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Sixteen Weeks of Different Volume of HIIT and MICT on Quality of Gait, Respiratory Fitness, Power of Lower Limbs, Risk of Falls, and Dementia Symptoms in Frailty Older Adults

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Abstract

Introduction: *Studies point to an increasing rate of population aging in the world, with it, a condition called frailty is becoming increasingly prevalent due, especially to sedentary lifestyle. With this, investigating the effect of different exercise approaches such as high intensity interval training (HIIT) and continuous moderate intensity training (MICT) on patterns associated with frailty is fundamental for an increasingly ageing and fragile population.* ***Objective:*** *To evaluate and compare the effectiveness of two*

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protocols of HIIT and MICT on the quality of walk, respiratory fitness, power of lower limbs, risk of falls of frailty elderly. ***Methodology:*** *Was selected a group of one-hundred and twelve subjects with a mean age of 64.81 + 2.71 years diagnosed with Alzheimer's Disease. After, they were divided in five groups Control (n=24) with no interventions, HIIT-HV (n=22) that was subjected to high-volume of HIIT, HIIT-LV (n=22) that was subjected to low-volume of HIIT, MICT-HV (n=22) that was subjected to high-volume of MICT, and MICT-LV (n=22) that was subjected to low-volume of HIIT. We used the Edmonton Test to determinate the Frailty, test 15 minutes Balke test to determine VO2 Max, the Tinetti test to risk of falls, the Dynamic Gait Index to check the quality of gait, and Mini Exam of Mental State (MEEM) before and after the intervention period. Statistical analyses were performed by treating the pre-test to post-test using the Kruskal-Wallis test with DUNN'S Post Test with 5% significance, and.* ***Results:*** *The HIIT-HV was best than all other, the HIIT-LV was best than MICT-HV and MICT-LV, no differences between MICT-HV and MICT-LV were noted.* ***Conclusions:*** *it seems that the HIIT or MICT exercise-base program increase the quality of gait, strength of lower limbs, and decrease the risk of falls and dementia symptoms of frailty elderly, however, only HIIT approach increase the respiratory fitness, with advantage to high intensity and high volume as expected.*

Keywords: Cardiovascular Conditioning, Autonomy. Gait, Gymnastic, Exercise

INTRODUCTION

Aging is inevitable to human nature and causes numerous tied conditions that modify life and the capacities inherent to a more fragile body. These conditions can be defined as a natural, irreversible process that affects every human being and causes a progressive structural and functional loss in the body, brain, and mind. The aging process brings with it several physiological changes, such as progressive muscle hypotrophy, functional weakness, bone decalcification, among others, which consequently leads to a decrease in functional independence (Lord et al., 2018). However, neurodegenerative diseases, as Alzheimer, could affect the brain, which causes several conditions

that affect the day by day tasks and subject the people to limitations (Tsai et al., 2019).

With human aging muscle strength tends to decrease due to the losing of lean muscle mass subjected by the decline in the number of fibers and/or reduction in the cross-section area (Christensen et al., 2018). In addition to the loss of muscle strength, the muscle's ability to exert strength quickly (potency) also decreases with age (3). Muscle strength is the valence that exert a protective mechanism in falls, one of the most frequent causes of injuries in the elderly, besides being important for the performance of daily activities (Cadore et al., 2013; Lord et al., 2018). Like physical abilities, mental faculties are also declined with age, which makes evident the need for interventions. Symptoms of dementia are often associated with the aging of the central nervous system which when no intellectual and physical maintenance is done can exhibit obvious signs of loss of function appearing to dementias as cognitive frailties as the presented in Alzheimer's Disease (Macuco et al., 2012).

Thus, investigating viable and inexpensive alternatives that can function as tools to reduce these symptoms and conditions are important from the scientific and clinical point of view, since they can support the decision-making of health professionals regarding the orientation or prescription of their interventions, which justifies the present investigation.

In this context, the locomotors system when affected by aging, and, indirectly to neurodegenerative diseases, can lead to greater difficulty in walking and leading to a gait outside normal patterns and increasing the possibility of falls which is an important public health problem (Cadore et al., 2013; R. B. B. Silva et al., 2017). For example, weakening of the anterior tibial muscle can also cause the tip of the foot to be dragged during walking, which multiplies the risk of falls (Curcio et al., 2019), and, due to this, in regards the lower limbs strength, the power can be a very good reference of the strength, because, in fact, the power is a product of the strength plus speed of the movement, and, if the power improve, probably, the strength increase occur concomitantly (Christensen et al., 2018; Zinner et al., 2016).

All these factors together can produce conditions of morbidity and decreased functional autonomy with consequences that can be irreversible, and in extreme cases, culminating in death (Cadore et al., 2013). However, an increasing number of evidence have shown that exercise intensity as well as

its volume play a key role in the physical abilities and mental abilities of the elderly (Calverley et al., 2020; Mendes et al., 2019; Origua Rios et al., 2018; Wu et al., 2020).

With this, there is a clear need to determine the best interventions according to people's capabilities and potential because conditions as frailty could be a limiting factor to interventions, although needs. Thus, a program that presents results in maintaining the functional autonomy of elderly independence in performing their daily activities should be considered an important tool for the maintenance of the life of this elderly person with importance in this research.

Due to the clear evidence that parameters like type, volume, and intensities of the interventions need be investigated, the aim of the present study is to evaluate and compare the effectiveness of two protocols of HIIT and MICT on the quality of walk, respiratory fitness, strength of lower limbs, risk of falls of frailty elderly.

METHODS

Participants and research ethics

This research is classified as experimental, with a longitudinal design, with a non-probabilistic and intentional sample composed of one hundred and twelve physically active elderly people from the city of Porto Velho, state of Rondônia with a mean age of 69.75 + 12.91 years, body mass of 69.34 + 14.12 kg and height of 167.1 + 15.67cm of both sexes, physically inactive.

The inclusion criterion was to be over 65 years old, to wish to participate voluntarily and to be physically inactive for at least 3 consecutive months. The individual who did not practice physical activity for more than once a week was considered inactive.

All subjects to participate in the research answered a questionnaire about their basic health conditions and reported not having impediments or contraindications to the practice of physical activity. They also underwent a monthly physical evaluation performed by the researchers and clinic performed by the physician who accompanied them at the José Adelino Health Post, in the Ulisses Guimarães neighborhood.

Participants who presented cognitive deficits (dementia, mental retardation, and neurological syndromes), diseases of the vestibular system

such as labyrinthitis and marked peripheral neuropathies and who presented severe previous lesions of limbs, spine or hip that caused deformities or amputations were excluded. Elderly with severe walking impairment were also excluded.

In a simple aleatory division, all group were distributed into five groups Control (n=24) with no interventions, HIIT-HV (n=22) subjected to high-volume of HIIT, HIIT-LV (n=22) subjected to low-volume of HIIT, MICT-HV (n=22) subjected to high-volume of MICT, and MICT-LV (n=22).

Alzheimer Diagnosis

The recruitment of those suffering from Alzheimer's disease was made through Physician and Nurses trained in care for people affected by this disease and through a medical diagnosis based on the parameters of the National Institute of Neurological and Communicative Disorders (NINCDS). In addition to the Physician's diagnostic, our previous verification about the memory, dementia, interviews, and, questionnaire corroborated to the Medical diagnosis by identifying those subjects as evidencing dementia symptoms.

Study protocols and procedures

The working groups were divided into four hours at morning with the first class from 6:00 to 6:40 am, second from 6:40 to 7:20 am, third from 7:20 to 8:00am, and fourth from 7:20 to 8:00am. The first and second classes were subjected to 3 days of exercise, while the third and fourth classes at 5 days of exercise.

The first class performed HIIT 3 times a week with intensity from 85 to 100% of maximal cardiac frequency, after called as HIIT-LV; however, the third class performed HIIT by 5 times a week and after named HIIT-HV. The second class performed MICT 3 times a week with intensity from 60 to 70% of maximal cardiac frequency and after called MICT-LV; however, the fourth class performed MICT by 5 times a week after called MICT-LV.

Each volunteer was informed of their heart rate limit, however, each of the volunteers was followed by a researcher to monitor their frequency to keep 100% of the time within the planned intensity.

All procedures after adjustments were applied for 5 consecutive days and new adjustments were performed and again applied for another 5 days,

this period was to adaptation. After, the tests to entire assessment data and the training methodology were applied with the objective of collecting starting data and the experimental intervention protocols respectively. Only the data collected after the acclimatization period was valid to our scientific evaluations.

The Ethics in Human Research Committee (CEP) with Human Beings of the Federal University of Rondônia approved this study and the approval opinion received the number 2,631,588.

Respiratory Fitness Assessment

The test of 15 minutes of Balke was used. The subject need to be able to travel on the track, as far as possible, for 15 min, trying to maintain a constant pace, avoiding pike, both during and at the end of the test, but the tested may vary between running and fast walking. At the end, the distance value is divided by the time traveled to reach the average velocity (Vm). Then the values are applied in the equation below:

$$\mathbf{Vo^2\ max = 33{,}3 + (Vm - 133) \times 0{,}17}$$

Note: Distance in meters / time traveled in seconds

Gait Analysis

All were accustomed to the Dynamic Gait Index tests as previously described and all tests were applied following the test guidelines according to De Castro et al., (2006). The test consists of a battery of 8 walking events with different obstacles, climbs and descents of stairs, for example, where the score increased from score 3 to normal standard, 2 mild impairment, 1 high degree of gait impairment, up to 0 with severe gait impairment.

Symptoms of Dementia

The Mini Mental State Examination (MMSE) was used to determine the symptoms of dementia as previously used in Fabrício-Wehbe et al., (2009). The MMSE had been validated in Brazil by Brucki et al. (2003) and has specific questions grouped into seven categories. Each category has the objective of evaluating specific cognitive functions, and their results vary from 0 to 30 points, where higher scores represent better cognitive function. For

the MMSE, the minimum cut-off point was 20 points, which represents an average/high education level according to the test (Bertolucci et al., 1994).

Risk of Falls

The Tinetti test was performed to assess the risk of falls. This test consists of 16 items: 9 for balance and 7 for gait. The test ranks characteristics such as gait speed, stride, symmetry and balance while standing in place and while spinning with one's eyes closed. The score for each exercise ranges from 0 to 1 or 0 to 2, with a lower score indicating poorer physical capacity. The overall score is the sum of the body balance score and the gait score. The maximum score is 12 for gait, 16 for body balance and 28 for the overall score. A score <19 points refer to a high risk of falling, between 19 and 24 points, a moderate risk of falling and above 24 points, a low risk of falling.

Training Protocols

The intervention protocol was performed by sixteen weeks. Daily, a standardized 5-minute warm-up with stretching exercises and calisthenics was performed to all groups.

The walking protocol (MICT) was performed over 40 minutes at 60% and 70% of the maximum heart rate measured by a Pollar Model FT1 in a 30 x 15-meter space adjacent to the Basic Health Unit of the municipal network in the East Zone of the City of Porto Velho, Rondônia, Brazil. A 5-minute cool down was carried out to promote calm using stretching techniques of very low intensity, like yoga.

A high-intensity interval training program was applied with an average duration of 20 minutes per meeting. All exercises were performed without equipment, using one's own body weight alone. Each exercise set was done against the clock at a ratio of 1:2, between activity and rest with 30 seconds of stimuli and 60 seconds of rest.

The main work-out was performed, consisting of forward-backward running, squats, push-ups, sit-ups, jumping jacks, walking lunges, dips, six-point support planks, pulse lunges, reverse lunges, skipping, mountain climbers, arm and leg raises, side steps, direction changing footwork and step-up-step-downs (25 cm).

Finally, a 5-minute cool down was carried out to promote calmness using stretching techniques as describe above. Each exercise was performed

for 30, 45 or 60 seconds for a recovery always 2x greater than the stimulus time. All classes had approximately 10 minutes of stimulation. During all moments of rest between one stimulus and another, the subject was free, yet encouraged to remain still and quiet awaiting the next stimulus in order to characterize a passive rest.

Assessment of the power lower limbs

The vertical jump predictive neuromuscular test was defined as an evaluative criterion of lower-lower limbs power. The My Jump® app (Carlos Balsalobre-Fernandez & PacoLabs© version 3.2.2) was installed on an iPhone® 9 (Apple©, USA) that provides video recording camera with frequency of 240 Hz and high resolution from 1080p to 60fps, being used to calculate the time (in meters per second) aerial phase of the vertical-wave predictive neuromuscular test jump, identifying in the video frames the times of the push phase (absence of contact of the feet with the ground) and the phase (presence of contact of one of the feet with the ground) and then turning them into a height of the jump.

The phases of jumping, and landing were standardized for the complete extension of the hip, knee and ankle joints in the quadrant established for the execution of the procedure with dimensions of 60x60 centimeters delimited by an adhesive tape. The performers performed the jump with countermovement (JMC) by means of a rapid flexion-extension of the lower limbs with the minimum pause between both phases. The trunk was vertical, and the hands positioned on the hips. During the aerial phase of the jump, the knees remained extended, contacting the ground with the tips of the feet, being allowed, consequently, the flexion of the knees to minimize the impact on orthopedic structures.

Each jump was recorded by video recording at the bottom end of the performer, the zoom-in feature with the iPhone® fixed on tripod support at 1.5 meters. This test was performed in three sequential sessions separated by 24-hour intervals to enable the applicability of three steps defined as familiarization step (adaptation), control (validation) and reliability (reproduction) of vertical jump performance. The applicability of the test was reliably identical in all stages. Previously, the performers performed five minutes of orthopedic heating (ballistic joint movements), specific hemodynamic with dynamic squats absent from external load. Then, they

performed maximizing the effort of drive, three jumps (only explosive concentric muscle actions) separated by a passive physiological recovery period of two minutes.

Frailty Assessment

The Edmonton Frailty Scale (EFS) was used to assess the frailty. The scale evaluates 9 domains, including two performance-based assessments: the Clock Drawing Test for cognition and the "Timed Up and Go" test for balance and mobility. The others are mood, functional independence, drug use, social support, nutrition, attitudes towards health, continence, medical illnesses, and quality of life. The maximum possible score is 17 points, which points to a high level of frailty. A score of 0-4 indicates lack of frailty, 5-6 apparent vulnerability, 7-8 slight frailty, 9-10 moderate frailty and 11 severe frailty (Rolfson et al., 2006).

Dementia Symptoms

The Mini Mental State Examination (MMSE) was used to determine the mental health of the volunteers. Its application is based on specific questions grouped into seven categories, each with the purpose of evaluating the operational cognitive functions of the mind. Scores range from 0 to 30 points, with higher scores considered as better. The cut-off point was a minimum of 20 points, representing a medium/high education level. This test was validated in Brazil by Brucki et al. (2003).

Energy expenditure monitoring

We calculated the caloric expenditure of an exercise as follows: Caloric expenditure= VO2 max * caloric equivalent * time of the activity. Five kilocalories were used as the caloric equivalent. The caloric expenditure of both groups was similar in order to provide the same caloric cost per day of activity for MICT and HIIT.

Statistical The description of the data was performed by means of mean and standard deviation. To determine the normality of the data, the Kolmogorov-Smirnov test was used. Then the Kruskal-Wallis test with DUNN'S Post Hoc with significance of 5% was used. Without then, Cohen's test was ∫ used to determine the size of the effect of each intervention.

RESULTS

All interventions enhance the gait performance with advantage to high-intensity approach

The figure 1 display the results to the Gait Index Test. No difference was noted to the Control Group (p>0.05). In the intragroup comparison all groups display differences from Pre- to Post-test (MICT-LV and MICT-HV p<0.05, HIIT-LV and HIIT-HV p<0.0001). To intergroup comparison the Post of MICT-HV was best than MICT-LV (p<0.05), the HIIT-LV was best than MICT-LV and MICT-HV (p<0.05 to both), and the HIIT-HV was best than MICT-LV, MICT-HV, and HIIT-LV (p<0.0001, 0.01 and 0.05 respectively). The size effect was small to MICT-LV (f= 0.11), and to MICT-HV (f= 0.13), moderate to HIIT-LV (f= 0.42), and high to HIIT-HV (f= 0.71).

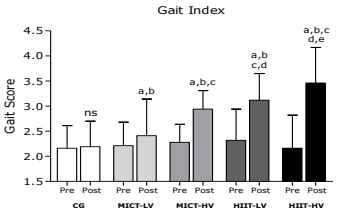

Figure 1: Results of Gait Index Test: One-hundred and twelve subjects were divided in five groups Control (n=24) kept with no interventions, MICT-LV (n=22) subjected to low volume of moderate-intensity continuous training, MICT-HV (n=22) subjected to high-volume of moderate-intensity continuous training, HIIT-LV (n=22) subjected to low volume of high-intensity interval training, and HIIT-HV (n=22) subjected to high-volume of high-intensity interval training. (a= difference to all pre-; b= difference to CG Post-; c= difference to MICT-LV Post-; d= difference to MICT-HV Post-; e= difference to HIIT-LV Post).

Only the HIIT interventions increase the respiratory fitness

The figure 2 display the results to test of 15 minutes of Balke. No difference was noted to the Control and to both MICT Groups (p>0.05). In the intragroup comparison both, the HIIT-LV as HIIT-HV display differences from Pre- to Post-test p<0.0001 both. The intergroup comparison display difference between the Post-test of HIIT-LV to Post-test of MICT-LV, and MICT-HV (p<0.01) and from the HIIT-HV display differences to MICT-LV, MICT-HV (p<0.0001 to both), and to HIIT-LV (p<0.05). The size effect was small to MICT-LV was moderate (f= 0.45), and high to HIIT-HV (f= 0.79).

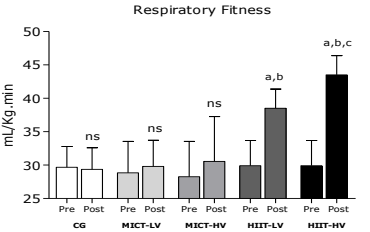

Figure 2: Results of the test of 15 minutes of Balke: One-hundred and twelve subjects were divided in five groups Control (n=24) kept with no interventions, MICT-LV (n=22) subjected to low volume of moderate-intensity continuous training, MICT-HV (n=22) subjected to high-volume of moderate-intensity continuous training, HIIT-LV (n=22) subjected to low volume of high-intensity interval training, and HIIT-HV (n=22) subjected to high-volume of high-intensity interval training. (a= difference to all pre-; b= difference to CG, MICT-LV, and MICT-HV Post-; c= difference to HIIT-LV Post-).

The MICT and HIIT interventions increase the power of lower limbs

The figure 3 display the results to vertical jump test. No difference was noted to the Control and to both MICT-LV Groups (p>0.05), however with difference to MICT-LV (p<0.05), to the HIIT-LV, and to the HIIT-HV from Pre to Post-test p<0.0001 both. The intergroup comparison displays difference of the Post-test of MICT-HV to Post-test of Control (p<0.05), and MICT-LV (p<0.01), from the HIIT-LV to Control to the MICT-LV and MICT-HV (p<0.0001) and from the HIIT-HV to Control, MICT-LV, MICT-HV (p<0.0001), and to HIIT-LV (p<0.05). The size effect was moderate to MICT-HV, and high to HIIT-LV (f= 0.75), and high to HIIT-HV (f= 0.81).

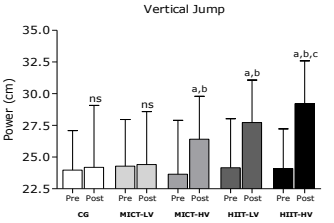

Figure 3: Results of the vertical jump test: One-hundred and twelve subjects were divided in five groups Control (n=24) kept with no interventions, MICT-LV (n=22) subjected to low volume of moderate-intensity continuous training, MICT-HV (n=22) subjected to high-volume of moderate-intensity continuous training, HIIT-LV (n=22) subjected to low volume of high-intensity interval training, and HIIT-HV (n=22) subjected to high-volume of high-intensity interval training. (a= difference to all pre-; b= difference to CG, and MICT-LV Post-; c= difference to HIIT-HV to Post- MICT-LV Post-test).

Only the HIIT interventions decrease the risk of falls

The figure 4 display the results to the Tinetti test. No difference was noted to the CG, MICT-LV, and MICT-HV (p>0.05), however, the HIIT-LV and HIIT-HV p<0.0001). To intergroup comparison the Post of HIIT-HV was best than MICT-LV, (p<0.0001, 0.01 and 0.05 respectively). The size effect was moderate to HIIT-LV (f= 0.47), and high to HIIT-HV (f= 0.83).

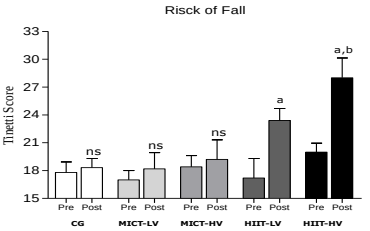

Figure 4: Results of Tinetti test: One-hundred and twelve subjects were divided in five groups Control (n=24) kept with no interventions, MICT-LV (n=22) subjected to low volume of moderate-intensity continuous training, MICT-HV (n=22) subjected to high-volume of moderate-intensity continuous training, HIIT-LV (n=22) subjected to low volume of high-intensity interval training, and HIIT-HV (n=22) subjected to high-volume of high-intensity interval training. (a= difference to all pre-; b= difference to CG, MICT-LV, MICT-HV, and HIIT-LV to Post).

All interventions decrease the dementia symptoms with advantage to higher intensity and higher volume

The figure 5 display the results to the Mini Mental State Examination. No difference was noted to the Control Gourp (p>0.05). In the intragroup comparison all groups display differences from Pre- to Post-test (MICT-LV and MICT-HV p<0.05, HIIT-LV and HIIT-HV p<0.0001). To intergroup comparison the Post of MICT-HV was best than MICT-LV (p<0.05), the HIIT-LV was best than MICT-LV and MICT-HV (p<0.05 to both), and the HIIT-HV was best than MICT-LV, MICT-HV, and HIIT-LV (p<0.0001, 0.01 and 0.05 respectively). The size effect was small to MICT-LV (f= 0.11), and to MICT-HV (f= 0.13), moderate to HIIT-LV (f= 0.42), and high to HIIT-HV (f= 0.71).

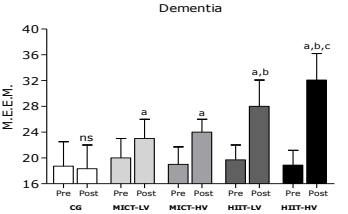

Figure 5: Results of Mini Mental State Examination: One-hundred and twelve subjects were divided in five groups Control (n=24) kept with no interventions, MICT-LV (n=22) subjected to low volume of moderate-intensity continuous training, MICT-HV (n=22) subjected to high-volume of moderate-intensity continuous training, HIIT-LV (n=22) subjected to low volume of high-intensity interval training, and HIIT-HV (n=22) subjected to high-volume of high-intensity interval training. (a= difference to all pre-; b= difference to CG, MICT-LV, and MICT-HV Post-; c= difference to HIIT-LV to Post).

DISCUSSION

The objective of the present study is to evaluate and compare the effectiveness of two protocols of HIIT and MICT on the quality of walk, respiratory fitness, power of lower limbs, risk of falls of frailty elderly. The main results display that all interventions enhance the gait performance with advantage to high-intensity approach, only the HIIT interventions increase the respiratory fitness, the MICT and HIIT interventions increase the power of lower limbs, all interventions decrease the dementia symptoms with advantage to higher intensity and higher volume, and only the HIIT interventions decrease the risk of falls.

Here, in accordance with several authors, appear correct to affirm that the intensity of exercise is a fundamental point to provoke adaptations, including, although the volume of exercise is a very important component of the physical exercise approach, the intensity can exert more influence in physical and mental adaptations to exercise evens when the total volume of exercise and the energy expended is lesser than another extensive method as walking, for example (Burgomaster et al., 2008; De Nardi et al., 2018; Gibala et al., 2012; Gibala & Hawley, 2017).

Cardiovascular conditioning is important in assessing the physical capacity of individuals with limitation of some nature, which will be useful to quantify the severity of this limitation and together with the Dynamic Gait Index can provide an overall view of the freedom of locomotion of the subject (Cadore et al., 2013; R. A. Da Silva et al., 2016).

The volunteers trained with all approach display improvement in their gait skills, and this, is an important data because could allow best daily activity accomplishment. Additionally, more development is the walk abilities can provide security during the performance of the several, perhaps, almost all tasks, which is desirable, in special to older because several accidents, as falls could be avoided, and this is an advantage to elderly because falls and bone fracture due to the falls often can subject the person a definitive condition as hospitalization or institutionalization causing many problems to all family (Lilamand & Raynaud-Simon, 2018; R. B. B. Silva et al., 2017).

Functional mobility tests have close connection with gait speed, where low speed is linked to postural instability and, different studies, have demonstrated that this relationship may denote risks of falling, decreased functional independence and consequent decrease in quality of life (Yuan et al., 2015). In this context, the imbalance and consequent fall as a consequence of the difficulty of locomotion leaves the elderly bedridden and is associated with 70% of the accidental deaths of people over 75 years of age (Barker et al., 2015; R. B. B. Silva et al., 2017), suggesting the importance of investigating and discovering effective tools for improving the quality of gait for the elderly. Here, the exercise showed important results with best gains dependent of the intensity.

To Vo2 Max only the HIIT approach increases this important marker. Is very weel described in the literature that the exercise improve the cardiovascular condition (Nieman & Wentz, 2019; Rider et al., 2014). Here, was a surprise the low- and high-volume of moderate-intensity exercise do not improve the respiratory fitness, although, the MICT-HV tends to improve the Vo2 Max. In fact, this displays more one time the importance of intensity of exercise to make change. Exercise with no body challenge do not will lead stress, and, due to this, the absence of stress does not subject the several systems to adaptations. However, even when people are subjected at high-intensity exercise, the stress proposed can to provoke adaptations, which corroborates with many other works (Faelli et al., 2019; Ramos et al., 2015; Wu et al., 2020). In another hand, studies has been show that the moderate-intensity continuous training can improve the cardiorespiratory fitness in the same magnitude than high-intensity interval training with 5 fold less volume of training (Burgomaster et al., 2008; Gibala et al., 2006; MacInnis & Gibala, 2016; Tjønna et al., 2013) suggesting a clear advantage to HIIT.

The power of lower limbs is implicated with protection against falls, and here this assessment together the Gait Index Test performance was performed to explain the possible mechanisms that can be associated to the decreasing of the risk of falls. The Tinetti test showed decreasing in the risk of fall, more one time, with clear advantage to HIIT, in special, when applied in high-volume.

These fasts suggest that vigorous muscle contraction can be desirable to improve the muscle power, in this case, probably only due to the improvement of the neural input, because, no long time of intervention was applied, which, although, of course, muscle hypertrophy was stimulated by exercise, the short time of exposure do not provokes large gain in muscle mass, but, which was seemed about the muscle power can be linked to the neurogenesis implicated with the neural adaptations (Phillips, 1997; Sale, 1988).

The four groups display decreasing of the dementia symptoms on the MMSE that if compared to the scores that define the cutoff point for risk or not risk of severe cognitive impairment. All groups, even reaching the low limit of earnings, remained in the position that indicates a moderate probability of entering a level of dementia with a high level of cognitive impairment. That is, no group has reached a non-risk condition for this level of dementia, but all have benefited from their respective intervention to minimize it. It, similarly to observed to the inhibitory control, and, if taken together, display a very well come enhancement in the cognitive functions, specially mediated by high-intensity and high-volume physical exercise, which, almost always are impaired in AD (Baker et al., 2010; Macpherson et al., 2017).

Additional to this discussion the high-intensity exercise appears to promote more improvement on the mental skills than the moderated-intensity exercise. This can be explained by the lactate production that is being implicated as the main molecule of communication between muscle and brain mediating the signals to BDNF production and neuroplasticity (Bergersen, 2015; Müller et al., 2020). Nevertheless, the lactate can be an energy source to the brain, like a primary substrate to energy production as previously reported (van Hall et al., 2009), even with no test of this hypothesis, is perfectly suggestible a relationship of the mental processing skills, with the level of lactate produced during the interventions, because the high-intensity

exercise can produce more amounts of lactate and the exercise with high lactate production has been pointed as a very good therapeutic intervention to the brain (Bergersen, 2015; Brooks, 2009), and this could be indirectly thought because although all interventions display advances, the high-intensity was best than the low-intensity exercise.

Today the discussion in the academy is what is the best intensity, or volume, both to produce the best adaptations? About this question our study displays an advantage first to more intensity, second to more volume, but, the combination of high-intensity plus high-volume provoked higher adaptations, which, although no was surprise provides support to make decision about the best approach to intervention in Alzheimer's Disease to enhance the physical and mental skills. If taken together, the high-intensity followed by high-volume is preferable than low-intensity and/or low-volume.

CONCLUSIONS

We challenge the classical approach postulated that physical exercise intervention to elderly need to be based in low intensity exercise. The classical approach based in low-intensity physical exercise did not produce good effects, but it can improve physical skills as gait quality, and mental as dementia symptoms. However, the respiratory fitness, the power of lower limbs, and the risk of falls only was affected by the HIIT interventions. This suggests a strong participation of the intensity of the exercise in the magnitude of the adaptations. Therefore, appear to be correct to affirm that the HIIT is more efficient to improve the gait, power of power limbs, respiratory capacity, decrease the risk of falls and the dementia symptoms.

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