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**High Intensity Functional Exercises
Associated or not with Cognitive
Stimulation Improves Cognition and
Physical Performance in Older Adults**

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Dedico este trabalho a minha família, por todo o suporte incondicional desde que me conheço por gente. Sou fruto do amor, carinho e do incentivo diário de vocês, palavras nunca serão suficientes para contemplar o amor que tenho por vocês. Também dedico a conclusão desta etapa a minha companheira de vida Laura, por ser minha motivação e razão das minhas maiores inspirações acadêmicas e pessoais. Aos meus amigos do peito, apesar da distância física, sempre os carrego comigo onde estou. Ao Luis, Marco Antônio, Diego e Mariana sou grato por ter compartilhado todo este processo com a amizade e parceria de vocês.

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RESUMO

Introdução: o envelhecimento é um processo não patológico; no entanto, pode ser acompanhado por uma variedade de disfunções musculoesqueléticas e cognitivas resultantes principalmente de fatores modificáveis, afetando a qualidade de vida e independência de pessoas idosas. Estudos indicam que exercícios físicos associados a desafios cognitivos, podem ter um impacto positivo no desempenho físico e na função cognitiva em idosos. **Objetivo:** investigar os efeitos de um programa regular de exercícios funcionais de alta intensidade associado à estimulação cognitiva no desempenho cognitivo e físico de indivíduos idosos. **Métodos:** este estudo é um ensaio clínico randomizado controlado. 96 homens e mulheres residentes da comunidade foram randomicamente designados para um programa de exercícios funcionais de alta intensidade com base no Programa Hife, com 50% dos exercícios físicos associados a uma tarefa cognitiva ou para o mesmo programa, mas sem o componente da tarefa cognitiva. Ambos os grupos realizaram duas sessões por semana de treinamento em grupo e exercícios progressivos de força e equilíbrio durante um período de 16 semanas. Questionários e testes físicos foram aplicados no início e após 16 semanas de intervenção. **Resultados:** ambos os grupos apresentaram melhorias clinicamente significativas na cognição e no desempenho físico em condições de simples e dupla tarefa ($P < 0.05$). Apenas o grupo de treinamento em dupla tarefa obteve melhores resultados em relação ao custo cognitivo ao realizar testes motores em condições de dupla tarefa ($P < 0.05$). Não foram encontradas interações grupo-tempo, exceto para a confiança no equilíbrio em ambos os grupos de intervenção ($P < 0.05$). **Conclusões:** a adição de uma tarefa cognitiva simultânea ao treinamento funcional de alta intensidade não oferece maiores benefícios quando comparada a realização de um programa de exercícios funcionais de alta intensidade com base no Programa Hife em adultos mais velhos residentes na comunidade.

Palavras-chave: Idosos. Envelhecimento. Desempenho físico. Cognição. Dupla Tarefa.

ABSTRACT

Background: Aging is a non-pathological process; however, it can be accompanied by a range of musculoskeletal and cognitive dysfunctions resulting primarily from modifiable factors, affecting older people's quality of life and independence. Studies indicate that physical exercise associated with cognitive challenges may have a positive impact on physical performance and cognitive function in older people.

Objectives: investigate the effects of a regular high-intensity functional exercise program combined with cognitive stimulation on the cognitive and physical performance of elderly individuals. **Methods:** This study was a randomized controlled trial. 96 community-dwelling men and women were randomly assigned to either a high-intensity functional exercise program based on The Hife Program with 50% of physical exercises associated with a cognitive task or the same program but without the cognitive task component. Both groups performed two sessions per week of group training and progressive strength and balance exercises during a period of 16 weeks. Questionnaires and physical tests were measured at baseline and after 16 weeks of intervention. **Results:** both groups showed clinically significant improvements on cognition and physical performance under single and dual-task conditions ($P < 0.05$). Only the dual-task training group showed better outcomes regarding cognitive cost when performing motor tests in dual-task conditions ($P < 0.05$). No group-by-time interactions were found except for balance confidence on both intervention groups ($P < 0.05$). **Conclusions:** the addition of simultaneous cognitive dual-task training does not seem to offer greater benefits when compared to a high intensity functional exercise program based on The Hife Program in community dwelling older adults.

Keywords: Older people. Aging. Physical Performance. Cognition. Dual-Task.

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LISTA DE ABREVIATURAS E SIGLAS

ADL - activities of daily living

IADL - instrumental activities of daily living

EG - experimental group

CG - control group

3MWT - Three-Meter Walk Test

FRT - Functional Reach Test

1-MSTST - One-minute Sit to Stand Test

CTT - Coin Transfer Test

SVFT - Semantic Verbal Fluency Test

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ARTIGO**High Intensity Functional Exercises Associated or not with Cognitive Stimulation Improves Cognition and Physical Performance in Older Adults**

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ARTIGO NA ÍNTEGRA

Abstract

Background: Aging is a non-pathological process; however, it can be accompanied by a range of musculoskeletal and cognitive dysfunctions resulting primarily from modifiable factors, affecting older people's quality of life and independence. Studies indicate that engaging in physical exercise, motor activities, cognitive challenges, as well as a combination of these, may have a positive impact on physical performance and cognitive function in older people.

Design: Randomized controlled trial.

Setting: the study took place at a municipal public health center (Porto Alegre, Rio Grande do Sul, Brazil).

Subjects: 96 community-dwelling men and women.

Methods: Participants were randomly assigned to either a high-intensity functional exercise program based on The Hife Program with 50% of physical exercises associated with a cognitive task (such as addition, subtraction, spelling words, identifying requested colors and figures, among others) or the same program but without the cognitive task component. Both groups performed two sessions per week of group training and progressive strength and balance exercises during a period of 16 weeks. Questionnaires and physical tests were measured at baseline and after 16 weeks of intervention.

Results: both groups showed clinically significant improvements on cognition and physical performance under single and dual-task conditions ($P < 0.05$). Only the dual-task training group showed better outcomes regarding cognitive cost when performing motor tests in dual-task conditions ($P < 0.05$). No group-by-time interactions were found except for balance confidence on both intervention groups ($P < 0.05$).

Conclusions: the addition of simultaneous cognitive dual-task training does not seem to offer greater benefits when compared to a high intensity functional exercise program based on The Hife Program in community dwelling older adults.

Keywords: Older people. Aging. Physical Performance. Cognition. Dual Task.

Key points:

- Both a high intensity functional exercise program and the same exercise associated with cognitive stimulation improved physical and cognitive performance.
- The addition of cognitive stimulation to a high intensity functional exercise program did not enhance its benefits.
- Both experimental and control groups had significant improvements in balance confidence when compared to baseline evaluations. But only the experimental group experienced a lesser decline in dynamic balance.
- Cognitive function improved in both intervention groups when compared to baseline assessments.

Introduction

Aging is a natural and multifactorial phenomenon characterized by the accumulation of degenerative processes, which, in turn, are defined by multiple alterations and damage to molecular pathways [1]. During this process, declines in executive functions and basic motor skills, such as postural control, muscle strength, and balance performance, are observed. Consequently, these factors negatively affect physical performance and increase the risk of falls in individuals undergoing this process.

Studies indicate that approximately 28-35% of individuals aged 65 or older experience falls each year, and this number can increase to 42% in those aged 70 or older [2]. Fall-related injuries are more common among older adults and are one of the leading causes of pain, disability, loss of independence, and premature death.

The ability to perform activities of daily living (ADL) and instrumental activities of daily living (IADL) is dependent upon cognitive (e.g., reasoning, planning), motor (e.g., balance, dexterity), and perceptual (including sensory) abilities, and the individual also needs the ability to complete the task (physical and/or cognitive ability) or to recognize that the task needs to be done without prompting (cognitive ability) [3]. Physical performance is considered to be predictive of both ADL and/or

IADL decline [4]. Thus the importance of effectively implementing a physical exercise program that can beneficially improve both cognitive function and physical performance in older adults.

A decline in physical performance is associated with both physiological impairments and psychological aspects, such as the fear of falling, especially in older individuals with a history of falls. Achieving effective gait, regardless of age, requires the ability to adapt to overcome environmental factors, reach goals, and also involves the execution of a cognitive task simultaneously with a motor task. This interaction can be explored using the dual-task methodology [5].

Physical quality gains when engaging in physical exercise are related to improved quality of life, autonomy and independence, enabling older individuals to engage in daily living and work activities [6], thus having an important role in maintaining functionality in this population. Also, a balance training intervention can potentially increase habitual physical activities in community-dwelling older adults with osteoporosis [7], which is important for the maintenance of independence and autonomy of older people.

In this study, we will assess the effects of the exercise program with and without dual tasks on the cognitive cost of performing a motor-cognitive dual-task test. The cognitive cost of dual-tasks can be used to indicate the percentage difference between the performance of a single task and the performance of two tasks performed simultaneously [8]. Studies suggest that the concept of interference in dual tasks is an important factor to be analyzed. Interference occurs when the attentional demands of the two tasks exceed the total capacity of attention, consequently leading to a decrease in performance in one or both tasks compared to the performance in a single task [9].

Therefore, the assessment of the effects of a dual-task exercise program on cognitive and physical performance of older people is of paramount importance for maintaining the functionality of this population, given the high risk of falls among this population. Hence, the development of an exercise program that establishes positive

effects on gait parameters, dynamic and static balance, as well as the potential for interpersonal integration of this population, becomes essential for promoting a higher quality of life among community-dwelling older individuals.

Methods

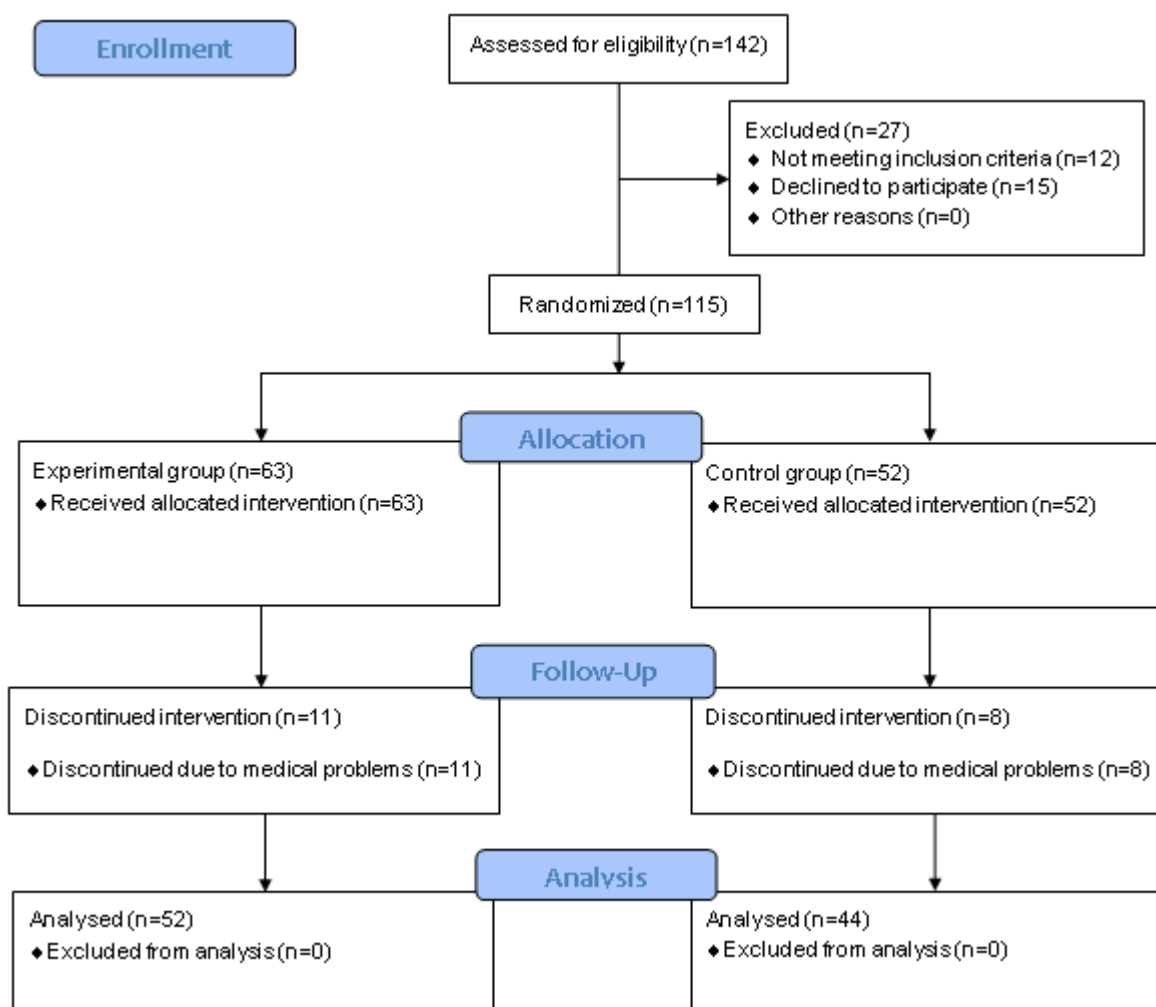
Study design and participants

This study was a controlled clinical trial, with a parallel two-arm design. Participants were randomly allocated into the experimental group (EC) or the control group (CG) using a computer-generated random number for each participant in the trial. Our study utilized an intention to treat analysis protocol. All participants of this study were blindly assigned to both intervention groups. Subjects in both groups were unable to distinguish between the treatments applied. Measurements post-intervention were assessed by independent assessors, who were blind to participant's conditions. In total, 59.72% and 64.91% of participants concluded all proposed reevaluations in the EG and CG respectively. All participants provided written informed consent. The current study was approved by the Ethics Committee of the involved institutions (CAAE 7359822.9.0000.5345 e 57359822.9.3001.5338) and was registered at the Brazilian Registry of Clinical Trials (ID: RBR-6pq5f74).

This study was carried out between March 2022 and August 2023. A total of 133 participants were enrolled in this study and 115 met the inclusion criteria (Figure 1). The inclusion criteria were: (1) male or female community-dwelling older adults who were aged ≥ 60 years; (2) reside in Porto Alegre; (3) be available to participate in the program on the established days and times; and (4) Be physically independent. The exclusion criteria were: (1) physical limitations that made it impossible to perform the proposed exercises; (2) uncontrolled chronic diseases; and (3) incapacitating pain.

Sample size was calculated using G*Power and it was estimated at a minimum of 36 participants (18 in each group), considering the effect size as 1.10, the α error at a probability of 0.05, and the power at 0.95.

Figure 1 - Flow diagram of subjects in the study



Intervention

Sessions were conducted in a group setting by eight pre-trained physical therapy students and took place at a municipal public health center. The sessions lasted for 50 minutes, twice a week, for 16 weeks. All sessions began with a five to seven-minute warm-up period, followed by physical exercises based on the High-Intensity Functional Exercise program (HIFE). The program was composed mostly by balance exercises in combination with standing, walking and lower-limb strength exercises. A full description of the progression of repetitions, intensity and types of strength and balance exercises has been previously published [10]. Intensity of the exercises was tailored to each individual's pace, with encouragement

to progress to higher intensities. Adjustments were made in each session based on individual responses [10].

Experimental Group

Participants in the experimental group were asked to perform a warm-up period followed by exercises described in the HIFE program with the addition of cognitive challenges (such as addition, subtraction, spelling words, identifying requested colors and figures, among others) applied during the execution of motor tasks in 50% of the total of exercises practiced. Cognitive dual-task training involved challenges in inhibitory control, memory, orientation and reasoning, participants were also asked to perform verbal fluency, addition or subtraction tasks.

Control Group

Participants in the control group were asked to perform a warm-up period followed by previously described exercises described in the HIFE program [10].

Outcome measures

Physical performance was assessed by the following tests: ABC Scale (Activities-specific Balance Confidence) questionnaire [11,12], Functional Reach Test [13], Three-Meter Walk Test (3MWT) [14] under both single-task and dual-task conditions (Coin Transfer Test - CTT [15] and a Semantic Verbal Fluency Test - SVFT [16]), and One-minute Sit to Stand Test [17]. Cognitive performance was measured by the application of the Montreal Cognitive Assessment (MoCA test) [18].

To assess the cognitive-motor interference we utilized the absolute values of the performance of the primary motor task (3MWT) and the secondary tasks (CTT or SVFT) individually and when performed simultaneously. The relative values are calculated based on the following formula [19]:

$$\text{Motor-cognitive interference} = \left(\frac{\text{dual-task value} - \text{single-task value}}{\text{single-task value}} \right) \times 100\%$$

Statistical analyses

Data were analyzed using SPSS for Windows (version 22.0). Descriptive statistics were used to present participants' profiles and independent T test and Chi-square analysis were used to compare baseline characteristics. A repeated measure analysis of variance (ANOVA) was applied to assess the effect of the different training programs between baseline and after 16 weeks. A significance level of 5% was adopted.

Results

A total of 96 (EG = 52; CG = 44) subjects participated in the study. There was no difference in characteristics comparing both experimental and control groups at baseline (Table 1). The mean age of the sample was 75.3 (SD \pm 5.8) and 73.8 (SD \pm 5.8) years to EC and CG, respectively, Women composed 94.2% of total participants in the experimental group, meanwhile composing 72.7% in the control group. Session attendance rates were 86.1% (SD \pm 10.7%; CI 95% 82.8 - 89.4). for the control group and 81.9% (SD \pm 12.1%; CI95% 78.5 - 85.4) for the experimental group. There was no significant difference between both groups regarding attendance in training sessions.

Table 1. Sample characterization

	Experimental Group N(%)	Control Group N(%)
Marital Status		
Single	5 (55.6%)	4 (44.4%)
Married/common-law union	21 (50%)	21 (50%)
Divorced	6 (50%)	4 (40%)
Widowed	20 (57.1%)	15 (42.9%)
Education		
Incomplete Elementary	19 (59.4%)	13 (40.6%)
Completed Elementary	5 (41.7%)	7 (58.3%)
Incomplete High School	2 (66.7%)	1 (33.3%)
Completed High School	18 (51.4%)	17 (48.6%)
Incomplete Tertiary	2 (33.3%)	4 (66.7%)
Complete Tertiary	6 (75.0%)	2 (25.0%)

	Experimental	
	Group N(%)	Control Group N(%)
Marital Status		
Single	5 (55.6%)	4 (44.4%)
BMI		
Normal (18-25)	23 (53.5%)	20 (46.5%)
Overweight (25-<30)	17 (58.6%)	12 (41.4%)
Obesity 1 (30-<35)	6 (33.3%)	12 (66.7%)
Obesity 2 (35-<40)	5 (100.0%)	-
Covid	24 (58.5%)	17 (41.5%)
SAH	33 (55.0%)	27 (45.0%)
DM	13 (58.3%)	10 (41.7%)
HFRF	6 (50.0%)	6 (50.0%)
Tobacco use	1 (12.5%)	7 (87.5%)
Alcoholism	4 (66.7%)	2 (33.3%)
Falls	16 (66.7%)	8 (33.3%)

Note: BMI, body mass index; SAH, systemic arterial hypertension; HFRH, heart failure or respiratory failure.

Table 2. Effects of the 16-week intervention

	Experimental group		Control Group	
	Baseline	Post	Baseline	Post
ABC (%)	70.6 ± 17.6	76.4 ± 18.4*	65.2 ± 25.5	80.9 ± 17.1*
FRT (cm)	28.7 ± 6.6	28.1 ± 7.9	29.1 ± 7.5	25.8 ± 8.2
MOCA (points)	20.4 ± 4.4	21.6 ± 4.4	20.5 ± 4.4	21.5 ± 3.8
3MWT (m/s)	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	1.6 ± 0.4
3MDT+COG (m/s)	0.9 ± 0.3	0.9 ± 0.3	1.1 ± 0.4	1.1 ± 0.4

DTE (%)	-30.8 ± 21.9	-33.9 ± 18.9	-23.8 ± 27.5	-33.9 ± 19.2
3MDT+MOT (m/s)	0.9 ± 0.3	1.0 ± 0.3	1.1 ± 0.4	1.1 ± 0.4
DTE (%)	-33.0 ± 24.1	-29.5 ± 19.6	-23.3 ± 24.6	-29.6 ± 20.3
60 CST (rep.)	19.4 ± 5.0	20.7 ± 5.0	21.8 ± 5.5	23.3 ± 5.3

Note: ABC, Activities-specific Balance Confidence questionnaire; FRT, Functional Reach Test; MOCA, Montreal Cognitive Assessment Test; 3MWT, Three-Meter Walk Test; 3MDT+COG, Three-Meter Walk Test associated with cognitive dual-task; 3MDT+MOT, Three-Meter Walk Test associated with motor dual-task; DTE, Dual-task effect; 60 CST, One-minute Sit to Stand Test.

Mixed repeated measure ANOVA demonstrated a significant effect of time on balance confidence [F (1.94) = 29.6, $p > 0.001$]. In addition, mixed repeated measure ANOVA demonstrated a significant interaction of time and intervention group [F (1.94) = 6.2, $p < 0.05$]. Post-hoc comparisons indicated that participants of both groups increased ABC scores following intervention period [HIFE+DT and HIFE (VD = -5.8, IC95% = -11.1 to -0.5, $p < 0.05$; MD = -15.7, IC95% = -21.5 to -9.9, $p < 0.001$), respectively.

After 16 weeks of training, mixed repeated measure ANOVA demonstrated a significant effect of time on balance [F (1.94) = 6.5, $p < 0.05$]. No effect was observed on the interaction of time and intervention group [F (1.94) = 3.0, $p > 0.05$].

Mixed repeated measure ANOVA demonstrated a significant effect of time on cognition [F (1.94) = 14.7, $p > 0.001$]. No effect was observed on the interaction of time and intervention group [F (1.94) = 0.1, $p > 0.05$].

Mixed repeated measure ANOVA demonstrated a significant effect of time on gait speed [F (1.94) = 6.2, $p < 0.05$]. No effect was observed on the interaction of time and intervention group [F (1.94) = 3.1, $p > 0.05$].

Mixed repeated measure did not demonstrated effects of time on gait following cognitive [$F(1,93) = 1.2, p > 0.05$] or motor [$F(1,94) = 0.4, p > 0.05$] dual-task situations. Also, no effect was observed on the interaction of time and intervention group on gait following cognitive [$F(1,93) = 0.5, p > 0.05$] or motor [$F(1,94) = 1.0, p > 0.05$] dual-task situations.

Considering the dual-task effects, mixed repeated measure demonstrated a significant effect of time [$F(1,93) = 5.4, p < 0.05$] on cognitive only. No effect was observed on the interaction of time [$F(1,94) = 0.2, p > 0.05$] on motor dual task effect. Mixed repeated measure did not demonstrated effects on the interaction of time and intervention group of both categories [$F(1,93) = 1.5, p > 0.05$; $F(1,94) = 3.0, p > 0.05$] cognitive and motor respectively.

Finally, mixed repeated measure ANOVA demonstrated a significant effect of time on functional lower extremity strength [$F(1,94) = 12.5, p < 0.01$]. No effect was observed on the interaction of time and intervention group [$F(1,94) = 0.1, p > 0.05$].

Discussion

The purpose of this study was to analyze the effects of a regular motor-cognitive dual-task exercise program on the physical performance of older individuals. It also aimed to assess its impact on the cognitive cost associated with performing a walking task simultaneously with secondary motor or cognitive tasks.

Both a high-intensity functional exercise program based on The Hife Program and the same program with 50% of physical exercises associated with cognitive stimulation showed significant improvements in balance confidence, dynamic balance, cognitive function, gait speed and functional lower extremity strength of older adults after 16 weeks of intervention.

Our results are in accordance with previous evidence demonstrating that a progressive resistance strength training is an effective intervention for improving physical functioning in older people, as it improves strength and the performance of simple and complex daily activities [20]. In addition, exercise combined with external

attentional focuses or challenging cognitive tasks have been demonstrated to improve motor performance in older adults [21].

After the intervention, both groups had significant improvements in The Activities-specific Balance Confidence (ABC) scale when compared to baseline evaluations ($p > 0.001$). More specifically, the total score of balance confidence (%) was 80.9% and 76.4% in control and experimental groups respectfully. This can be explained as the activities performed in the experimental group were harder and more complex when compared to tasks given to the participants in the control group, thus the participants may have experienced failures in the process of completing them which could lead to poorer balance confidence and self-efficacy in performing daily tasks [22]. Functionality and independence in ADLs depend on mobility, which is related to strength, balance, and gait performance. These gains can be associated with an increase in balance confidence. Improvement in the variables above may also explain better confidence scores in both groups.

Different factors contribute to a decline in postural control during the aging process, such as decreased weighting of proprioceptive information, increased dependence on visual information, increased coactivation of leg antagonist pairs, and increased cognitive load to maintain balance [23]. Our study demonstrates that participants in the experimental group experienced a lesser decline in dynamic balance, more specifically -2.09% when compared to a -11.34% decline in the control group. This is corroborated by a meta-analysis that suggested beneficial effects of dual-task training with variable priority for enhancing postural stability, especially among older individuals [24]. Our findings are similar to what other researchers found in a study comparing a balance training program and a perturbation training program [25], it was showed that components of a perturbation training (such as ball catching/throwing exercises and foot passing exercises) improves anticipatory muscular activity and muscle latency contraction in aging population. The previously mentioned exercises were more emphasized in the experimental group, thus could explain why its participants experienced a lesser decline in dynamic balance.

The results of the present study suggest that the 16 week intervention not only can maintain cognitive function but also slightly improve it as demonstrated by an increase in MOCA scores on both experimental and control groups. This effect is expected as general physical training has positive outcomes for brain structure and function and positively impacts cognition, without necessarily targeting one specific cognitive function [26]. Furthermore, a high intensity training protocol is an effective training method for acutely increasing peripheral brain-derived neurotrophic factor levels in adults, and it may effectively increase it in the long term [27]. An increase in BDNF levels is important as it has neurotrophic, neuroprotective and cognitively beneficial properties [28].

It is well known that cognitive impairments are expected as aging occurs, such as disproportional age-related decrease in executive function (responsible for planning, initiating, sequencing, and monitoring complex goal-directed behavior as well as controlling complex activities) [29]. Thus, the maintenance of cognitive function in older people induced by exercise via increased BDNF-facilitated neurogenesis and neuroplasticity, improvement in vascular function, reduced stress and inflammation, and improved insulin sensitivity is a positive result and of paramount importance in this population [30].

Also it should be noted that the MoCA test is a cognitive screening test and potentially has a “ceiling effect” in different cognitive domains, which may limit the observation of gains in domains that already have a maximum score in the pre-test [31]. Interestingly, no significant difference was obtained between the experimental and control groups, we suggest that only half of the exercises being prescribed in dual task fashion may not be enough to demonstrate a more positive effect on cognitive function when compared to a high-intensity functional exercise program based on The Hife Program.

Regarding gait speed as assessed by the 3 meter walking test, both groups demonstrated better results after 16 weeks of training, when compared to baseline measurements. This is an important finding as gait speed has been well documented as closely associated with disabilities, frailty, sedentary lifestyle, falls, muscle

weakness, cognitive impairment, lower quality of life and life satisfaction and high mortality rates in community-dwelling older individuals [32]. Comparing baseline and post intervention evaluations, the control group had greater results when compared to the experimental group, our findings corroborate what a randomized control trial found in 12 months of a physical and cognitive training program, where the intervention did not improve gait speed over a multicomponent physical training in older community-dwelling men and women [33]. In our case a multicomponent exercise program such as the Hife program can induce greater adaptations to gait parameters without the increase in complexity of a motor cognitive dual-task physical exercise program.

Our hypothesis related to superior effects of the experimental group on physical performance was rejected as it did not demonstrate superior results when compared to the control group. These results are in accordance with previous ones that also didn't find differences comparing single task and dual task exercise programs on physical performance in older adults [34-36]. It's important to consider that the present study was based in an group-intervention protocol, and that group-based exercise programs regardless of the intervention could require additional cognitive demands in executive functions when compared to an individual training program. Such demands include a greater inhibitory control of attention, and more specifically, interference control which is crucial to selectively attend a specific task, focusing on it and suppressing attention to other stimuli [37], like environmental distractions and external noises in general. Thus, the allocation of cognitive resources to avoid environment distractors during sessions could, in part, explain why there was no significant difference between the intervention groups. Furthermore, considering that The Hife Program protocol include exercises such as "reaching for an object in various directions", "throwing and catching a balls", and "kicking a ball" and all its varying complexities we could infer that the program is not composed only by single task exercises but also by motor-motor dual task situations [10] which may have impacted our results.

Gait speed while performing a cognitive dual task remained the same after the 16 weeks of intervention on both experimental and control groups, considering that dual-task performance is the interference of one task due to concurrent performance of a second task resulting in a pattern of performance deterioration of one or both tasks [38] and it declines during the aging process, our findings suggest that both a multicomponent single-task and dual-task training programs can maintain this important aspect of functionality.

When comparing baseline assessments on gait speed during a simultaneous motor dual-task, only the experimental group showed a significant benefit, improving more than 0.05 m/s which is considered functionally meaningful [39].

Additionally, our study showed that the experimental group exhibited significant intervention benefits on dual task effect during the 3 meter walking test associated with motor and cognitive dual-tasking when compared to the control group. Both groups demonstrated a decline on DTE% while performing a cognitive dual-task, however CG had a 10% decline when compared to a 3% decline in EG. This is explained as other studies found that reduced dual-task interference was only observed after dual-task training [40].

Analyzing DTE% while performing a motor dual-task, the present study shows that the experimental group had a percentage increase of 10.61% whereas there was a 27.04% percentage decrease in the control group. This difference could be explained as the dual-task intervention may have exposed participants to more motor-motor exercises during the training program, thus leading to improved performance.

After 16 weeks of training, functional lower extremity strength as measured by the 60CST test improved in both intervention groups, having a 6.70% and a 6.88% percentage increase in scores post intervention in EG and CG respectively. This is justified as a The Hife program improves participant's lower-limb strength, balance, and mobility in general. Also a high intensity functional exercise program is expected to improve physical functioning and can be an effective exercise modality to

counteract declines in functional capacity and sedentary behavior associated with aging [41].

Although both intervention groups demonstrated similar results on physical and cognitive performance, the experimental group showed better outcomes regarding cognitive cost when performing motor tests in dual-task conditions. This finding is important as completing activities of daily living is associated with our executive function [42] and consequently our ability to dual task, proving to be essential for a healthy aging process.

In conclusion, the results of our study confirm that a high intensity functional exercise program alone or associated cognitive stimulation effectively improves dynamic balance, functional lower extremity strength, gait speed and cognitive function community-dwelling older adults. In conclusion, we consider that associating cognitive stimulation to a high intensity functional exercise program in a motor-cognitive dual-task fashion does not improve cognition and physical performance when compared to a high Intensity functional exercise program alone after 16 weeks of training.

Future considerations

To effectively improve cognitive and motor performance we consider that the training protocols should include a level of task specificity to promote task related adaptations, and variable task prioritization of the training tasks [43] whereas in our study we prioritized a general dual task approach, this type of training aims to improve the general processing capacity that is crucial in several different tasks and to achieve this goal, a variety of different task-combinations are used in order to achieve this ultimate objective [44]. An alternative approach of focusing cognitive training on specific tasks based on the needs of participants assessed by MOCA scores domains could prove to be more beneficial.

Acknowledgements: We would like to thank all the community-dwelling men and women who participated in our study. We are also grateful for the cooperation

throughout the study from the staff of the municipal public health center in IAPI, Porto Alegre.

Declaration of Conflicts of Interest: None declared.

Declarations of Sources of Funding: None of the authors received funding.

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APPENDICES

APPENDIX A - COGNITIVE CHALLENGES

The cognitive challenges applied during the execution of motor tasks resemble those used in the testing phases.

A - Inhibitory control challenge, using the Stroop Color-Word Test method, in which the participant sees the name of a color written in full, but the text is written in a different color. Depending on what is requested by the researcher, the participant must then say the word that is written, the color in which the word is written, or the initial letter of the word;

B - Verbal fluency and reasoning challenge, in which participants will be instructed to recite aloud the months of the year or the days of the week in reverse order (December, November, October, September, August, July, June, May, April, March, February, January);

C - Orientation challenge, in which a clock-like figure containing the numbers 12, 3, 6, and 9, each in a different color, is placed on the floor, so that the participant is positioned in the center, facing 12 o'clock. The researcher then recites the colors of the numbers, or their equivalent times, so that the participant must take a step in the direction that was instructed (upon hearing the command "12 o'clock," the participant should take a step forward; upon hearing the command "3 o'clock," the participant should take a step to the right; upon hearing the command "6 o'clock," the participant should take a step backward; upon hearing the command "9 o'clock," the participant should take a step to the left. The researcher can use equivalent commands, such as "noon" or "six o'clock").

D - Memory challenge, in which the researcher starts, for example, a shopping list, and each participant must add an item, reciting all the others said

previously in the correct order, so that with each new participant adding their item, the list grows longer. For example, the researcher begins by saying: "I went to the market and bought an apple." Participant 1: "I went to the market and bought an apple and a banana." Participant 2: "I went to the market and bought an apple, a banana, and beans"; and so on. The list can be created in various ways, based on other contexts, such as names of animals (I went to the zoo and saw a...), etc.

E - Addition or subtraction. The participants must mentally and aloud perform calculations recited by the researcher. They will be asked to add $10 + 3$; to subtract $30 - 17$; to add $50 + 12$; to subtract $38 - 15$.

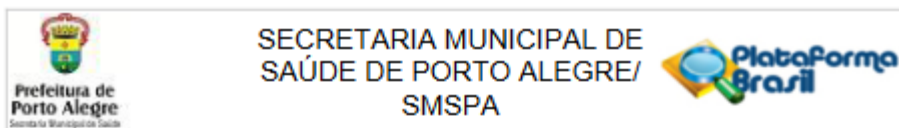
F - Naming objects. During the execution of the exercises, the researcher will present some everyday objects to the participant, such as a bottle, a pen, a comb, or a cell phone. The participant must name them.

G - Orientation challenge, in which the researcher will ask the participant to state the current day of the week, approximate time, month, or year.

The challenges from A to G, as well as their possible variations, will be associated with strength exercises and applied to Groups 1 and 2. It is important to emphasize that the level of the challenge requested will respect the participant's level of education.

ANN EX

ANNEX A

**PARECER CONSUBSTANCIADO DO CEP**

Elaborado pela Instituição Coparticipante

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Efeitos de um programa de exercícios de dupla tarefa na execução da marcha de idosos

Pesquisador: Adriana Torres de Lemos

Área Temática:

Versão: 1

CAAE: 57359822.9.3001.5338

Instituição Proponente: Secretaria Municipal de Saúde de Porto Alegre

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 5.947.867

Apresentação do Projeto:

A expectativa de vida da população idosa vem aumentando gradativamente ao longo dos anos. O envelhecimento é um processo não patológico, entretanto, pode vir acompanhado de uma série de disfunções musculoesqueléticas e cognitivas, decorrentes de fatores majoritariamente modificáveis. Tais disfunções podem influenciar negativamente no desempenho funcional dos indivíduos idosos, interferindo na qualidade de vida e independência dessa população. Estudos apontam que a prática de exercício físico, de atividades motoras, de desafios cognitivos, bem como a associação destes, têm impacto positivo no que diz respeito à neuroplasticidade, proporcionando aprimoramento da atenção, qualidade da marcha e equilíbrio.

Espera-se que a participação regular em um programa de exercícios de dupla tarefa motora-cognitiva mostre resultados superiores, quando comparados à exercícios motores individuais, e promova melhora na qualidade da marcha de indivíduos idosos, diminuindo, assim, o risco de quedas e favorecendo a independência e a participação na comunidade.

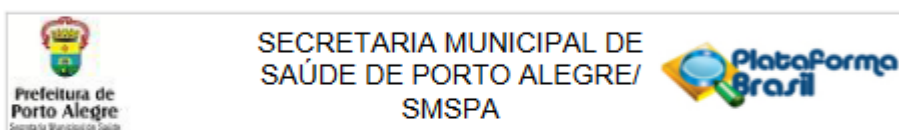
Objetivo da Pesquisa:

Principal:

Avaliar o efeito de um programa regular de exercícios de dupla tarefa na qualidade da marcha de indivíduos idosos.

Endereço: Rua Capitão Montanha, 27 - 6º andar
Bairro: Centro Histórico **CEP:** 90.010-040
UF: RS **Município:** PORTO ALEGRE
Telefone: (51)3289-5517 **Fax:** (51)3289-2453 **E-mail:** cep_sms@hotmail.com

Página 01 de 04



Continuação do Parecer: 5.947.667

Secundário:

- Avaliar o efeito do programa de exercícios com e sem dupla tarefa sobre a qualidade de vida, confiança em equilíbrio, depressão geriátrica e capacidade cognitiva;
- Avaliar o efeito do programa de exercício com e sem dupla tarefa no custo cognitivo para realização dos diferentes testes motores.

Avaliação dos Riscos e Benefícios:

Riscos

Pode haver algum desconforto emocional em responder aos questionários. Durante a execução dos exercícios, pode ocorrer cansaço físico e, após, dor muscular decorrente do programa de treinamento. Há um mínimo risco de que quedas possam ocorrer durante a aplicação dos testes.

Benefícios

Colaboração com o aumento de conhecimento na área de Fisioterapia em Gerontologia, para a busca de novos métodos de aplicação de exercícios físicos para idosos da comunidade e participação gratuita em programa de exercício físico por 12 meses.

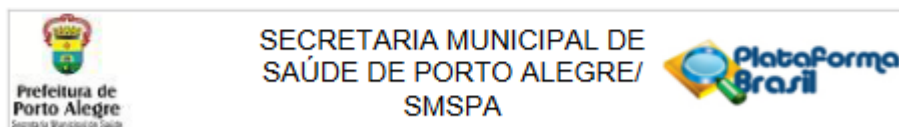
Comentários e Considerações sobre a Pesquisa:

- a. Título: Efeitos de um programa de exercícios de dupla tarefa na execução da marcha de idosos.
- b. Pesquisador responsável: Adriana Torres de Lemos.
- c. Equipe de pesquisa: Felipe de Souza Stigger; e Enzo Albani Rossoni Teza.

- d. Nível da pesquisa: Ausente, esclarecer.
- e. Instituição: Universidade Federal de Ciências da Saúde de Porto Alegre.
- f. Curso: Programa de Fisioterapia da Universidade Federal de Ciências da Saúde de Porto Alegre.
- g. Local de realização do estudo: Ausente, esclarecer.
- h. Duração do estudo: vinte e quatro meses.
- i. Número de sujeitos da pesquisa: O tamanho amostral calculado foi de 18 idosos em cada grupo, utilizando o programa G*Power versão 3.1.9.2. Esclarecer o número total de grupos e explicitar o número total de participantes.
- j. Critérios de inclusão: Ter 60 anos de idade, ou mais; residir em Porto Alegre; ter disponibilidade para participar do programa nos dias e horários estabelecidos; e ser fisicamente independente.
- k. Critérios de exclusão: Possuir limitações físicas que impossibilitem a execução dos exercícios propostos; doenças crônicas não controladas; dor incapacitante.
- l. Data prevista para conclusão do estudo: dezembro de 2024.
- m. Orçamento: O orçamento apresentado se constitui em um valor global, na ordem de R\$ 150,00 (cento e cinquenta reais), cuja origem não é informada.

Endereço: Rua Capitão Montanha, 27 - 6º andar	
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Continuação do Parecer: 5.947.667

Considerações sobre os Termos de apresentação obrigatória:

- a. Analisar a redação do TCLE – Termo de Consentimento Livre e Esclarecido (TCLE). Presente e de acordo com a investigação proposta.
- b. Termo de uso de imagem e som – Ausente, esclarecer.
- c. Formulário de projeto de pesquisa (quem assinou e quando foi assinado): Assinado pela Universidade

c. Formulário de projeto de pesquisa (quem assinou e quando foi assinado): Assinado pela Universidade Federal de Ciências da Saúde de Porto Alegre, através da Pró-Reitora de Pesquisa e Pós-Graduação, Dinara Jaqueline Moura, em 25 de março de 2022.

d. Termo de ciência e autorização da coordenação (quem assinou e quando foi assinado): Não localizado.

e. Termo de compromisso de utilização e divulgação dos dados – Ausente, esclarecer.

f. Outros documentos – Parecer Consubstanciado do CEP Universidade Federal do Rio Grande do Sul, assinado por Fernanda Bordignon Nunes em 10 de março de 2023.

g. Emenda – A solicitação de emenda ao projeto se deve à alteração no cronograma de coleta de dados e, conseqüentemente, de análise destes. Justifico a necessidade de ampliação do prazo do estudo para que possamos contemplar o número amostral calculado no projeto. Assim, a data de término do estudo será alterada de 31/08/2023 para 30/12/2024, sendo o término da coleta de dados alterado de 16/05/2023 para 30/09/2024. A única modificação que ocorreu no projeto foi a acima descrita, motivo pelo qual rerepresentamos o projeto (destaque em amarelo para o cronograma), apresentamos um anexo com a página de cronograma modificado e alteramos o mesmo na página da plataforma Brasil (esse fato causou um problema em relação ao registro do início das coletas, pois não é permitido colocar data de início anterior à data atual, mesmo em se tratando de emenda. Assim, o registro da data de início de coleta ficou equivocado, tendo em vista que esta já foi iniciada conforme cronograma disposto na versão anterior).

Recomendações:

Anexar Curriculum Lattes, de todos os pesquisadores envolvidos, devidamente atualizado.

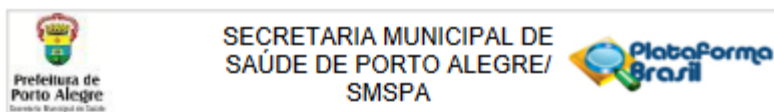
Sugere-se modificação no cronograma, devendo passar a constar a revisão bibliográfica até o penúltimo mês, haja vista que novos estudos referenciais podem ser obtidos, porém sem necessidade de nova emenda.

Conclusões ou Pendências e Lista de Inadequações:

Aprova-se o pedido de alteração do Cronograma de acordo com a justificativa apresentada na emenda anexada, haja vista a necessidade de contemplar o número amostral calculado no projeto.

Considerações Finais a critério do CEP:

Endereço: Rua Capitão Montanha, 27 - 6º andar	CEP: 90.010-040
Bairro: Centro Histórico	
UF: RS	Município: PORTO ALEGRE
Telefone: (51)3289-5517	Fax: (51)3289-2453
	E-mail: cep_sms@hotmail.com



Continuação do Parecer: 5.947.667

O parecer de aprovação do CEP SMSPA deverá ser apresentado à Coordenação responsável, a fim de organizar a inserção da pesquisa no serviço, antes de seu início. Os relatórios semestrais devem ser apresentados ao CEP SMSPA, através de submissão na Plataforma Brasil, como "Notificação".

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Outros	Emenda_janeiro_23.pdf	04/01/2023 19:33:20	Adriana Torres de Lemos	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Completo_janeiro_23.pdf	04/01/2023 19:32:37	Adriana Torres de Lemos	Aceito
Outros	Carta_Resposta.pdf	28/04/2022 16:58:41	Adriana Torres de Lemos	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Completo.pdf	28/04/2022 16:58:26	Adriana Torres de Lemos	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE.pdf	28/04/2022 16:58:07	Adriana Torres de Lemos	Aceito
Outros	AutorizacaoSMS.pdf	30/03/2022 11:50:02	Adriana Torres de Lemos	Aceito
Outros	Termo_compromisso_relatorios.pdf	30/03/2022 11:47:22	Adriana Torres de Lemos	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

PORTO ALEGRE, 16 de Março de 2023

Assinado por:
Alexandre Luis da Silva Ritter
(Coordenador(a))

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ANNEX B

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- [Conducting and reporting trials for older people](#)
- [Review of methodologies of cohort studies of older people in](#)
- [Review of Diagnostic Test Accuracy \(DTA\) studies in older people](#)
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