±6.1	0.98[£]

¢Brazilian minimum wage in 2016 was R$ 880. £Chi-square test

Table 2. Comparison between the body composition variables pre- and post-intervention using DXA

		G1	p	G2	P	Δ (CI)	p
RSMI	Pre	5.58±0.75	0.16[§]	6.3±1.18	0.47	0.58 (0.32-0.82)	0.001[§*]
	Post	5.45±0.76		6.26±1.15			
perG	Pre	35.8±6.82	0.37[§]	35.53±8.73	0.31	0.27 (-0.24 - 0.78)	0.28[§]
	Post	36.2±6.87		35.76±8.60			
LLMM	Pre	8.64±1.71	0.05[§] *	10.28±2.15	0.94	0.63 (0.32-0.64)	0.001[§*]
	Post	8.36±1.77		10.29±2.10			
TMM	Pre	28.88±4.26	0.25[§]	32.68±4.63	0.84	0.63 (-0.16 - 0.70)	0.2[§]
	Post	28.58±4.25		32.66±4.59			
z-score	Pre	0.33±1.07	0.15[§]	0.15±0.37	0.16	0.38 (0.03-0.81)	0.06[§]
	Post	0.24±1.02		0.17±0.38			

G1 = HOPE group; G2 = control group; RSMI = relative skeletal mass index; perF = body fat percentage; LLMM = lower limb muscle mass; TMM = total muscle mass; Δ = variation delta after the intervention; *p<0.05; [§] paired t-test

Table 3. Comparison of the functional capacity variables pre- and post-intervention

		G1	p	G2	p	Δ (CI)	p
TUG	Pre	16.08±	0.02[§*]	14.40±4.76	0.34[§]	0.78 (-2.91 - 0.36)	0.12[§]
	Post	14.01±2.08		12.90±1.79			
Calf circumference	Pre	28.02±2.01	0.71[§]	28.81±2.25	0.16[§]	0.54 (-0.04 - 1.13)	0.06[§*]
	Post	27.83±2.16		29.01±2.30			
Timed sit-to-stand	Pre	21.08±4.69	0.05[§*]	24.81±15.17	0.31[§]	-2.45 (-5.99 - 1.06)	0.16[§]
	Post	18.75±3.36		21.01±6.92			
Gait speed	Pre	0.77±0.19	0.14[§]	0.81±0.13	0.25[§]	0.38 (0.06 - 0.70)	0.02[§*]
	Post	0.87±0.27		1.05±0.69			
Grip strength	Pre	15.75±3.22	0.01[§*]	16.01±2.89	0.22[§]	0.47 (-2.20 - -0.33)	0.01[§*]
	Post	18.17±3.21		16.80±2.74			
SPPB	Pre	7.08±1.24	0.004[§*]	7.50±0.85	0.44[§]	-0.09 (-0.47 - 0.29)	0.62
	Post	8.08±1.08		7.70±0.48			

Δ = variation delta after the intervention; paired t-test; *p<0.05

When comparing pre- and post-intervention body composition through DXA, differences were noted in lower limb muscle mass in the HOPE group after the intervention. When compared to the control group, there was a statistically significant difference in the musculoskeletal index and lower limb muscle mass, as shown in Table 2. When comparing the results for functional capacity, there were significant gains in G1 in the functional tests: TUG, SPPG, grip strength and timed sit-to-stand. In the comparison between the groups, there were differences in gait speed and grip strength. The comparison of the tests is presented in Table 3.

DISCUSSION

Various studies have shown that conventional resistance training, with intensities exceeding 60% of one maximum repetition (1MR) can reverse lean muscle loss in older people. However, these studies exclude more elderly people or those with any type of functional limitations or make recommendations since high-intensity resistance training may be contraindicated due to risk of muscle and tendon injuries(Van Roie *et al*., 2013) (Cannon *et al*., 2007)(Candow *et al*., n.d.)(Balachandran *et al*., 2014) The present study offered functional training with progression of intensity, done through varying the range of movement, progressing from lower positions such as seated and evolving to standing, and no external load was provided unlike conventional resistance training. Nevertheless, there were gains in muscle mass, as well as increased functional capacity. McGregor *et al*. (2014) conducted a literature review and found that mere muscle mass reduction does not justify loss of strength and functional capacity in older people, but that there is a direct relationship between muscle mass loss and bone mass loss. The authors also discuss and propose muscle quality as a more realistic measurement for identifying lifestyle and quantifying the effects of interventions among older people, especially the more elderly, since muscle quality is also associated with muscle composition (architecture, type of fibers), metabolism, infiltrated with fat and fibrosis, and neural activation which enable maintenance of the necessary mobility for continuation of a lifestyle (Mcgregor *et al*., 2014). Liu *et al.* (2014) examined the effects of functional exercises on muscle strength and performance for carrying out daily living activities, through a systematic literature review, comparing these exercises with resistance exercises. They did not observe any statistically significant differences and also emphasized that functional training protocols may be more effective for improvement in daily living activities, since this approach is systemic, active, multi-jointed and involves strength, coordination and balance(Liu *et al*., 2014). These findings coincided with the present study. Cervantes *et al*. (2019) carried out a resistance training protocol among sarcopenic older people (classified according to the EWGSOP2) living in a long-term care facility,

through free weights elastic bands, twice a week for 12 weeks, and noted increased muscle strength and functional capacity(del Campo Cervantes *et al*., 2019). These findings were consistent with the present study, differing only in regard to the profile of the older people analyzed, which here were older people living in a community. In creating the HOPE protocol, Clegg *et al*.(Clegg *et al*., 2014)(Clegg *et al*., 2011) were targeting the effects of loss of mobility on the functional capacity and quality of life of sarcopenic, fragile older people, and proposed easily appliable exercises that could be done at home with indirect supervision of health professionals. In the present study, there were functional capacity gains in sarcopenic older people after doing such exercises. It should be pointed out that training protocols for functional performance, especially of the lower limbs, can be widely used to increase muscle strength and power, as occurred in a study by Santanasto *et al*. (2017) which monitored older people (mean age of 78.9 years), with reduced mobility measured by the SPPB. After interventions based on walking and sit-to-stand exercises, there were significant gains compared to the older people who only participated in health education talks. These findings coincide with the present study (Santanasto *et al*., 2017).

Also with respect to mobility, the TUG test was used to establish levels of training within the HOPE protocol and, as presented in a systematic review, this test indicates reductions in mobility, flexibility and muscle strength, which may contribute to lower functional capacity, transfers and consequent fall risk (Barry *et al*., 2014). In the present study, the TUG was specifically used to establish training level progression and may be used in follow-up for determining level of adherence to exercises, especially when indicated to be done at home. The literature also pointed out that reduced mobility is directly associated with the risk of pre-sarcopenia and sarcopenia. Instruments are also discussed for screening it, such as the chair stand test, which is a subdomain of the SPPB, where the older person needs to sit and stand from a chair five consecutive times. Scores under 13 seconds indicate sensitivity and specificity for identifying sarcopenic risks(Pinheiro *et al*., 2016). Maruya *et al*. (2016) monitored pre-sarcopenic or sarcopenic individuals during six months with exercises performed at home daily, and did not observes changes in body composition, despite increased muscle strength(Maruya *et al*., n.d.). These findings are consistent with the present study in regard to functional capacity, but differ in terms of body composition, which demonstrates that systematization of a training protocol, with a progressive load, was effective for muscle mass gain, especially in the lower limbs.

The SPPB was referred to in a study by Grosicki *et al*. (2019) as a functional performance test that can indicate strength and fragility in older people with low mobility or in more elderly people, and is a tool based on daily living problems(Grosicki *et al*., 2019). In the present study, SPPB indicated improved functional capacity among older people who did the training using the HOPE protocol. These older people were also more elderly and had mobility limitations, as measured by the TUG, which was also used as a predictor for improvement in performing tasks. Sherrington *et al*. (2008) conducted a meta-analysis and established criteria for prescribing exercises to prevent falls, which involved postural balance through base variation and weight transfer, dosimetry in the prescription in terms of series and repetitions, muscle strength resistance training (even if only against one's own body), in a measure sufficient to achieve the proposed objective. These exercises needed to be done slowly, working on major muscle groups, in groups or at home(Sherrington *et al*., 2011). Even though the recommendation focused on fall prevention, the present study demonstrated that the same recommendations can be applied to sarcopenic individuals, with significant effects on the functional capacity outcome. There was a sample loss of 50% among all the groups that participated due to complications inherent to sarcopenia with risk of hospitalization, falls and death. Therefore, low-cost strategies need to be implemented aimed at minimizing the impact of this syndrome, which has become a public health problem because of population aging, especially in relation to autonomy and quality of life (Shaw *et al*., 2017)(Ethgen *et al*., 2017).

The limitations of the present study were: not having performed monitoring in the home environment via telephone and visits, as recommended in the original HOPE protocol, which could have prevented sample loss.

Conclusion

The adapted HOPE protocol was a good non-pharmacological functional training strategy that resulted in increased muscle mass and functional capacity in sarcopenic older people.

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