EFFECT OF DIFFERENT WEEKLY COMBINED TRAINING FREQUENCIES ON FUNCTIONAL CAPACITY, HEMODYNAMIC AND ANTHROPOMETRIC ASPECTS OF ELDERLY PEOPLE WITH CARDIOMETABOLIC RISK FACTORS

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Abstract

Objective: The objective of this study was to compare the effects of two different weekly frequencies of a 12-week combined training period on functional capacity, hemodynamic, and biochemical profile in older people with cardiometabolic risk factors. Methods: This is a pragmatic clinical trial. Functional, hemodynamic, and biochemical outcomes were assessed at baseline and after 12 weeks. Participants were divided into two groups: G2x (trained twice a week), and G3x (trained three times a week). Both groups performed the same training program, which consisted of strength and aerobic training with progressive intensity. Data analysis was performed using intention to treat (ITT), employing a 2-way analysis of covariance (ANCOVA) for repeated measures, with the baseline values used as covariates. The significance adopted was 0.05.

1. INTRODUCTION

The population ageing is a global trend that brings significant challenges for promoting health and quality of life, since the prevalence of cardiometabolic risk factors and gradual loss of functional capacity, reduced aerobic fitness, strength, and agility in older adults is more pronounced[1]. The presence of risk factors, such as hypertension, diabetes, and dyslipidemia, increases the susceptibility of older people to cardiovascular diseases, which remain one of the leading causes of morbidity and mortality worldwide[2]. In addition, older adults with cardiometabolic risk factors exhibit lower functional capacities, such as muscle strength, mobility, lower and upper limb power and flexibility, compared to older adults without cardiometabolic risk factors[3,4].

Exercise is consolidated as a valuable tool for improving functional capacity[5], cardiovascular health[6,7], and metabolic and biochemical markers[8,9] in older adults with cardiometabolic risk factors[10]. Although there is a consensus regarding the benefits of exercise for the older population with cardiometabolic risk factors, determining the dose-response of the training for this population still generates uncertainty. Current recommendations suggest performing multicomponent training two to three times per week[5]; however, this variation still raises questions about the most effective weekly frequency to optimize health outcomes in this population.

In this sense, comparisons between strength training frequencies were conducted in postmenopausal women with osteoporosis, showing better outcomes for three sessions per week compared to twice-weekly sessions and a control group[11]. On the other hand, a clinical trial comparing one, two, and three weekly sessions of combined training in women over 60 years old found no significant differences between the training groups[12]. However, no studies were found comparing different weekly session frequencies of combined training involving individuals with cardiometabolic risk factors.

Thus, the optimization of training prescription through the manipulation of different training variables, such as weekly frequency, still requires further investigation from a functional, cardiovascular, and metabolic perspective. Therefore, this study aims to investigate the effects of two different weekly frequencies of combined training on functional capacity, blood pressure, and biochemical profile in older adults with cardiometabolic risk factors. We hypothesized that performing three weekly sessions of

combined training would lead to better adaptations in cardiovascular risk factors and functional capacity than performing two weekly sessions.

1.1 OBJECTIVES

1.1.2 General Objective

To compare the effect of two different weekly frequencies of combined training on functional capacity, hemodynamic and anthropometric aspects of elderly individuals with cardiometabolic risk factors.

2. METHODS

2.1. EXPERIMENTAL APPROACH TO THE PROBLEM

This study was a pragmatic clinical trial with two intervention groups. Initially, an anamnesis was conducted to collect sociodemographic data and information about the participants health, as well as to investigate their engagement in other physical activities. Subsequently, anthropometric, functional, hemodynamic, and biochemical assessments were performed for two weeks. After these baseline assessments, participants were divided into two groups: one group performed combined training twice a week (G2x), and the other group three times a week (G3x). Both groups followed the same training program, which lasted 12 weeks, with the total exercise volume being higher in the group that trained three times per week due to the increased session frequency. All the assessments performed at baseline were repeated after 12 weeks.

2.2. ETHICAL APPROVAL

The research was performed in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee for Research Involving Human Beings of the Federal University of Santa Catarina, Brazil (CAAE: 3.615.659), in accordance with Resolution 466/12 of the National Health Council on research involving human subjects.

2.3. SUBJECTS

The participants in this study were individuals enrolled in the Cardiopulmonary Prevention and Rehabilitation Program (PROCOR) which is a community program for individuals with cardiometabolic risk factors offered by the Federal University of Santa Catarina (UFSC). This program provides specialized support for the safe practice of physical exercises and the promotion of cardiovascular health. Due to the structure of the program and the prior enrollment of participants, it was not possible to randomize the groups.

The inclusion criteria were being enrolled in the PROCOR program, having medical clearance to perform physical exercises, presenting one or more cardiometabolic risk factors, and having no physical limitations that could impair the execution of the proposed exercises.

2.4. PROCEDURES

2.4.1. Training Protocol

The intervention was conducted with two groups following the same supervised combined training protocol, differing only in weekly frequency. The G2x group performed sessions on Tuesdays and Thursdays, while the G3x group participated in sessions on Tuesdays, Thursdays, and Fridays. The training program was carried out at the UFSC rehabilitation center and the strength training room, under the supervision of Physical Education professionals and students.

Initially, the participants underwent two weeks of familiarization aimed at introducing them to the Borg scale (6-20) and providing guidance on the correct execution of strength exercises. This process also sought to ensure proper adaptation to the protocol. The program was structured into three mesocycles, each lasting four weeks, with the goal of progressively increasing training intensity from one mesocycle to the next.

During strength training, participants performed four exercises: bench press, leg press, seated row, and hip abduction machine. Additionally, at the beginning of each mesocycle, load assessments were conducted, in which participants performed the first set at the lower limit of the repetition zone and in the second set, they were instructed to perform the maximum number of repetitions, both with the same load used during the previous mesocycle. As a safety precaution, the number of repetitions was limited to a maximum of 20. Based on the number of repetitions exceeding the lower repetition limit (RE), the load was adjusted to the mesocycle as follows[13].

Upper limb exercises: Final weight (Kg) = weight used in the test (Kg) + RE/2

Lower limb exercises: Final weight (Kg) = weight used in the test (Kg) + RE

The aerobic training consisted of interval and pyramid workouts performed on treadmills. Intensity was prescribed using the Borg rating of perceived exertion scale (6-20), and higher intensities were achieved through variations in speed or incline. For those

training three times per week, two sessions were focused on speed variation, and one on incline variation. Participants trained twice per week, alternating between sessions of speed variation and incline variation.

2.5. PRIMARY OUTCOME (FUNCTIONAL CAPACITY)

2.5.1. Strength

Lower limb strength was measured using the 30-second sit-to-stand test. The test result used was the number of repetitions performed in this time, in one attempt[14]. Upper limb strength was assessed using the 30-second arm curl test, with a 2.0 kg dumbbell for women and a 4.0 kg dumbbell for men. The test result was the total number of curls completed in a single attempt with the dominant arm[14].

2.5.2. Balance/Agility

Agility/dynamic balance was measured using the Timed Up and Go (TUG) test[15]. The test result was the shortest time to stand up from a seated position, walk 3.00 meters, turn around, and return to the seated position. The TUG was performed at two walking speeds (maximum and usual), with two attempts for each, and the shortest time of each speed was recorded.

2.5.3. Flexibility

Flexibility was assessed using the sit-and-reach test, in which participants sat on a mat with their legs fully extended and their feet placed against a box used for the test, reaching forward[16]. The total distance reached represented the final score, with two reach attempts recorded.

2.5.4. Cardiorespiratory Fitness

Aerobic capacity was evaluated using two tests: the 6-minute walk test (6MWT), which participants completed one attempt, and the result was the total distance covered in that time[14]; and the 1000-meter test (1000m), that was developed due to the presence of a ceiling effect observed in the 6MWT in many participants in previous PROCOR training semesters, in which participants also made one attempt, and the score was the total time in seconds to complete the distance, allowing walking and/or running.

2.6. SECONDARY OUTCOMES

2.6.1. Hemodynamic profile

Three blood pressure measurements were obtained using a portable automatic monitor (OMRON, model HEM-7200, Brazil). Each participant remained seated and in silence for 10 minutes, and then three measurements of blood pressure and heart rate were taken, with a one-minute interval between each. The same procedure was repeated on a second day, resulting in a total of six systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements (in mmHg) and six heart rate measurements. The final values were determined by calculating the arithmetic mean of the measurements from both days, resulting in the final average. Additionally, mean arterial pressure (MAP) was calculated using the standard equation: $MAP = (SBP + 2 \times DBP) / 3$[(2)].

2.6.2. Biochemical Profile

Participants were instructed to fast for 12 hours and retain their usual medication intake. Blood samples were collected through venipuncture using serum separator tubes without anticoagulant. The analyzed biochemical parameters included the lipid profile (total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides) and fasting glucose, all expressed in mg/dL. The analyses were performed at the Clinical Biochemistry Laboratory of UFSC. Triglycerides, total cholesterol, and HDL were measured using an enzymatic colorimetric method, while LDL was calculated using Friedewald's formula: LDL-c = CT - (HDL-c + TG/5), where TG/5 represents the cholesterol associated with VLDL. All analyses were conducted using the Mindray BS-120 biochemical automation equipment, following the manufacturer's instructions. Renal function was assessed by measuring creatinine levels using a modified Jaffé method.

2.7. STATISTICAL ANALYSES

The data were analyzed using JASP (Version 0.19.3) [computer software]. The characterization variables had their normality and homogeneity tested using the Shapiro-Wilk and Levene tests, respectively. Variables classified as normal are presented as the mean and standard deviation. Categorical variables for characterizing the sample are presented as absolute frequency (sample *n*) and relative frequency (%). For comparing baseline characteristics between groups, the independent *t*-test was used for continuous

data and Fisher's exact test for categorical data. To compare adherence between groups, the Wilcoxon rank sum test was used, and data are presented as median and interquartile range (P25-P75).

For the comparison of the group (G2x and G3x) and time (pre-intervention and post-intervention), a 2-way analysis of covariance (ANCOVA) for repeated measures was performed, with the baseline values used as covariates. Outcomes were analyzed by intention to treat (ITT), which included all patients, once randomized, and missing data were imputed with simple imputation, replacing missing values with the last observed value. The significance adopted was 0.05.

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APPENDIX

APPENDIX A – FREE AND INFORMED CONSENT FORM

FREE AND INFORMED CONSENT FORM

Title: EFFECTS OF COMBINED TRAINING ON HEALTH PARAMETERS IN INDIVIDUALS WITH CARDIOVASCULAR RISK FACTORS.
Principal Investigator: Prof. Dr. Aline Mendes Gerage da Silva (CDS/UFSC)
Dear Sir/Madam, you are being invited to participate in a research project to be conducted by the Federal University of Santa Catarina, whose **objective** is to analyze the effects of a low-cost and easily applicable combined physical training program on health parameters in individuals with cardiovascular risk factors. This project is based on Resolution 466/2012 of the National Health Council, and the researchers commit to complying with all its provisions.
Justification: Combined training (aerobic + strength) is considered one of the main non-pharmacological strategies used in the prevention and treatment of cardiometabolic diseases. Understanding the short-, medium-, and long-term effects of this type of training helps clarify the risks and benefits of this practice in individuals who already present risk factors for cardiovascular diseases.
Inclusion criteria: Being between 45 and 80 years old, having at least one cardiometabolic risk factor (Hypertension, Diabetes, and/or other cardiovascular disease), and being fit to engage in physical exercise.
Exclusion criteria: Not properly using medication for an existing chronic condition; presenting severe complications of the existing chronic condition (e.g., severe autonomic neuropathy in individuals with Diabetes); and having muscular and/or joint impairments that prevent the performance of physical exercise.
Procedures: By agreeing to participate in the study, you will undergo the following procedures:
a) measurement of body mass, height, and body composition assessment;
b) evaluation of functional capacity (strength, muscular endurance, flexibility, agility, and cardiorespiratory fitness in field and laboratory);
c) assessment of psychosocial outcomes (quality of life, sleep, depressive symptoms) and cognitive health;
d) measurement of blood pressure and capillary blood glucose before and after some sessions;
e) blood tests for cardiometabolic biomarkers;
f) heart rate measurements;
g) dietary habits assessment;
h) internal and external training load monitoring;
i) aerobic and strength training, with possible inclusion of non-conventional modalities (stretching, Yoga, etc.) or nutritional intervention;
j) scheduled open interviews.
Risks and discomforts: The procedures are low risk and similar to those already performed in the extension project. Possible mild discomfort during blood tests or fatigue during exercise may occur. Questionnaires may cause minor emotional discomfort. Participants may stop at any time. Full support will be provided in case of any adverse event.

Benefits: Participants may benefit from monitoring of blood pressure and glucose, health education, and individualized exercise prescription.
Confidentiality: Participant identity will be preserved. Data will be used only for scientific purposes. Participants may withdraw at any time without penalty.
Compensation and indemnification: There are no costs or payments. In case of expenses or damages, compensation is guaranteed according to regulations.

The participant may withdraw consent at any time without penalty and without affecting participation in the extension project.

Participant signature: _____
Date: ___/___/_____

Sincerely,

Prof. Dr. Aline Mendes Gerage da Silva (UFSC)
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APPENDIX B – Anamnesis

I) SOCIODEMOGRAPHIC PROFILE

I.1) Full Name:_____

I.2) Address: _____

I.3) CEP: _____ **I.4) Contact Phone:** _____ **I.5) Mobile:** _____

I.6) In case of emergency, notify (name and phone): _____

I.7) Date of birth: ____/____/____

I.8) Marital status: (0) Married/partnered (2) Single
(1) Separated/divorced (3) Widowed

I.9) Education level: (0) Incomplete elementary school (1) Incomplete high school
(2) Elementary school completed (3) High school completed (4) Incomplete higher education
(5) Higher education completed

II) HEALTH HISTORY

II.1) Has a doctor ever told you that you have or have had:

II.1.1) Coronary artery disease (0) No (1) Yes How long?_____

II.1.2) Hypertension / high blood pressure (0) No (1) Yes How long?_____

II.1.3) Diabetes (high blood sugar) (0) No (1) Yes How long?_____

II.1.4) High cholesterol and/or triglycerides (blood fat) (0) No (1) Yes How long?_____

II.1.5) Pulmonary disease (asthma, emphysema, COPD, etc.) (0) No (1) Yes How long?_____

II.1.6) Enlarged heart or history of heart transplant (0) No (1) Yes How long?_____

II.1.7) Arrhythmias, dysrhythmias, or heart failure (0) No (1) Yes How long?_____

II.1.8) Aneurysm, stroke, or cerebrovascular accident (0) No (1) Yes How long?_____

II.1.9) Heart valve disease (0) No (1) Yes How long?_____

II.1.10) Chagas disease (0) No (1) Yes How long?_____

II.1.11) Blocked artery, myocardial infarction (heart attack), or coronary bypass surgery (0) No (1) Yes
How long?_____

II.1.12) Other diseases or health problems?_____
_____

II.1.13) Are you under medical supervision? (0) No (1) Yes

II.2) Do you feel chest pain (angina)? If yes, how often?

_____

II.3) Which medications do you regularly use (Include name, dose, weekly frequency, and time of day)?

_____

II.4) Do you have any physical limitation (pain, injury, or surgery involving bones, muscles, or joints) that limits or prevents physical activity?

_____
_____
_____

II.5) During physical activity have you ever experienced any of these symptoms?

1. Chest pain or discomfort (0) No (1) Yes
2. Shortness of breath during light exercise (0) No (Yes)
3. Dizziness or fainting (0) No (1) Yes
4. Palpitations or tachycardia (0) No (1) Yes
5. Leg pain when walking (0) No (1) Yes
6. Severe fatigue during light activities (0) No (1) Yes

II.6) Has any first-degree relative had heart disease? (0) No (1) Yes (7) Don't know
II.7) Do you currently smoke? (0) No (1) Yes
II.7.1) If yes, on average how many cigarettes do you smoke per day? ___ cigarettes (7) Don't know (8) Not applicable
II.8) Have you had COVID-19? (0) No (1) Yes

V. QUALITY OF LIFE ASPECTS

Please answer all questions. If you are unsure about how to respond, choose the option that seems most appropriate. This is often your first choice. Please consider your values, aspirations, pleasures, and concerns. We are asking about your perception of your life over the **LAST TWO WEEKS.**

V.1) How would you rate your quality of life?
( ) Very poor ( ) Poor ( ) Neither poor nor good ( ) Good ( ) Very good

V.2) How satisfied are you with your health?
( ) Very dissatisfied ( ) Dissatisfied ( ) Neither satisfied nor dissatisfied ( ) Satisfied ( ) Very satisfied

V. 3) How satisfied are you with your ability to perform daily activities?
( ) Very dissatisfied ( ) Dissatisfied ( ) Neither satisfied nor dissatisfied ( ) Satisfied ( ) Very satisfied

V.4) How satisfied are you with yourself?
( ) Very dissatisfied ( ) Dissatisfied ( ) Neither satisfied nor dissatisfied ( ) Satisfied ( ) Very satisfied

V.5) How satisfied are you with your personal relationships? (friends, relatives, acquaintances)
( ) Very dissatisfied ( ) Dissatisfied ( ) Neither satisfied nor dissatisfied ( ) Satisfied ( ) Very satisfied

V.6) How satisfied are you with your living conditions?
( ) Very dissatisfied ( ) Dissatisfied ( ) Neither satisfied nor dissatisfied ( ) Satisfied ( ) Very satisfied

V.7) Do you have enough energy for your daily life?
( ) None ( ) Very little ( ) Moderate ( ) A lot ( ) Extremely

V.8) Do you have enough money to meet your needs?
( ) None ( ) Very little ( ) Moderate ( ) A lot ( ) Extremely