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# Effects of 8-Weeks Concurrent Strength and Aerobic Training on Body Composition, Physiological and Cognitive Performance in Older Adult Women

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**Abstract:** (1) Background: Despite plenty of evidence supporting the advantages of regular physical exercise amongst older women, it is not clear what the best methodology is to improve these parameters. Considering the growth of older population and aging process, this study analyses an 8-weeks concurrent training intervention; (2) Methods: A total of 48 older women participated in concurrent strength and aerobic exercises training intervention being used to know physical and cognitive improvements in older women through physical, physiological and vigilance tests; (3) Results: Significant differences were found in weight and body mass index (BMI) between pre-intervention and post-intervention and even better results, but non-significative, in maximum oxygen consumption (VO2max), total fat percentage and skeletal muscle mass. Additionally, we found cognitive improvements in vigilance (RT) related to executive functions. (4) Conclusions: An 8-weeks concurrent training program (strength and aerobic exercises) give another efficient possibility to obtain better physical, physiological and cognitive improvements in older women.

**Keywords:** concurrent training; cognitive; aging; physiological parameters; body composition characteristics; older adults

## 1. Introduction

Nowadays, the research about aging has increased due to the growth of older adult population, especially in western countries [1]. Indeed, it is the first time in history that a lot of people could live into their 60s and more [2], and it is estimated to be 2 million people over 60 and 400 million over 80 in the world by 2050 [3]. In Europe, in the last ten years, the population aged 65 years or over increased 2.6 % which is approximately one-fifth of the EU population and predictably, by 2100, people aged 80 years or more should more than double to reach 14.6 % of the whole world [4]. Health for older adults is one of the most important concerns regarding quality of life related to health and its association to regular physical exercise (PE) [5]; it is broadly demonstrated that it has wide benefits for health [6].

The healthy benefits of PE in older adults are diverse and depend on the kind of exercise that could be acute (which have a short reversible character term on the cognitive system [7,8]) or chronic. (which have enduring character on the different brain structures and functions [9]). In fact, World Health

Organization (WHO) [10], the American College of Sport Medicine (ACSM) [11] and the American Heart Association (AHA) [12] suggest at least 150 min of moderate physical activity or 75 min vigorous activity per week should be done. In this sense, we are currently aware of plenty of scientific works that have been done to assess the influence of regular PE on health [5] and, important in this work, on cognitive functions [13–16], but in this case, we cannot find many works with older women.

A review of the literature reveals that regular PE causes positive effects on the organism and physiological adaptations such as the development of body composition characteristics [6,14]. These changes cause a body composition improvement at both functional and performance levels [17,18]. Better body composition is normally associated with regular PE, thereby previous research observed differences in body composition between PE trained older women and non-trained older women [5,19–21]. There even exist differences between active and inactive older women in body composition [22,23]. The PE trained older women's body composition improvements are produced in mid-thigh cross-sectional area [24], weight loss [23] fat mass and BMI [19], statistical significant and non-significant body weight, skeletal muscle mass and fat mass [5,21–25]. Some of these studies are cross-sectional studies and others are RE interventions from 24 weeks to 24 months.

Within the physiological parameters, the maximum oxygen consumption (VO2max) is an indicator to know the level of cardiorespiratory fitness and the functionality of the cardiovascular system [26–29], which is still highly analysed and used nowadays. Another factor which is improved by moderate regular PE is cognitive function which provokes physiological adaptations, benefits in quality of life and mental health [30,31]. In this sense, fitness level is considered as a moderator between the effect of regular PE and cognitive function [32], in fact, these physiological adaptations, at cardiovascular level linked to a good fitness level, explain the association between these variables based on the premise of the "cardiovascular hypothesis". Thus, individuals who have a good fitness level have better performance in various cognitive tasks compared to individuals with low cardiovascular capacity. In this context and in accordance with this hypothesis, studies showed that regular aerobic physical exercise probably could have an important stimulus for essential changes at the neural level [33], which, therefore, appear to be a good influence on cognitive performance [34]. Within this framework, new research found that made use of magnetic resonance techniques is also remarkable [9,35], and some have been linked to adaptations at the brain level—all of this seems to be a good influence on cognitive performance.

In the present paper, we study the vigilance or sustained attention. In this sense, this ability is linked to the determination goal maintenance capacity and the deployment of attention over the course of a task in order to respond appropriately (quickly and accurately) to relevant stimuli [36]. A review of the literature reveals the fundamental role of vigilance during the tasks we do in laboratory and performance context in different environments (e.g., air traffic controllers, professional drivers, industrial activities, etc.) [37]. Thus, an optimal vigilance level minimizes human errors [38]. Vigilance suffers fluctuations that occur during the time of the tasks we perform [39]. Generally, these changes are attributed to fatigue caused by sleep [40], the duration of the task or the duration of PE [41]. Essentially, our vigilance ability it is not stable and the attentional demands task brings efficiency decrement over time called time-on-task effect [42]. Vigilance was assessed here using the psychomotor vigilance task (PVT). Previous studies have demonstrated that the PVT is highly sensitive to vigilance decrements [40] indexed by Reaction Times (RT) lengthening, performing decrements over the course of a task reflect a decrease of attentional resources over time [43]. Far from being a simple reaction time task, this vigilance task has high demands that are supported by neuroimaging studies [44] showing brain activity typically associated with the sustained care network [45] and allocation of attentional resources [46].

Therefore, our main objective was to observe the chronic effects, to elder trained people (more than 6 months regularly working in a gym), of 8-weeks physical training program (regular PE), on the cognitive functioning (vigilance) and check the changes produced in the body composition characteristics (body weight, total fat percentage and skeletal muscle mass) and physiological parameter (VO2max) for the analysis of vigilance, it will be done through an attentional task: PVT which will be performed by participants in two different phases (pre-intervention and post-intervention). In addition, We believe that 8-weeks concurrent training program (strength and aerobic exercises) in older can improve physical fitness and cognitive mechanisms (vigilance).

## 2. Materials and Methods

### *2.1. Participants*

At this work we have raised a quasi-experimental (controlled-trial design) and the sample was selected using a non-proportional quota sampling. The sample size was calculated at a 95% confidence level based on the population of women ages between 60 years old or older (n=45 older adult women) (see Figure 1). All participants were selected for the study through information leaflets and posters, had normal or corrected vision and did not suffer any physical or neurological disorder that could affect the results of the experiment. The participants were informed about the objectives of the investigation and signed consent detailing their possible benefits and risks. Inclusion criteria for participants group in the present research were: (1) 60 years of age or beyond; (2) be able to communicate; (3) not to have illnesses that may have an impact on physical overload or serious behavioural or psychiatric disorders; (4) be capable and willing to provide informed consent. Exclusion criteria for the current study were: (1) not to have acute or terminal illness; (2) have an unstable cardiovascular disease or other medical condition; (3) unable to finish the pre-intervention test; (4) excluded by PVT test; and (5) excluded by other causes. The project complies ethical principles of the Helsinki declaration for human research (1975) ratified at the 64th General Assembly, Fortaleza (Brazil) in October 2013 [47]. All participants have been written informed sufficiently, knowing the research objective and gave their consent to use the data for the investigation. We asked all participants not to modify behavior patterns and not to do another physical activity that was not their daily activities because it could modify participants' results.

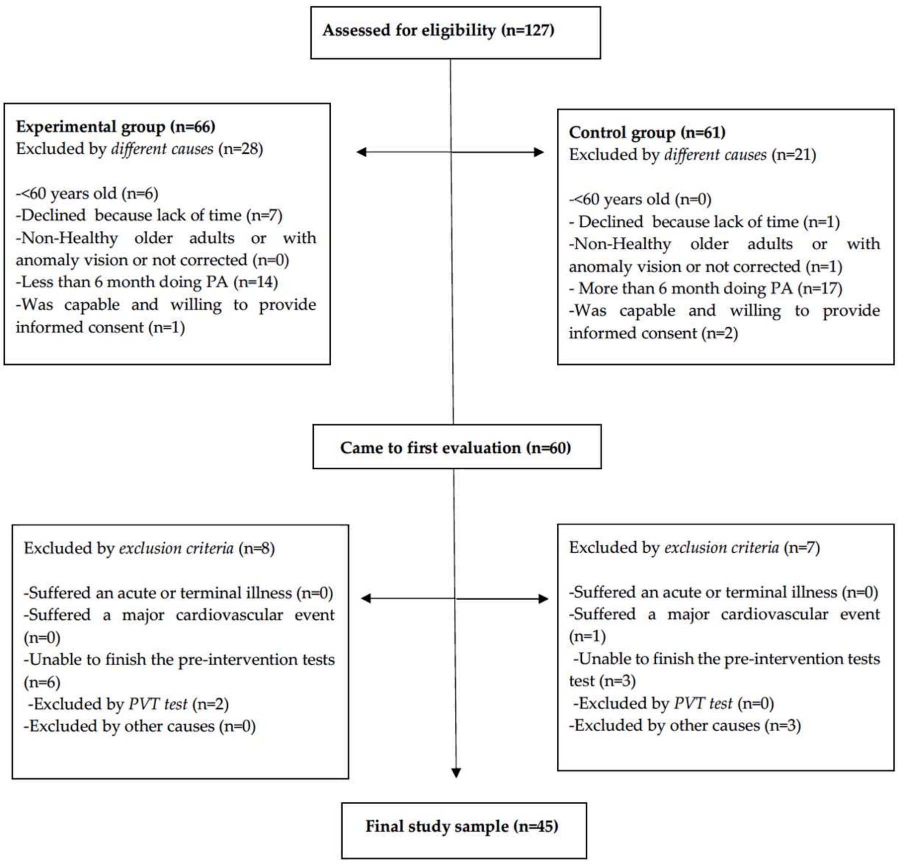


**Figure 1.** Participant's flow diagram.

## 2.2. Measures

### 2.2.1. Body Composition Characteristics Measurement

Body weight (kg), BMI (kg/m$^2$), total fat percentage (%) and skeletal muscle mass (kg) were measured by a Bioelectrical impedance analysis (BIA) device (Tanita B-1000). Body height (cm) was measured using a stadiometer (Seca 22, Hamburg, Germany). For this test we gave previous information about how to prepare the test and tell them to come on a four-hour fast, with light clothes, do not drink alcohol last eight hours before, no training eight hours before [48]. All test were repeated at the same space and time in post-test with the same condition humidity (30–40%) and temperature (20–24 °C).

### 2.2.2. Physiological Measurement (VO2max)

To calculate the VO2max, it was carried out through the one-mile RWT for a self-generated treadmill (Matrix tape model E1 in miles format), [49]. The test consists of walking at the highest possible speed for a mile to record the time spent for it and the heart rate at the time of the conclusion of the test. For the standardization of the test, all subjects performed a progressive warm-up for 300 yards to be able to estimate the maximum speed they considered they could maintain for a mile, even so, and for safety reasons it was explained that they could interrupt the test at any time and If they were wrong, they could even use the emergency brake. Following the protocol described by Widrick, Ward, Ebbeling, Clemente, & Rippe [50] during the development of the test, they could not modify the speed, so as not to distort the results.

Heart rate monitor (FT40) (Polar Electro, Finland) was used to record the heart rate (HR) during the pre-intervention and post-intervention evaluation sessions. In addition, HR data was encoded with Microsoft Excel Software.

### 2.2.3. Cognitive Measurement by the PVT

To present the stimuli of the PVT, a Tablet (iPad 6th generation) was used. The PVT consists of presenting a grey background with white numbers in the centre of the screen. The centre of the tablet´s screen was located at a prudential and comfortable distance for the participants, which ranged between 50 and 80 cm from the participants' heads and at the level of their eyes. The Vigilance Buddy app was used to control the presentation of stimuli and the collection of data in a room without distractions. After a random time, interval that ranges between 2000ms and 10,000ms, the numbers begin to increase rapidly at a speed of more ms (see Figure 2). The participants had to press the centre of the Tablet as quickly as possible when the circle began completing. They responded with their dominant hand trying not to anticipate. Verbal and written instructions were given to the participants before starting the PVT in each experimental session. The experimenter emphasized that participants should respond as quickly as possible, avoiding anticipations and that they should keep their eyes on the centre of the screen. After the response, the participant was provided feedback on the obtained RT. Anticipations were also recorded and indicated and feedback was provided with the phrase "False positive" if they made anticipation. The exact number of trials of each participant depended on the latency of the individual's response.

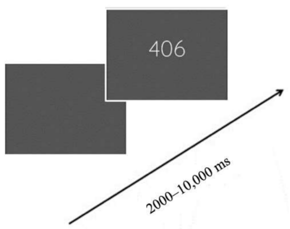


**Figure 2.** Example of a psychomotor surveillance task trial.

The task duration in both pre-intervention and post-intervention was ten minutes test as considered “gold standard for assessing vigilance attention” [51] (p. 2033). Participants completed a pre-intervention trial and a post-intervention trial to verify that they had understood the operation and that they experienced what a false positive meant.

### 2.3. Procedure

#### 2.3.1. Pre-Intervention Session

The selected participants visited the medical area and were evaluated in a session of approximately 40 min. They were evaluated between 9:30 am and 5:00 pm and environmental conditions were controlled (space, temperature, and humidity). All test were performed at the same space and time with the same condition humidity (30–40%) and temperature (20–24 °C). The evaluations were carried out 48 h before starting the 8-week intervention.

At the beginning of this session, the heart rate monitor recording band was placed during the entire experimental session. The comfortably seated participants completed the PVT and the planned questionnaires, then they were made the body composition analysis.

Once completing the analysis of body composition, questionnaires, and PVT, the participants performed the RWT as indicated in the method and for this purpose three tapes were adapted for recording in miles per hour instead of Km per hour. Following the RWT, approximately five minutes were left to the participants to cool down, change and other needs. After this break, the experimenter met again with each of the participants for approximately 15 min to explain correctly how the training program was carried out. For this reason, the experimenter gave a series of guidelines for its realization (timing, volume, and intensity of the sessions, etc.). Every day of training, the subjects filled out a record sheet indicating the attendance that day and the intensity of the training. Finally, we consider the diet program suggested for the specialist based on ACSM recommendation [29,52] were ready-witted and was followed for 89% of the older women participant.

#### 2.3.2. Intervention

Participants completed a concurrent strength and aerobic training program of at least five days a week, lasting 8-weeks (between the months of July and August). During the intervention, they had to do a warm-up to 10 min in a cardiovascular machine (there were free to choose the machine) and after that 10 strength exercises (from two sets, at the beginning, to four sets, at the end of the intervention) and 60 min aerobic work divided into three blocks (Figure 3): (1) four strength exercises (upper body major muscle group) followed by 20 min in a trade mill (6–8 borg scale) with 5 min rest, (2) three strength exercise (lower body) followed by 20 min in a trade mill (6–8 borg scale) with 5 min rest, (3) three strength exercise (Shoulder, triceps, and biceps) followed by 20 min in a trade mill (6–8 borg scale) 3 days a week. The other 2 days they have to do a warm-up to 10 min in a cardiovascular machine (there were free to choose the machine) and 60 min continuous aerobic training in a trade mill (6–8 borg scale) [53], following the recommendations that the ACSM performs for older [11]. The training program was supervised by the PE specialists and was adapted individually, for each of the participants complying with the principles of sports training and the age of the participants and, besides, considering the individual physical characteristics of each from them. Of a total of 40 sessions that the participants had to do, the average number of sessions they conducted was 30.25 ± 4.32. The average intensity of the sessions was of a vigorous level (7.14 ± 1.22) according to the Borg scale. The control group did not practice any supervised training program and were recommended not to modify their daily activities.

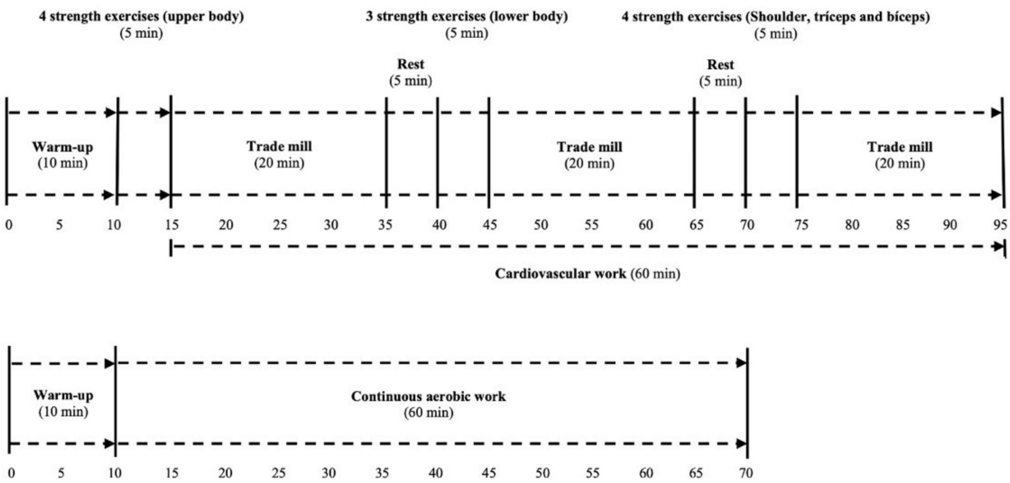


**Figure 3.** Two types of training Concurrent training (3-days/week) and Continuous aerobic (2 days/week).

2.3.3. Post-Intervention Session

All participants from the intervention group who completed the intervention visited the centre's medical area and were evaluated at the same time of the day as in the pre-intervention session (between 9:30 am and 5:00 pm) and with the same environmental conditions (space, temperature, and humidity). The post-intervention evaluation was performed 48 h after the last 8-week intervention training. Everything was the same as in the pre-intervention session. The control group also do this session after 8-weeks.

### *2.4. Statistical Analyses*

In the present research, it is used quasi-experimental pre-post design [54]. For the treatment of the data, we use adequate statistical methods to calculate percentages and central and dispersion parameters (arithmetic mean and standard deviation). For the comparison of samples and to observe statistically significant differences between pre-intervention and post-intervention of control and experimental group of older women was performed by paired-sample t-test in body composition characteristics (body weight, BMI, total fat percentage and skeletal muscle mass) and physiological parameters (Vo2max and HR). Effect size is indicated with Cohen's d for t-tests and partial eta squared for Fs.

Trials with RTs below 100 ms in experimental group (pre-intervention = 12.33% and post-intervention = 10.20%) were assumed to represent anticipation errors and were discarded from the analysis [55]. Analyses of variance (ANOVA) were used to analyse the RTs.

Data were analyzed using the SPSS statistical program (IBM SPSS Statistics for Windows 21.0. Armonk, NY, USA). For all analyses, significance was accepted at $p < 0.05$.

## **3. Results**

Different body composition features on experimental and control group are specified in the pre-intervention and post-Intervention in the descriptive analysed (Table 1). A t-test with the data from body weight pre-intervention (69.90 ± 15.30) and post-intervention (68.32 ± 14.58) showed lower values after of physical intervention statistically significant in the experimental group, t(18) = 4.18, $p < 0.001$, d = 0.10. In addition, a t-test with the data from BMI pre-intervention (27.25 ± 5.19) and post-intervention (26.67 ± 4.92), t(18) = 3.83, $p < 0.001$, d = 0.11, showed also significant values in the experimental group. None-significant differences were obtained in control gro up.

**Table 1.** Participants' body composition characteristics (mean ± SD) of the present study.

| Body Composition Characteristics | *Experimental Group (n = 18)* | | *p* value | Cohe's d | *Control Group (n = 27)* | | *p* Value | Cohe's d |
|---|---|---|---|---|---|---|---|---|
| Age (years) | 64.76 ± 4.25 | | | | 67.23 ± 7.42 | | | |
| Body Height (cm) | 159.8 ± 6.32 | | | | 154.03 ± 4.12 | | | |
| | *Pre-intervention* | *Post-intervention* | | | *Pre-intervention* | *Post-intervention* | | |
| Body Weight (kg) | 69.90 ± 15.3 | 68.32 ± 14.58 | 0.001 | 0.011 | 71.16 ± 12.63 | 71.48 ± 12.10 | 0.325 | −0.025 |
| Body Mass Index (BMI) (kg/m$^2$) | 27.25 ± 5.19 | 26.73 ± 4.92 | 0.005 | 0.010 | 31.05 ± 5.07 | 31.85 ± 4.13 | 0.112 | −0.173 |
| Total Fat Percentage (%) | 31.11 ± 6.57 | 30.31 ± 6.1 | 0.177 | 0.126 | 44.78 ± 5.78 | 45.42 ± 3.68 | 0.087 | −0.132 |
| Skeletal Muscle Mass (kg) | 45.71 ± 9.09 | 46.72 ± 10.03 | 0.467 | −0.105 | 21.53 ± 4.58 | 21.39 ± 6.47 | 0.189 | 0.024 |

Note: cm = centimetres, kg = kilograms, m$^2$ = square meters, % = percentages.

For the physiological parameters by RWT (Table 2), body weight, age, HR, and walking time were used to estimate VO2max using the Kline et al. equation [49]. A t-test with the data from VO2max (ml.kg$^{-1}$.min$^{-1}$) [pre-intervention (28.93 ± 11.09) and post-intervention (33.51 ± 19.30)] showed higher values after of physical intervention, t(18) = 2,84, $p < 0.011$, d = −0.88. None-significant differences were obtained in control group.

**Table 2.** Participants' physiological characteristics (mean ± SD) of the present study.

| Physiological Characteristics (RWT) | Experimental Group (n=18) | | *p* Value | Cohen's d | Control group (n=27) | | *p* Value | Cohen's d |
|---|---|---|---|---|---|---|---|---|
| | Pre-Intervention | Post-Intervention | | | Pre-Intervention | Post-Intervention | | |
| VO2max | 28.93 ± 9.06 | 33.51 ± 9.87 | 0.001 | 0.372 | 28.31 ± 6.81 | 27.91 ± 7.11 | 0.078 | 0.057 |
| Final HR | 139.10± 15.96 | 132.16 ± 9.97 | 0.113 | 0.521 | 135.40 ± 12.83 | 134.85 ± 11.80 | 0.520 | 0.044 |

Note: VO2max is given in ml.kg$^{-1}$.min$^{-1}$; HR= Heart Rate. Final HR is given by RWT.

A repeated-measures ANOVA with participants' mean RT revealed a significant main effect of phase, $F(1,17) = 10{,}54$, $p < 0.004$, η2 partial = 0.32, with shorter RT in the post-intervention than in the pre-intervention in the experimental group. The main effect of time-on-task and the interaction between effect phase and time-on-task, was not significant, in both cases, $F < 1$. As we can see in Figure 4, participants' answer was faster, in general, in post-intervention (433,30 ± 46,49 ms) than pre-intervention (385,87 ± 67,03 ms). The repeated-measures ANOVA in control group´s participants were not used because of the absence of significant differences between pre-intervention and post-intervention.

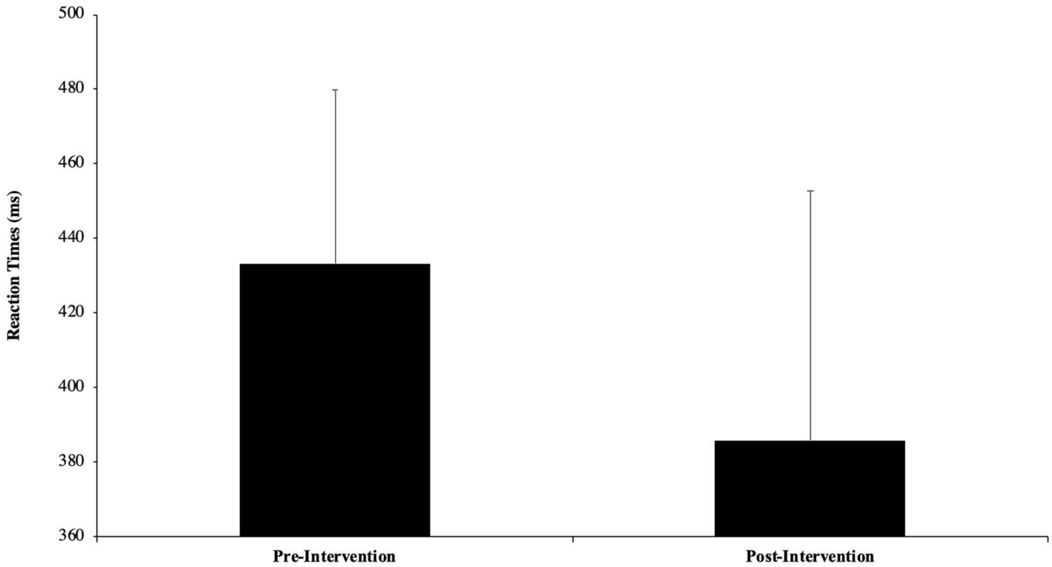


**Figure 4.** Experimental group's participants mean of Reaction Times (RT) as a function of phase condition.

## 4. Discussion

The main objective of this paper was to observe the chronic effects, to elder trained people (more than 6 months regularly working in a gym), of 8-weeks physical training program (regular PE on the cognitive functioning (vigilance) and check the changes produced in the body composition characteristics (body weight, total fat percentage and skeletal muscle mass), physiological parameters (VO2max), since literature suggests that cognitive aspects improve even in healthy population with PE [56].

The results showed that participants in post-intervention responded faster than participants in pre-intervention. Crucially, it is important the fact that this concurrent training has had improvements in RT going from 433.30 ms in pre-intervention to 385.87 ms in the post-intervention. Importantly, consider that sport training context based on 60 min/day (five days/week) aerobic exercises and a circuit of strength of ten exercises with 12 repetitions per exercise (three days a week) following the recommendations that the ACSM performs for adults and older adults [11], what a proper and motivating atmosphere does where physiological parameters and perceptual-cognitive skills are heightened, that could have an influence in executive function, as suggested by Mikalački et al. [25] comment PE program for older should follow international guidelines to have expected benefits.

Regular concurrent training (strength and aerobic) increases cardiorespiratory and muscular fitness results and improve body composition characteristics, and better cognitive function, and other benefits [6,57–59] also intensity as a factor is shown as a determinant in physiological responses indicating better benefits of vigorous than moderate PE [57]. These work results agree with the benefit showed by these studies. In this sense, our results coincided with Monleon's study [14] where 29 adults complete an eight months physical activity interventions and PVT showed improvements where mean RT postintervention were lower than preintervention. In fact, our results seem to indicate a greater level of vigilance in people with a better physical condition (post-intervention) than those who have a worse physical condition (pre-intervention) in older women. In addition, the current paper goes beyond, corroborating the belief that vigilance may be related to higher levels of cardiovascular capacity [60,61] considering that the experimental group already had a previous fitness level. These findings showed changes in the cardiovascular capacity as a consequence of time-on-task functions in older women [62]. Also it is important to notice that previous studies for this task used not too much time task (maximum 10 min), time probably insufficient to get significant differences in vigilance performance in older women [63].

With regards to body composition characteristics, this study results suggest that trainee older, change this factor after 8-weeks concurrent strength and aerobic training. This outcomes show a BMI decrease as expected due to different studies show a lower BMI level in older people as much activity they do [64] other authors agree but in a six month climbing stairs protocol in sedentary people [20] that it is less intensity but longer; in all cases exist no significant differences.

Concerned to body weight and in spite of some authors support of short term PE alone have a modest impact on body weight loss, they believe it is needed longer period of time (12–18 months) for grater loss [59]. This study shows body weight loss improvements as others works in older with different protocols [65] in short term protocol.

According to total fat percentage it is important to highlight that this is directly associated to the lipid profiled (LP) [66] where active older have better LP compare to sedentary older [67]. Due to the RE, the total fat percentage is reduced and lot of elderly individuals research showed it [19,23,68]. All this intervention was long term intervention e.g., Cai lifestyle intervention [23] was 24 month; other research [19] also compare active (six moth minimum) and inactive older but in state program three times a week, one hour session between six months to five years. But not only long term intervention has improvements also short term (12 weeks) studies showed total fat percentage reduction [65]. Nevertheless other short terms works (ten weeks) did not show reduction in total fat percentage with similar intensity and duration protocol [69] but in this study with older with rheumatoid arthritis.

Considering physiological parameters and following a guidance for prescribing PE in the ACSM [57] who highlight that "exercise intensity is an important determinant of the physiological responses to exercise training" (p. 1339) clarify that vigorous PE brings grater benefits than moderate PE as our intervention. In this study, some body composition (Body weight and BMI), and physiological variables (VO2max) and cognitive function (RT) in the intervention group experienced significant differences after concurrent training program. However, the differences in physiological and body composition and vigilance of control group were no significant.

Also it is known that one of the main responses of prolonged training are cardiovascular physiological adaptations [70] and to improve VO2max the ACSM [18] and other authors [71,72] give some advises proceeding international guidelines where describe the PE program should be 40–45 min continues sessions from 50–80% of intensity. The present work results, after 8-weeks of strength and aerobic training, fulfilling the hypotheses that we had raised, just showed significant improvement of VO2max in the post-intervention the intervention group which may be a consequence of these cardiovascular adaptations fulfilling with "cardiovascular hypothesis". Similar short term intervention studies showed VO2max improvements but with aerobic exercise only [73,74] in this line other authors consider baseline fitness and PE dose is important in response of VO2max to cardiovascular PE [75]; nevertheless recent studies determine that concurrent training (strength and aerobic) as our study, gave better cardiovascular results than only aerobic training and consider it as a better alternative to improve older VO2max and health conditions considering that our intervention group had more than six month concurrent training with good level of physical fitness.

This physiological and cognitive finding here is consistent with the relation that a good cardiovascular capacity has better performance in cognitive tasks in older [76,77]. There is strong evidence of RE improve different cognitive function [59,68,78–80] same as inactivity and obesity are related to cognitive impairment [23,58]; also RE is shown as a maintaining cognitive function predictor in older [81]. In spite of this evidence, samples of most of these studies are with no healthy population, however research, even with healthy subjects, also showed cognitive benefits in RE [56]. Likewise PE is associated with attention improvements [82] as our cognitive results. To measure the attention the PVT according to Basner & Dinges [40] is amongst the most broadly used instrument of behavioural alertness. As known, the attention decrease could reduce the capacity to achieve more complex task [83] and to solve that are different system to improve vigilance [13,84] nevertheless the one of the most studied training is the PE and it relationship with this cognitive function [85]. Regarding the PVT the reaction time (RT) is a vigilance indicator that could been used to measure cognitive improvements and has been used extensively with positive results in different task and time [86–88] being PVT-10 (10 min) considered gold standard [51]. This study results does not match with other intervention which mean RT exposed showed no significant results in main effect of aerobic fitness between sport group and non-sport group [87–89].

We are aware that this sample could be higher, in spite of this we are proud to have this group of older since this kind of intervention is complicated due to the level of training required and the inherent risk level. Also, we have struggled with the cognitive discussion due to the lack of studies using this protocol (PVT) to compare active people conducting a concurrent training program that give to this study the importance to be taken as a reference for future research. Owing to all outcomes showed these physical improvements that are linked to cognitive improvements and it is related to certain activity in parts of the brain. As Drummond [44] says, regular PE improve prefrontal areas that it is related to executive function, very important nowadays to our older and their healthy aging process.

## 5. Conclusions

The outcomes in the study give another evidence that concurrent training could be a good method to improve physiological and body composition as other works but our main finding is related to cognitive improvements (vigilance) which could help trainers and researchers in their daily jobs and future research helping them. It is important the diffusion of the results breaks the gap related to cognition between research and daily work in gyms, sports centres, rehabilitation centres, etc. We are aware that the study has limitations as the intervention time, small sample and even the lack of two comparison groups with two different training protocols. However, despite these limitations, the study adds more evidence of this kind of methodology especially related to cognitive function.

Despite the fact that the RE research where PE has been suggested for older there is no existing consensus about which kind of PE provides better cognitive improvement from what we understand this study could give an orientation of a special work that could improve it or at least vigilance. Due to the increase of older population and the preoccupation to have better qualities of life and the better aging process we gave some lines of works although more investigation is required moreover, longer intervention to look for significant differences and lasting results in older, is necessary.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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