Effects of remote home-based exercise program on functional capacity and perceived loneliness in older adults during COVID-19 lockdown

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Abstract

Objective: to determine the effects of a simple home-based exercise program on functional capacity and perceived loneliness of older adults in lockdown due to the COVID-19 pandemic. *Method:* Twenty-nine volunteers were randomly divided into two groups: (1) control group (CG); and (2) home-based exercise group (HBEG). Lower limb muscle strength, functional capacity, and perceived loneliness were assessed at baseline (pre-test), 4 weeks, and 8 weeks (post-test) using the Chair Standing Test (CST), Gait Speed Test (GST), Timed Up and Go test (TUG), and Perceived Loneliness Scale (PLS). *Results:* The number of repetitions on the CST differed statistically between the groups (CG vs. HBEP, p=0.006) and among timepoints (Pre *vs.* 4W *vs.* 8W, p=0.043.). In the CG group, TUG test completion time was statistically lower at baseline than at 8 weeks (p=0.021) (pre 12.0±5.9 s vs. 8W 12.7±6.5 s). There was no statistical difference in TUG time in the HBEG. No statistical differences were found on the GST and PSL between groups or among timepoints. Conclusion: The home-based exercise program improved general functional capacity after 8 weeks of training, but perceived loneliness and gait speed were unchanged in the older adults experiencing lockdown due to the COVID-19 pandemic.

Keywords: Exercise; Aged; Self-testing; Loneliness; Covid 19.

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The authors declare that there is no conflict in the conception of this work.

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Received: April 24, 2022
Approved: July 27, 2022

https://dx.doi.org/10.1590/1981-22562022025.220073.en

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the coronavirus strain that causes coronavirus 2019 (COVID-19). The virus was first reported in December 2019 in Wuhan, China, rapidly spreading around the globe thereafter. In late January 2020, the World Health Organization declared the COVID-19 outbreak a public emergency of international concern and, in early March, went on to declare the disease a pandemic[1].

The majority of epidemiology experts maintain that the most effective way of controlling the rapid spread of COVID-19 (China and other locations) is for government authorities to quickly implement robust lockdown measures (Jiménez-Pavón et al. (2020) [2]. Numerous countries adopted different degrees of lockdown restrictions. Countries such as Italy, Spain, the United Kingdom, the United States of America and Brazil only started implementing social distancing strategies several weeks after the outbreak, resulting in rapid spread and high incidence rates of COVID-19. Based on the latest guidance regarding the COVID-19 pandemic, older adults and individuals with hypertension, diabetes, cardiovascular and respiratory diseases are identified as being at higher risk of contamination and death[2-4,]

Although lockdowns measures seem to be the best option to prevent the fast spread of infections caused by the COVID-19, there are adverse health consequences for individuals in lockdown, especially the more vulnerable and at higher risk, such as older adults[5]. In this phase of life, individuals are more exposed to the physical limitations, loss of social support and more severe perceived loneliness associated with aging[6,7]. Anxious symptoms, depression, hypertension, obesity, sleep disorders, cardiovascular diseases, decreased physical activity levels, and decline in functional capacity are more common in this population, as reported by researchers[,5-7]. Lockdowns can lead to older adults becoming even less active, spending more time engaging in sedentary lifestyle and low-energy expenditure activities (i.e., sitting, lying, reading), exposing them to greater risk of disease. In addition, lack of physical activity over time reduces the mechanical load applied to the musculoskeletal system. This situation can accelerate muscle mass loss, resulting in sarcopenia, frailty, and comorbidities.

There is no doubt that the older adult population is the most impacted by lockdown restrictions, and this group will be the last to resume their normal daily routines. Since lockdown is a necessary measure, finding alternatives to promote and/or maintain health in older adults is critical to minimize problems in the future. One of the most efficient, cost-effective, straight-forward and safe ways of tackling the health issues caused by the COVID-19 pandemic is physical activity[8] Physical activity is considered a non-pharmacological tool recommended as primary prevention, treatment, and control of associated risks for developing chronic diseases and mental health issues[9-11]. Physical activity also plays a vital social role in building social connectedness, friendship and trust among participants[12]. Furthermore, physical activity guidelines for older adults help to decrease the incidence of chronic diseases, diabetes, cancer and excess body fat, and to improve or maintain strength, muscle mass and functional capacity, while also lowering risks of falls and cognitive decline (WHO, 2020)[12].

Since the pandemic, protective measures have forced older adults to stay at home in lockdowns, making remote home-based exercise routines important to avoid the deleterious effects of a sedentary lifestyle on health and well-being. Furthermore, access to exercise equipment within the home tends to be very limited. Therefore, studies determining the impact of lockdown measures associated with the pandemic on fitness levels and exploring how remote home-based exercise programs might minimize losses in functional capacity and perceived loneliness in older adults become imperative[13].

The aim of the present study was to determine the effect of a simple, accessible, low-cost, short-term home-based exercise program on functional capacity and perceived loneliness in older adults during Covid-19 lockdown.

METHOD

Participants undertook the present study within their homes. Prior to the study, and after the principal investigator had clarified all of their questions and concerns, all participants signed an informed consent form approved by the University of Sao Paulo, School of Arts, Sciences and Humanities Institutional Committee of Ethics in Human Research (protocol CEP-EACH/USP 74029), observing CNS resolution 466/2012.

Participants

Participants from the University Hospital at the University of Sao Paulo Medical Center including older adults enrolled on the University of Sao Paulo Senior Program, São Paulo, Brazil, were recruited using social media platforms. Older adults with dementia, psychiatric disorders, cognitive impairment, stroke, and visual or hearing deficits were excluded from the current study. Healthy older adults with independent mobility and no cognitive impairment (mini-mental assessment) were included in the study sample. A duly trained gerontologist collected the study information during an online interview with participants using a standard medical and health screener to ensure participants matched the eligibility criteria.

Participants were instructed to wear comfortable clothing and shoes, perform the test on a non-slip hard surface with sufficient space to allow for the correct execution of movements. None of the participants were in use of assistive devices. Although the tests were self-administered at home, a family member or caregiver was present at the time of the test in case any unforeseen safety issues arose. Participants were also instructed to refrain from consuming alcohol, caffeinated beverages or engaging in vigorous exercise for the twenty-four hours leading up to testing.

According to the sample size calculation (G*Power software, Heinrich Heine University, Dusseldorf, Germany), the minimum sample size required was 30 participants, considering a beta of 0.8 and alpha < 0.05 (95% confidence interval (95% CI) and maximum error of 2%). A total of 84 older adults contacted the researchers via telephone and digital platforms to volunteer for the study. After eligibility criteria analysis, 29 participants were enrolled in this cross-sectional, randomized controlled quantitative study. Participants were randomly assigned into two groups: (1) control group (CG), not engaged in any physical activity; and (2) home-based exercise program (HBEP) group. Both groups completed functional capacity and loneliness assessments at pre-intervention, week 4, and week 8 (Figure 1).

Experimental Design

This study hypothesis was tested by randomly assigning older adults into two groups (CG and HBEP groups). Participant assessments were executed alone (self-assessment) without in-person face-to-face instructions and interactions due to government restrictions (i.e. lockdown rules). Participant assessments were self-administered and remotely supervised (online). Prior to testing, participants received recorded instructional videos on how to set up and execute the tests by email or via other digital platforms. In the event of questions or concerns, participants contacted the researchers directly by phone, text message, or video chat. In addition, the older adults remained in their homes throughout the study period.

Anthropometric Assessments

Body mass was measured using scales accurate to the nearest 0.1 kg (W200A-LED, Welmy, Sao Paulo, Brazil), and height was measured using a stadiometer accurate to the nearest 0.1 cm. Body mass index (BMI) was obtained by dividing body mass (kg) by height (m) squared (BMI = body mass (kg)/height (m^2)). These measures were already contained in the medical records.

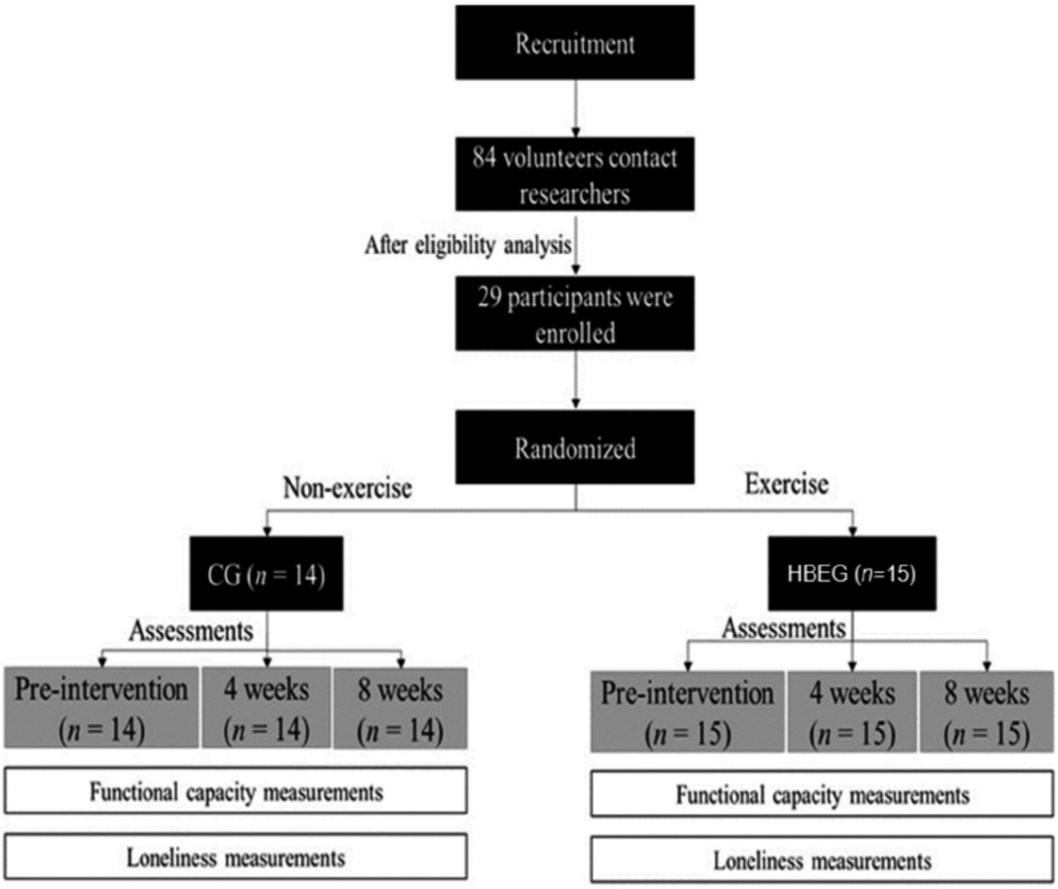


Figure 1. Flow diagram illustrating process of participant selection for the experimental study. São Paulo, Brazil, 2021.

Pre and post-intervention Assessments

Chair Stand Tests

The Chair Stand Test (CST) is part of the Senior Fitness Test Protocol to assess lower limb muscular endurance and strength[14]. The CST protocol consisted of 30 seconds of repeatedly sitting and standing up from a 43cm-high straight-back chair with no armrests, placed against a wall or stabilized for safety. Participants' started in a sitting position centrally in the middle of the seat with their feet flat on the floor and shoulder-width apart. Arms were kept close to the chest and crossed at the wrists. From a sitting position, participants stood upright and then returned to the sitting position, repeating this cycle for 30 seconds. Participants reported the total number of completed repetitions executed as their final score.

Gait Speed Tests

The gait speed test (GST) was used to assess gait speed of the participants. To perform this test, each individual was instructed to place a mark with tape on a flat floor surface. The start and endpoints were 4.5 meters apart (test zone) with 50 cm before and after the defined distance allowing for acceleration and deceleration. Participants started walking at their usual pace, and the time taken to complete the 4.5 meters was recorded as their final score. Gait speed was expressed in meters/second ($m.s^{-1}$). GST results are associated with attributes of general health status as an indicator of physiological reserve in older adults, and also serve as a prognostic factor for risk of falls, frailty, institutionalization and mortality in geriatric patients[15].

Timed Up and Go Tests

The Timed Up and Go (TUG) test was used to assess dynamic balance, agility and functional mobility, according to Podisiadlo & Richardson[16]. Participants performed the TUG test using a standard chair (43 cm). The test zone was marked out using tapes on the floor, placed 3 meters apart. Participants were instructed to support their backs and arms on a chair in a seated position. The test started when they stood up and started walking on a flat surface for 3 meters, then turned around, walking back to the chair and sat down as fast as possible. The completion time was reported as the final score.

Loneliness Assessments

The loneliness outcome was measured using the University of California Los Angeles scale (UCLA, version 3). This version was validated in 1996 for its psychometric properties in a US adult cohort sample. It has become the most widely used scale to measure loneliness as it corresponds to various mental and physical health outcome aspects. Version 3 has been used extensively online. The coefficient α from validation studies ranged from 0.89 to 0.94 on this scale. The scale consisted of 20 positively and negatively worded questions (i.e., How often do you feel that there are people you can talk to?; How often do you feel that people are around you but not with you), with four response options for each question: "always," "sometimes," "rarely," or "never." Following author scoring rules, the positively worded items are reversed so that all 20 items are scored from 1 ("never") to 4 ("always"), for a total possible composite score ranging from 20 to 80 points, with higher scores indicating greater loneliness[17].

The home-based exercise program was self-administered and supervised synchronously (online). The exercises consisted of repeated sitting and rising from a chair (43 cm) (body mass based squat movement). Participants performed 3 sets of 8-12 repetitions (range 24-48 repetitions/session), with 3-5 minutes break between bouts, three times per week for 8 weeks. Each training session was 15-18 minutes long, including exercise and recovery. The sitting and rising from a chair exercise was selected because the movement executed is easy and straightforward to understand and follow.

This exercise program was also based on a study by Fujita et al.[18], where frail older adults engaged in a repeated sit-to-stand exercise. The authors showed that frail individuals were able to safely execute 48 complete repetitions with a short pause between bouts. The movement was performed at participants preferred cadence (~3 seconds) to avoid abrupt movement and potential spinal compression and back pain. None of the participants reported any type of pain during the intervention period. The frequency of 3 times per week was based on older adults guidelines for resistance training [19]. The program attendance cut-off criteria adopted was 85% participation. If participants did not meet these criteria, their data were excluded from the analysis.

Statistical Analysis

The experimental data were normally distributed (Shapiro–Wilk test, $p>0.05$) and, thus, data normality was assumed *a priori*. Student´s *t*-test was used to determine whether participant groups were matched for age, height, body mass, and body mass index (BMI). Two factors were considered for statistical testing: 1) Timepoint (pre, after 4 weeks [4W], or after 8 weeks [8W], as a paired condition); and 2) Group (control or HBEG, as an unpaired condition). The two-way ANOVA (with one-factor repetition) was selected to compare the following variables between timepoints and groups: CST (number of completed repetitions), GST (gait speed, in meters/second), TUG (time to complete the test, in seconds), and UCLA score (loneliness scale, points on scale). When statistically significant interactions were found, Tukey´s post-hoc test was applied to determine differences. For all statistical analyses, the level of significance (p-value) was set at 5% ($P<0.05$). Data were analyzed using SigmaPlot software version 14 (Systac Software, Inc., San Jose, CA, USA).

RESULTS

Pre-test Measurements

Participants' pre-test characteristics are presented in Table 1. As verified by Student´s *t*-test, participants were matched for age, height, body mass and BMI ($p>0.05$). The Two-Way ANOVA for repeated measures showed no statistically significant pre-test differences for CST, GST, TUG and PSL between the CG and HBEG groups ($p>0.05$).

Pre and Post-Test Measurements

Chair Standing Test (CST)

The number of repetitions during the CST differed statistically between the groups (CG vs. HBEG, $p=0.006$) and among timepoints (Pre *vs.* 4W *vs.* 8W, $p=0.043$). The interaction between the two factors (group vs. timepoint) was also statistically significant ($p=0.003$). The post-hoc test revealed that the number of repetitions on the CST was 37% higher (mean difference 3.6 repetitions) in the HBEG group than in the CG, a statistically significant difference ($p<0.005$, Figure 2A. Comparing the timepoints Pre, 4W, and 8W, the number of repetitions on the CST was statistically higher after 8W than at Pre-training ($p=0.039$) In the CG, this difference was not statistically different ($p>0.05$), whereas in the HBEG the number of repetitions was statistically ($p<0.001$) higher after 8W than at Pre-training. Comparing groups for timepoints 4W and 8W, the number of repetitions in the HBEG was statistically higher than in the CG ($p<005$).

Gait Speed Test (GST)

As illustrated in Figure 2B, no statistical differences in gait speed on the GST were found between groups (CG *vs.* HBEG group, $p=0.323$) or among timepoints (Pre *vs.* 4W *vs.* 8W, P=0.068). However, the *p*-value of the main effect among timepoints was 0.068. As depicted in Figure 2B, gait speed in the HBEG decreased after 8W of training, although this decline was not statistically supported at a *p*-level of 5%.

Timed Up and Go Test (TUG)

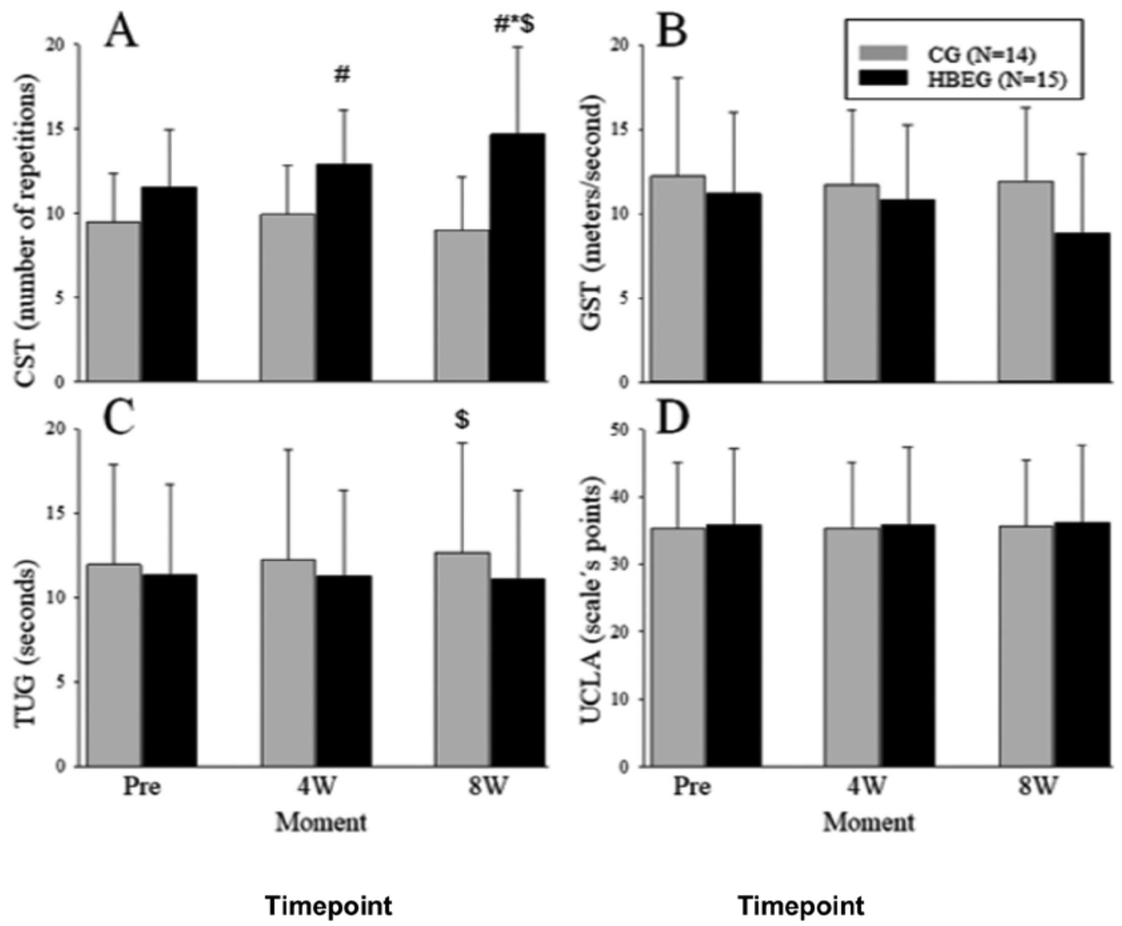
The time taken to complete the TUG test showed no statistically significant difference between the groups (CG *vs.* HBEG group, $p=0.551$) or among timepoints (Pre *vs.* 4W *vs.* 8W, $p=0.627$), as depicted in Figure 2C. The interaction between the two factors (group and timepoint), however, differed statistically ($p=0.021$). In the CG, performance at pre-training was statistically lower compared to the 8W timepoint ($p<0.05$), indicating longer time to complete the TUG at week 8. In the HEBEG group, this same comparison revealed no statistical difference between timepoints($p>0.05$).

Perceived Loneliness

As depicted in Figure 2D, scores on the loneliness scale did not differ statistically between the groups (CG *vs.* HBEG groups) or among timepoints (Pre *vs.* 4W *vs.* 8W) ($p>0.05$).

Table 1. Pre-test characteristics for age, height, body mass, and body mass index in control group (CG) and home-based exercise program (HBEG) group. São Paulo, Brazil, 2021.

Variables	CG	HBEG
Age (years)	70.5 ± 8.1	67.9 ± 7.7
Height (cm)	158.1 ± 7.6	159.4 ± 10.4
Body mass (kg)	70.6 ± 13.5	73.5 ± 16.5
BMI (kg/m^2)	28.2 ± 4.9	29.0 ± 6.1



#Statistical difference versus CG, *statistical difference versus 4W and $statistical difference versus Pre-training.

Figure 2. Comparison of outcomes on Chair Stand Test (CST, in A), Gait Speed Test (GST, in B), Timed Up and Go test (TUG, in C) and on loneliness assessment scale (UCLA, in D) between the control group (CG) and home-based exercise program (HBEG) group at timepoints pre, 4 weeks and 8 weeks (Pre, 4W and 8W, respectively). São Paulo, Brazil, 2021.

DISCUSSION

The primary aim of the study was to determine the effect of home-based physical training on functional capacity and perceived loneliness in older people experiencing lockdown. The main results showed that a simple, easy-to-perform, low-cost, equipment-free, short-duration physical training program consisting of squat exercises against one's own body weight (TUG and CST) improved muscular endurance and lower limb strength, gait speed, as well as maintained dynamic balance, agility, and functional capacity in older people experiencing lockdown. Thus, the self-directed intervention had a protective effect against physical inactivity exacerbated by lockdown restrictions. However, there was no impact on perceived loneliness post-intervention in either of the groups. In addition, a reduction in dynamic balance, agility, and functional capacity was observed in the sedentary group after 8 weeks.

The results obtained from the 30-second CST showed that the HBEG performed a higher number of repetitions than the CG (63% higher, or additional ~6 repetitions) (Figure 2A). These results are consistent with the findings of the study conducted by Fujita et al.[18,20]. These authors performed 12 weeks of physical training in institutionalized older people based on squatting against own body weight. The exercise consisted of sitting and standing up repeatedly from a chair. A 19.4% increase in isometric knee extension torque was found at week 4 (pre: 1.07±0.28 Nm/kg vs. 1.26±0.26 Nm/kg) and 23.9% (1.31±0.28 Nm/Kg) at week 12. The results obtained by the authors are important because aging is associated with reductions in muscle function and structure. These declines lead to sarcopenia, directly affecting functional capacity, activities of daily living and an independent lifestyle[21,22]. Furthermore, these changes may have a greater impact if the older person reduces their level of physical activity, as seen in lockdown[23]. During the pandemic, physical training programs in the home environment seem extremely promising for improving or maintaining individual fitness and health, as demonstrated by the results of the present study.

Regarding GST, the study data showed that the intervention increased walking speed after 8 weeks of physical training. The HBEG was, on average, 55% faster (0.65 m.s-1) than the CG (0.42 m.s-1), with a gain of 0.23 m.s-1 post-intervention (Figure 2B), although this was not statistically supported at a p-level of 5%. The gait speed gain observed in the current study is higher than that reported by Hortobagyi et al.[24], who showed gains of 0.10 m.s-1 even in healthy older people. The researchers also showed that different types of exercise intervention, such as resistance training (0.11 m.s-1), coordination (0.09 m.s-1), and multimodal (0.09 m.s-1), resulted in similar improvements in gait speed.

According to Hardy et al.[25], and Studenski et al.[26], higher walking speed is associated with increased survival rate in older adults. Conversely, a gait speed of less than 1.0 m.s-1 predisposes individuals to greater health risks and represents a strong predictor of adverse health-related events in older adults, such as increased risk of falls, fragility, disability, hospitalization, morbidity and mortality[27-29]. Confirming these findings, Atkinson et al.[30], Muehlbauer et al.[31] and Stahnke et al.[32], also identified a negative association of walking speed with back or leg pain, poor vision, low levels of physical activity, low aerobic capacity, cognitive impairment, and depression. Therefore, exercise interventions play an important role in improving walking speed of older adults. Thus, the present study showed that gait speed can be increased even after a remote home-based physical training program targeting the lower limbs.

As reported in the results section, the time to complete the TUG test showed no interaction between the two factors (group and timepoint). The CG took longer to complete the test at post-assessment compared to pre-assessment, indicating loss of dynamic balance and agility over 8 weeks. However, the HBEG showed no statistically significant differences between pre and 8 weeks, indicating maintenance of dynamic balance and agility throughout the study. The application of the TUG test requires the subject to make rapid changes in direction and shifts in center of mass. Thus, performing the test involves several physical abilities, such as dynamic balance, agility, muscle strength, speed and power. Although the training program implemented in the study focused predominantly on muscle strength, the maintenance of these abilities in the HBPG, relative to the declines seen in the CG, is considered a positive outcome. The results of this study are similar to those reported by Vieira et al.[33], showing that TUG results remained unchanged between a control group and a group of older women who performed Pilates for 12 weeks.

Although no statistically significant differences were detected according to mean times, comparison of individual standardized changes showed that TUG performance of the HBEG versus the CG at pre and 8 weeks differed (Figure 3C), indicating a negative effect of lockdown (with longer TUG completion times at week 8). Sakugawa et al.[34] conducted a study in which older adults completed 12 weeks of training, 16 weeks of de-training, and 8 weeks of retraining. TUG test performance was faster at post than pre-training periods. In the current study, the training program also involved muscular strength, but the exercise intensity was lower than in Sakugawa's study, a factor which may account for these differences. Martinez et al.[35] suggested a TUG completion time of ≥10.85 seconds as a cut-off point for predicting sarcopenia. Although both groups in the current study had times exceeding 10.85 s, completion times for the CG increased over time (pre-training: 12.0±5.9; 4 weeks: 12.3±6.5 and 8 weeks: 12.7±6.5), i.e. an average of almost 2 seconds higher than the cutoff point, which may predispose these individuals to greater health risks such as sarcopenia. On the other hand, the HBEG had TUG times (pre-training: 11.4±5.3, 4 weeks: 11.3±5.1 and 8 weeks: 11.1±5.3) closer to the 10.85 seconds cutoff recommended by Martinez et al.[35] Thus, a home-based physical training program proved sufficient to maintain performance on the TUG test, avoiding additional losses in the physical abilities involved in the test.

Regarding scores on the perceived loneliness test, there were no statistically significant intra or intergroup differences, or for individual standardized changes between HBEG and CG at pre and 8 weeks. This result is consistent with a recent meta-analysis conducted by Shvedko et al.[11] examining the effects of physical activity on loneliness in socially isolated and socially supported older adults in the community. Positive effects of physical activity on social interactions were demonstrated, i.e., physical activity improved social relationships between participants based on mutual needs and interests. However, physical activity was not effective in reducing perceived social isolation and loneliness. Similarly, the home-based physical training program conducted in the current study proved unable to change perceived loneliness, probably because the program was conducted individually and failed to promote sufficient social interaction. In addition, the present study had some limitations that should be considered. Although statistical differences in functional ability were found, data collection and testing applications can lead to potential measurement bias. Nevertheless, scientific evidence demonstrates the benefits of supervised remote home-based exercise programs on the functional capacity of older adults.

CONCLUSION

The physical training program implemented proved feasible with excellent adherence and can serve as a basis for mitigating the impact of aging and lockdown on muscle function and functional ability. As demonstrated in the present study, individuals involved in the program improved muscle strength, gait speed, and maintained dynamic balance and agility. Physical training programs play an important role in reducing falls, sarcopenia, frailty, disability, hospitalization and chronic diseases. Thus, the older adults in lockdown, despite the pandemic, were able to engage in simple, regular exercise routines in order to improve and/or maintain their physical health.

Edited by: Yan Nogueira Leite de Freitas

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