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Impacts of Aerobic and Resistance Exercise Order in Concurrent Training on Blood Pressure and Body Composition in Overweight and Obese Men bank workers: Randomized Control Trial

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Abstract

Background: Concurrent training, has demonstrated effective in improving cardiovascular health and body composition. However, the optimal sequencing of these modalities remains unclear, particularly among overweight and obese populations. This study aimed to examine the impact of different sequences of resistance and aerobic exercises on specific anthropometric measurements and blood pressure in overweight and obese adults.

Method: Twenty-one obese males with age: 41.43 ± 2.22 years; joined in an 8-week study and were randomly allocated to one of 3 groups: aerobic to resistance training (ART), resistance to aerobic training (RAT), or control (COT). The study examined within-subject and between-group differences in response to concurrent exercise sequences, analyzed using repeated measures ANOVA.

Results: Except for diastolic blood pressure (DBP), both intervention groups showed drops in systolic blood pressure (SBP), Percentage of body fat (BFP), Index of body mass (BMI), and waist-hip ratio (WHR). A significant effect of exercise modality on SBP ($F(2,18) = 6.871$, $p = .006$, $\eta^2 = 0.433$). Pairwise comparisons analyses demonstrated that the RAT group ($MD = -5.786 \pm 1.589$, $p = .006$) showed meaningfully superior decreases in SBP related to the CT group. There were significant group differences in BFP levels ($F(2, 18) = 13.987$, $p = 0.001$, $\eta2 = 0.608$). Both groups significantly reduced BMI and WHR by ($F(2, 18) = 6.193$, $p = 0.009$, $\eta2 = 0.408$) and ($F(2, 18) = 11.143$, $p = 0.001$, $\eta2 = 0.553$) correspondingly.

Conclusion: The sequence of exercises in concurrent exercise plays a crucial role in influencing blood pressure and anthropometric indices. Both training sequences effectively improved anthropometric measures, while RAT training demonstrated greater efficacy in lowering systolic blood pressure (SBP).

Keywords: Concurrent training exercise sequence, blood pressure, anthropometric index

1. Introduction

A rising global public health concern affecting people of all ages and socioeconomic backgrounds is obesity.

Overweight and also obesity rates are also sharply rising in economically developing and emerging countries (Ford et al., 2017). Over 600 million persons worldwide were obese and over 1.9 billion overweight in 2014 (Juni, 2015). Body mass index (BMI) is the most widely used indicator of overweight and obesity, consistently applied across all adult age groups and both sexes. A body mass index of ≥25 kg/m2 is considered overweight and obese, and ≥40 kg/m2 is considered extreme (class III) obesity, according to the World Health Organization (Weisell, 2002).

Numerous negative effects of obesity on health exist, and it stands alone as a risk factor for higher death. Additionally, it increases the risk of evolving type II diabetes, hypertension, excessive cholesterol, and impaired glucose tolerance, among other cardiovascular diseases. A few malignancies, musculoskeletal issues, and sleep apnea are among the other disorders linked to fat (Lagerros & Rössner, 2013). Exercise and dietary adjustments are fundamental to the primary prevention and treatment of obesity, as evidenced by the well-established therapeutic advantages of physical training for individuals with obesity(Galani & Schneider, 2007). Healthcare providers find it extremely difficult to prescribe appropriate exercise for this disease due to the patient's diminished mobility, discomfort during exercise, poor muscle contraction quality, exhaustion, and decreased ability for activity (Tallis et al., 2018).

Different researchers recommend concurrent training for obese individuals to achieve their physical fitness (Bouamra et al., 2022; Villareal et al., 2017). And also, the ACSM recommends that the physical exercise program include both anaerobic and largely aerobic workouts (Pescatello, 2014). Studies has shown that the combined approach of AT and RT is both safe and effective for overweight and obese individuals (Ho et al., 2012). Combined training, or CT, is the coupling of aerobic and resistance training within the same session. It is quite popular among people with busy schedules (Petré et al., 2018). Therefore a comprehensive fitness program should include both resistance and aerobic training in order to accomplish a variety of objectives, including improving cardiovascular fitness, body composition, muscle fitness and overall health (Cadore et al., 2010). Also combining aerobic and resistance training protocol also contributes to a notable improvement in body composition, a drop in the proportion of total body fat, and an improve in lean body mass (Eklund et al., 2016; Skrypnik et al., 2015).

Furthermore, there is a connection among serum levels of leptin, cortisol, and testosterone and weight loss. In actuality, lipolysis and protein metabolism are significantly impacted by these hormones (Møller & Jørgensen, 2009). Resistance and aerobic training would adjust the balance of anabolic and catabolic hormones (Popovic et al., 2019). In recent years, more information on the molecular mechanisms behind the specific adaptations to concurrent exercise stimuli has become available(Coffey & Hawley, 2017). Training adaptations are thought to be the culmination of acute signaling reactions and subsequent gene expression that are triggered by repeated exercise sessions(Egan & Sharples, 2023).

Consequently, some proteins progressively amass (proteinogenesis) and mitochondrial biogenesis transpires, culminating in an altered energy metabolism(Hodson, 2019).

Despite these known benefits, an important and underexplored aspect of combined training is the sequencing of resistance and aerobic exercises. The order in which these exercises are performed may influence acute responses and long-term adaptations (Eklund, 2012). While a few studies have explored performance outcomes (Panissa et al., 2022; Wilson et al., 2012) and biochemical mechanisms (Coffey & Hawley, 2017; Fyfe et al., 2014) in athletes or healthy adults, there is a critical gap in research addressing how exercise sequence affects clinical outcomes such as blood pressure and anthropometric markers, particularly in overweight and obese adults. Most existing studies have not specifically evaluated whether initiating a session with aerobic versus resistance training leads to superior improvements in health indicators during a structured program (Medeiros et al., 2015; Mengistu et al., 2025). Therefore, our study aims to fill this gap by assessing how different exercise orders in an eight-week concurrent training program impact blood pressure and body composition. This makes our study unique in targeting a practical and applicable variable (exercise order) within a clinical population, with direct relevance for individualized exercise prescription.

So, this study aims to explore how the sequence of RT and AT during concurrent training affects selected anthropometric indexes and blood pressure in overweight and obese adults.

2. Method

2.1. Study Setting

The research was conduct at Debre Markos metropolitan city, Amhara Regional state (ANRS). The town is found in the North-west of Addis Ababa, Ethiopia at a distance of 300 kms. It was conducted at Debre Markos University Sport Science Academy center for fitness and health at Debre Markos town, a controlled environment with individual exercise stations. Participants had access to a range of weight machines, free weights, and treadmills, with certified fitness trainers overseeing all sessions. Private changing facilities were provided for convenience, while bottled water was supplied to maintain hydration. Additionally, a research assistant trained in first aid was present on-site to ensure safety. Before giving their informed consent, participants received a comprehensive explanation of all procedures, potential risks, and protocols to uphold ethical standards. This aligned with the procedures established by the ACSM (Ozemek et al., 2025). Furthermore, the research ethics committee at Debre Markos University, Sport Academy revised and providing feedback on all aspects of the study involving human subjects. Finally, the study was conducted in accordance with the ethical guidelines set forth in the 2000 revision of the Declaration of Helsinki.

2.2. Research Design

This research employs a randomized repeated measures parallel group experimental design, which is particularly appropriate for evaluating the effects of interventions over time in distinct groups. The parallel group approach allows for a direct comparison between intervention conditions while minimizing contamination across treatments (Murray, 1998). Randomization helps reduce selection bias and ensures balance in key prognostic factors across groups, thereby enhancing the internal validity of the findings (Lavori et al., 2019).

2.3.Population

Subjects were recruited from among the employees working in both governmental and private banking institutions located in Debre Markos Town. The selection method entailed finding eligible candidates using predetermined inclusion and exclusion criteria to ensure a representative sample from both sectors.

2.4.Inclusion and Exclusion Criteria

Subjects were eligible if they had a BMI above 24.9 kg/m², were aged 30 to 45 years, had no contraindications through the Physical Activity Readiness Questionnaire (PAR-Q) and medical history, and were physically capable of performing the required exercises. Exclusion criteria included major clinical conditions restricting safe exercise participation, uncontrolled hyperglycemia (fasting blood glucose ≥ 126 mg/dL) or hypertension (resting BP ≥ 140/100 mm Hg), recent severe medical events (e.g., heart attack, stroke, surgical intervention, or advanced liver disease), medical advice against participation, or uncertainty in adhering to the study protocol.

2.5.Sample size Determination

The sample size was determined using an expected mean variance from prior research on overweight and obese adults undergoing an 8-week exercise intervention. An effect size of 0.58, BMI values of 36.2 ± 3.5 and 34.1 ± 2.8 kg/m², a two-sided significance of 0.05, and β, 0.80 power were used (Bouamra et al., 2022). Using G*Power software (version 3.1.9.7), the required sample size was initially calculated as 5 participants per group, which was increased to 7 per group to accommodate an anticipated 20% dropout rate.

2.6.Sampling Technique

Samples were recruited using a simple random sampling method from employees of governmental and private banks in Debre Markos Town who volunteered for the exercise program. A total of 51 individuals voluntarily registered, of which 15 were excluded based on the eligibility criteria. The remaining 37 were involved in the sampling frame, from which 21 participants were selected through simple random sampling. The sampling procedures were displayed on figure 1.

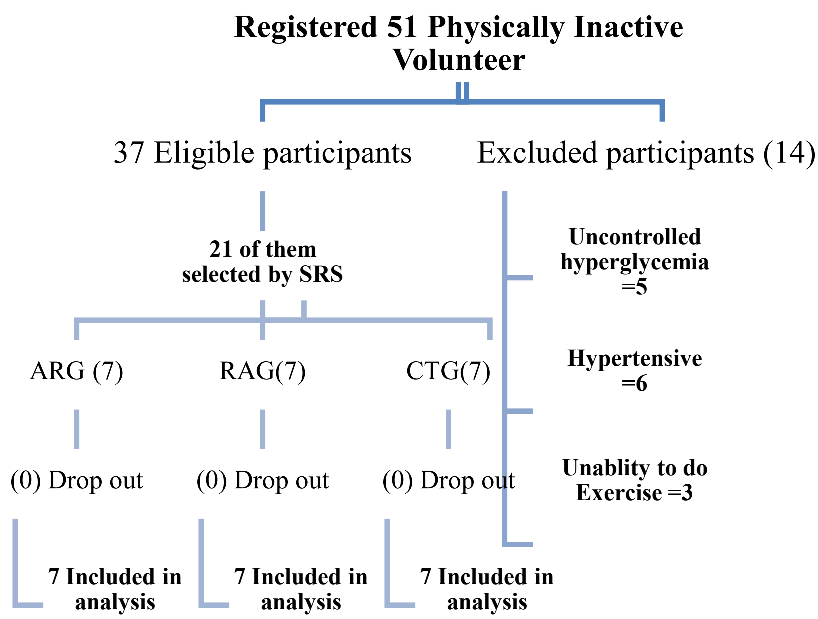

Figure 1. Participants selection and allocation procedures

2.7.Training Protocol

The intervention was supervised by certified fitness trainers to ensure safety, effectiveness, and adherence. The combined exercise Program comprised of 3 training programs within a week over 8 weeks, with each session consist of 70 minutes. Each training session consists of a 5–10-minute warm-up, 40-50 minutes of main training that is concurrent training with different order of resistance and aerobic exercise, and a 5–10-minute cool-down. The RT exercise targeted major muscle groups with six exercises per session (dumbbell curl, machine, squatting, leg press, neutral rowing, triceps pulley, and vertical bench press.), performed in three sets of 8-12 reps at 40-80% of 1RM (Willis et al., 2012). Aerobic exercises were done on a treadmill at 50-80% of HR max (Asad, 2013). Subjects were requested to avoid participation in extra resistance or aerobic exercise during the study. The protocol was adapted from previous research on obese populations. The exercise protocol was adapted from prior research conducted on an obese population (Sheikholeslami-Vatani et al., 2015). The COT group did not participate in any structured exercise during the expermentation period and was requested to preserve their usual activities.

2.8.Measurements of Study Variables

2.8.1. Blood Pressure (BP)

BP was assessed using an anutomated computerized Sphygmocor XCEL instrument (AtCor Medical, CardieX, Australia, Sydney) (De la Torre Hernández et al., 2021). The cuff was placed on the subject's left arm though they remained still on the clinical table. Following the initial brachial BP reading, reinflate the cuff to a diastolic pressure to capture wave form for five seconds.

2.8.2. Waist–Hip Ratio (WHR)

Waist (WC) and hip (HC) perimeters were measured using a Sammons Preston Tape (Narang, NewDelhi) to the nearest 0.1 cm (Khan et al., 2009). To ensure accuracy during the waist measurement, subjects were instructed to breathe normally and wear light clothing. The waist dimension was taken just above the navel, while the hip measurement was taken at the broadest part of the buttocks (Hu et al., 2010). The WHR was intended by dividing the WC by the HC (Bredella et al., 2009).

2.8.3. Body Mass Index (BMI)

Body mass and height of participants will be measured without shoes and will measure to the adjacent 0.01 kg and 0.01 cm, correspondingly, with a standard instrument (Continental stadiometer Scale Corporation, Chicago, IL, USA). BMI was determined by dividing the body mass in kgs by height squared in meters (m^2).

2.8.4. Body Fat Percentage (BFP)

A Lange caliper (Cambridge Scientific Instruments, Cambridge, MD, USA) was used to measure skinfold thickness at the abdominal, triceps, thigh, and suprailiac sites on the right side of the body, accurate to 0.5 mm. A single technician performed all skinfold measurements, adhering to a reliability threshold of 2 mm among three readings per site, the mean was used for data analysis. To estimate BFP, body density (BD) was first calculated using an equation tailored for elder adults (Nevill et al., 2008)

$$BD = (0.29288 \times \text{sum of all skinfolds}) - (0.0005 \times \text{sum of all skinfolds squared}) + (0.15845 \times \text{age}) - 5.76377.$$

The BD values were then converted to percent body fat using the Siri equation: $\%BF = ((4.95/D) - 4.50) \times 100$ for analytical purposes (Siri, 1993).

2.9.Statistical Analysis

Statistical analyses were performed using SPSS software, version 27 (SPSS Inc., Chicago, IL, USA). To ensure reliable results, a Bonferroni correction was applied for multiple comparisons in the RMANOVA, which was performed on SBP, DBP, WHR, and %BF. Within-subject changes over time were evaluated, and comparisons between different exercise modalities were made across groups. A two-tailed testing approach was used, and statistical significance was set at a p-value of 0.05 or less.

3. Results

Baseline descriptive data and adjusted absolute changes in PBF, SBP, DBP, WHR, and BMI over the study period are summarized in Table 1. All participants completed the study without any exclusions related to exercise complications, resulting in 21 subjects included in the analysis; 7 each from the ART, RAT, and CT groups.

Table 1. Baseline and follow-up characteristics

	ARG		RAG		CTG	
	Baseline	Follow-up	Baseline	Follow-up	Baseline	Follow-up
Age	40.71±2.49		41.86±2.34		41.71±1.97	
SBP	129.14±3.67	124.86±3.28	128.57±3.67	120.71±1.38	129.85±4.05	131.43±4.89
DBP	82.85±3.28	81.57±1.90	81.00±2.23	80.57±2.29	82.85±3.33	82.43±2.37
BFP	23.92±1.32	19.38±0.73	24.42±.92	20.14±.99	24.45±1.06	24.13±1.11
BMI	28.22±1.04	25.03±1.91	27.59±.65	25.18±1.03	27.95±1.22	28.22±1.09
WHR	1.21±0.10	1.07±.07	1.16±.092	1.01±.067	1.29±.075	1.30±0.07

Note. SBP: systolic blood pressure; DBP: diastolic blood pressure; BFP: percent Body fat; BMI: Body mass index and WHR: waist - hip ratio.

The average ages of participants in each group were: ART, 40.71 ± 2.49 years; RAT, 41.86 ± 2.34 years; and CT, 41.71 ± 1.97 years. Pretest analysis showed no significant change across the groups for any measured variables, confirming the effectiveness of the randomization process.

As displayed in Table 2, the results revealed that following aerobic-first concurrent training, the ART group experienced a significant reduction in systolic blood presser ($F(1,18) = 24.194$, $p = .001$, $\eta^2 = 0.573$). Post hoc analysis further confirmed a notable improvement between baseline and follow-up measurements in both the ART and RAT groups (MD = 4.286 ± 1.241, $p = 0.033$; MD = 7.857 ± 1.241, $p < 0.001$), while the control group showed no significant changes.

The diastolic blood pressure (DBP) of obese adults did not show a notable improvement between baseline and follow-up measurements, $F(1,18) = 3.792$, $p = .067$, $\eta^2 = .174$. However, the results for body fat percentage indicated a significant within-subject effect after the training intervention, $F(1,18) = 50.13$, $p = .001$, $\eta^2 = .736$, saying that the concurrent training program had a meaningful effect on BFP. Subsequent analysis further demonstrated a significant reduction in percent of body fat within the ART and RAT groups, with mean differences of MD = 0.143 ± 0.023 ($p < .001$) and MD = 0.150 ± 0.023 ($p < .001$), respectively. In contrast, no notable change was demonstrated in the waiting list group, indicating that the enhancements in body fat percentage were specifically attributed to the training intervention.

The analysis revealed a notable reduction in BMI between pretest to posttest measurements in the aerobic-first training (ART) group (MD = 3.192 ± 0.554, $p = .001$) and the resistance-first training (RAT) group (MD = 2.407 ± 0.554, $p = .011$). However, no meaningful difference was observed in the control group. Additionally, waist-to-hip ratio (WHR) levels showed a significant overall improvement, as indicated by the within-subject effect, $F(1,18) = 37.155$, $p < .001$, $\eta^2 = .674$. This improvement was evident in both the ART (MD = 0.025 ± 0.554, p < .001) and RAT groups (MD = 0.141 ± 0.025, p < .001), whereas no significant difference were detected in the CTG.

Table 2. Test within subject difference on SBP, DBP, BFP, BMI and WHR

Variables	Within -Subjects Effects			Pairwise comparison					
	F	Sig.[b]	η^2	groups	Mean Difference	Std. Error	Sig.[b]	95% CID Lower Bound	Upper Bound
SBP	24.194	.000	.573	ART	4.286	1.241	.003	1.679	6.893
				RAT	7.857	1.241	.000	5.250	10.464
				CTG	-1.571	1.241	.222	-4.178	1.035
DBP	3.792	.067	.174	ART	1.286	.635	NS	-.049	2.620
				RAT	.429	.635	NS	-.906	1.763
				CTG	.429	.635	NS	-.906	1.763
BFP	50.130	.000	.736	ART	.143	.023	.000	.095	.191
				RAT	.150	.023	.000	.102	.198
				CTG	-.013	.023	NS	-.061	.035
BMI	30.850	.000	.632	ART	3.192	.554	.001	2.027	4.357
				RAT	2.407	.554	.011	1.242	3.571
				CTG	-.265	.554	NS	-1.430	.900
WHR	37.155	.000	.674	ART	.129	.025	.000	.077	.181
				RAT	.141	.025	.000	.089	.193
				CTG	-.009	.025	.733	-.061	.043

SBP: systolic blood pressure, DBP: diastolic blood pressure, BFP: Body fat percentage, BMI: body mass index, WHR: waist - hip ratio, η^2: effect size.

As presented in Table 3, the sequence of exercise in concurrent training had a considerable change core effect on SBP, $F(2,18) = 6.871$, $p = .006$, $\eta^2 = 0.433$. Post hoc analysis using the Bonferroni adjustment indicated that the RAT group (MD = -5.786 ± 1.589, p = .006) showed a significant difference compared to the COT group, whereas no notable variance was demonstrated between the ART and RAT groups. In contrast, diastolic blood pressure (DBP) did not exhibit any notable differences among the groups. Additionally, body fat percentage (BFP) demonstrated a more pronounced reduction in both the RAT and ART groups compared to the CTG, with mean differences of MD = -0.153 ± 0.041 (p = .005) and MD = -0.210 ± 0.041 (p = .001), respectively.

The analysis displayed a significant principal effect of training modality on body mass index (BMI), $F(2,18) = 6.193$, $p = 0.009$, $\eta^2 = 0.408$. Bonferroni-adjusted post hoc comparisons showed that BMI was significantly reduced in both the ART (MD = -1.46 ± 0.523, p = 0.036) and RAT (MD = -1.699 ± 0.523, p = 0.013) groups compared to the control group. Furthermore, a significant difference in waist-to-hip ratio (WHR) was observed among the groups, $F(2,18) = 11.143$, $p = 0.001$, $\eta^2 = 0.553$. Specifically, both the ART and RAT interventions led to a significant reduction in

WHR compared to the control group (MD = -0.144, SE = 0.044, p = 0.013; MD= -0.204, SE= 0.044, p = 0.001, correspondingly). However, no change was found among the ART and RAT groups.

Table 3. Test between subject effect

Variables	Between-Subjects Effects			Pairwise comparison					
	F	Sig.[b]	η^2	Treatment groups	Mean Difference	Std. Error	Sig.[b]	95% CID Lower Bound	Upper Bound
SBP	6.871	.006	.433	ART-RAT	1.929	1.589	NS	-2.266	6.123
				ART-CTG	-3.857	1.589	NS	-8.052	.337
				RAT-CTG	-5.786	1.589	.006	-9.980	-1.591
DBP	13.238	NS	.365	ART-RAT	1.429	1.332	NS	-2.086	4.943
				ART-CTG	-.429	1.332	NS	-3.943	3.086
				RAT-CTG	-1.857	1.332	NS	-5.372	1.657
BFP	13.987	.000	.608	ART-RAT	.057	.041	.553	-.052	.165
				ART-CTG	-.153	.041	.005	-.262	-.045
				RAT-CTG	-.210	.041	.000	-.318	-.102
BMI	6.193	.009	.408	ART-RAT	.236	.523	NS	-1.145	1.616
				ART-CTG	-1.463	.523	.036	-2.844	-.083
				RAT-CTG	-1.699	.523	.013	-3.079	-.318
WHR	11.143	.001	.553	ART-RAT	.060	.044	NS	-.057	.177
				ART-CTG	-.144	.044	.013	-.261	-.027
				RAT-CTG	-.204	.044	.001	-.321	-.087

SBP: systolic blood pressure, DBP: diastolic blood pressure, BFP: Body fat percentage, BMI: body mass index, WHR: waist to hip ratio, η^2: effect size. The data are demonstrated as the means ± standard error.

Discussion

The aim of this research was to evaluate the impact of aerobic and resistance exercise order in concurrent training on cardiovascular and metabolic health indicators in men adults. The within-group analysis revealed notable improvements in cardiovascular and anthropometric measures after both aerobic-first concurrent training (ART) and resistance-aerobic training (RAT). Both groups showed a significant reduction in SBP, BFP, BMI, and WHR, with the exception of diastolic blood pressure.

The most notable finding was the significant decrease in SBP observed in both the AT followed by RT and RT followed by AT groups within groups. Similarly in young normotensive men (Lovato et al., 2012) and controlled hypertensive older persons (Fernandes et al., 2022), it was found that an acute session of concurrent exercise effectively reduced blood pressure levels, regardless of the order of execution. Whereas between group comparison, the RAT group showed significant improvement, which was further confirmed by post hoc analysis. But not significant change observed with ART group. These results align with existing literature that supports the efficacy of exercise interventions, particularly those combining aerobic and resistance training, in different order reducing systolic blood pressure in RA group in healthy adults (Mazzoccante et al., 2016).

The improvement in SBP suggests that concurrent training, regardless of sequence, may be particularly beneficial for cardiovascular health in obese adults. In contrast Ramos et al. (2019) demonstrated that resistance followed by aerobic training on women hypertensive patients did not show significant difference. In contrast, DBP did not show a significant change, which was in line with previous studies that found that consistent effects of exercise on DBP in obese individuals (Mazzoccante et al., 2016). This may suggest that while concurrent training has a substantial effect on systolic blood pressure, its impact on diastolic pressure may be less pronounced or require a longer duration of intervention to achieve significant results.

The results regarding body fat percentage (BFP) demonstrated a significant reduction in both the AT followed by RT and RT followed by AT groups compared with control group, indicating that the improvements in BFP were specifically attributed to the training intervention. These results align with previous research highlighting the influence of concurrent training in reducing BF and improving body fat distribution (Alves et al., 2017; Li et al., 2025). The reduction in body fat percentage suggests that concurrent training may lead to significant changes in body composition, likely due to both increased energy expenditure and enhanced metabolic function (Canli & Aldhahi, 2024).

Regarding body mass index (BMI), significant reductions were observed in both the ART (MD = -1.46 ± 0.523, $p = 0.036$) and RAT (MD = -1.699 ± 0.523, $p = 0.013$) groups, compared to the CTG. But no significant variation between both intervention group. This is consistent with studies showing that both AT followed by RT and RT followed by AT can be more effective in reducing BMI than control group (Canli & Aldhahi, 2024; Mohamadzadeh Salamat, 2017). These outcomes underscore the value of CT as a comprehensive approach to managing obesity-related health risks.

The WHR was similarly significantly reduced in both the ART (MD = -0.144, SE = 0.044, $p = 0.013$) and RAT (MD = -0.204, SE = 0.044, $p = 0.001$) groups compared to the CTG. However, no significant variance was found between the ART and RAT groups. This suggests that both exercise sequences similarly affect central adiposity, a critical determinant of metabolic health. These findings bring into line with researches involving Prolonged training periods, such as the 32-weektraining program (Faramarzi et al., 2018). The reduction in WHR is particularly important because it reflects improvements in abdominal fat, which is a key risk factor for cardiovascular diseases and other metabolic conditions (Alanazi et al., 2025).

While the results provide strong indication for the effectiveness of concurrent training in improving key health parameters, there are several limitations to reflect. Such as the duration of the intervention was relatively short, and it is possible that longer interventions would yield more significant or sustained improvements. Future research should examine the prolonged-term effects of concurrent training on cardiovascular and metabolic health, as well as explore potential mechanisms that underlie the notable enhancements in body composition and blood pressure.

This study offers significant clinical significance by evolving nonpharmacological approaches for managing blood pressure and anthropometric indexes in male overweight and obese adults. The findings indicate that a structured eight-week concurrent training program, varying the sequence of aerobic and resistance exercises with short rest periods, produces meaningful improvements in blood pressure control and body composition. These results are both statistically significant and clinically important, suggesting a lowered hazard of cardiovascular complications and improved metabolic health. Furthermore, concurrent training may boost compliance by delivering an efficient and convenient workout regimen tailored for those with limited time or motivation for extended exercise sessions. The study also refines existing exercise guidelines by offering specific evidence on the optimal sequence (resistance followed by aerobic training) of training modalities to maximize health benefits. Consequently, this research contributes valuable insights to advise clinical administrative and guide future investigations in exercise therapy for excess body weight populations.

Despite the strengths of this research, including its structured design, objective measurements, and statistical rigor, several limitations should be acknowledged. The lack of dietary control is a notable limitation, as variations in participants' nutritional intake during the intervention period could have influenced key outcome measures such as body composition and metabolic biomarkers. Although subjects were counseled to maintain their typical dietary habits, the absence of formal monitoring reduces our ability to account for this potential confounding variable. This limitation underscores the need for enhancements in future studies and should be taken into account when evaluating the findings.

Conclusion

In conclusion, this research's findings indicate that concurrent exercise, regardless of the exercise sequence, significantly enhances cardiovascular health and body composition in obese adults. Both ART and RAT proved more effective in reducing BFP, BMI, and WHR. Notably, the RAT group exhibited greater effectiveness than the ART group in lowering systolic blood pressure among previously inactive obese adults. These results demonstrate the importance of exercise sequence in influencing metabolic and cardiovascular outcomes. Future studies should investigate the long-term impact of various exercise sequences to optimize training programs for individuals with obesity, incorporating dietary control.

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References

Alanazi, M. A., Alshehri, K., Alerwy, F. H., Alrasheed, T., Lahza, H. F. M., Aref Albezrah, N. K., Alghabban, Y. I., & Mohammed Abdulghani, M. A. (2025). Abdominal volume index is associated with higher oxidized LDL, high blood pressure and lower HDL among obese adults. *BMC Endocrine Disorders*, *25*(1), 56. https://doi.org/10.1186/s12902-025-01884-6

Alves, A. R., Marta, C. C., Neiva, H. P., Izquierdo, M., & Marques, M. C. (2017). Effects of order and sequence of resistance and endurance training on body fat in elementary school-aged girls. *Biol Sport*, *34*(4), 379-384. https://doi.org/10.5114/biolsport.2017.69826

Asad, M. (2013). Effect of 8 weeks aerobic, resistance and concurrent training on cholestrol, LDL, HDL and cardiovascular fitness in obesity male. *Applied Research in Sport Management*, *1*(3), 57-64.

Bouamra, M., Zouhal, H., Ratel, S., Makhlouf, I., Bezrati, I., Chtara, M., Behm, D. G., Granacher, U., & Chaouachi, A. (2022). Concurrent training promotes greater gains on body composition and components of physical fitness than single-mode training (endurance or resistance) in youth with obesity. *Frontiers in physiology*, *13*, 869063.

Bredella, M. A., Utz, A. L., Torriani, M., Thomas, B., Schoenfeld, D. A., & Miller, K. K. (2009). Anthropometry, CT, and DXA as predictors of GH deficiency in premenopausal women: ROC curve analysis. *J Appl Physiol (1985)*, *106*(2), 418-422. https://doi.org/10.1152/japplphysiol.90998.2008

Cadore, E. L., Pinto, R., Lhullier, F., Correa, C., Alberton, C., Pinto, S., Almeida, A., Tartaruga, M., Silva, E., & Kruel, L. (2010). Physiological effects of concurrent training in elderly men. *International journal of sports medicine*, 689-697.

Canli, U., & Aldhahi, M. I. (2024). The physiological and physical benefits of two types of concurrent training: a randomized controlled trial. *BMC Sports Sci Med Rehabil*, *16*(1), 8. https://doi.org/10.1186/s13102-023-00798-x

Coffey, V. G., & Hawley, J. A. (2017). Concurrent exercise training: do opposites distract? *The Journal of physiology*, *595*(9), 2883-2896.

De la Torre Hernández, J. M., Veiga Fernandez, G., Brown, J., Sainz Laso, F., Lee, D. H., Fradejas, V., Garcia Camarero, T., Elmariah, S., Inglessis, I., Zueco, J., Vazquez de Prada, J. A., Ben-Assa, E., &

Edelman, E. R. (2021). Validation study to determine the accuracy of central blood pressure measurement using the SphygmoCor XCEL cuff device in patients with severe aortic stenosis undergoing transcatheter aortic valve replacement. *J Clin Hypertens (Greenwich)*, *23*(6), 1165-1175. https://doi.org/10.1111/jch.14245

Egan, B., & Sharples, A. P. (2023). Molecular responses to acute exercise and their relevance for adaptations in skeletal muscle to exercise training. *Physiological Reviews*.

Eklund, D. (2012). Acute hormonal and muscular responses and recovery: chronic adaptations to single session combined strength and endurance training with regard to order effect.

Eklund, D., Häkkinen, A., Laukkanen, J. A., Balandzic, M., Nyman, K., & Häkkinen, K. (2016). Fitness, body composition and blood lipids following 3 concurrent strength and endurance training modes. *Applied Physiology, Nutrition, and Metabolism*, *41*(7), 767-774. https://doi.org/10.1139/apnm-2015-0621

Faramarzi, M., Bagheri, L., & Banitalebi, E. (2018). Effect of sequence order of combined strength and endurance training on new adiposity indices in overweight elderly women. *Isokinetics and Exercise Science*, *26*(2), 105-113. https://doi.org/10.3233/IES-172195

Fernandes, D. R., Sisconeto, T. M., Freitas, S. S., Souza, T. C. F., Delevatti, R. S., Ferrari, R., Puga, G. M., & Kanitz, A. C. (2022). Effect of the execution order from concurrent exercise session on blood pressure responses in hypertensive older men. *Motriz: Revista de Educação Física*, *28*(spe2), e10220005122. https://doi.org/http://doi.org/10.1590/s1980-657420220005122.

Ford, N. D., Patel, S. A., & Narayan, K. M. V. (2017). Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. *Annual Review of Public Health*, *38*(Volume 38, 2017), 145-164. https://doi.org/https://doi.org/10.1146/annurev-publhealth-031816-044604

Fyfe, J. J., Bishop, D. J., & Stepto, N. K. (2014). Interference between Concurrent Resistance and Endurance Exercise: Molecular Bases and the Role of Individual Training Variables. *Sports Medicine*, *44*(6), 743-762. https://doi.org/10.1007/s40279-014-0162-1

Galani, C., & Schneider, H. (2007). Prevention and treatment of obesity with lifestyle interventions: review and meta-analysis. *International journal of public health*, *52*, 348-359.

Ho, S. S., Dhaliwal, S. S., Hills, A. P., & Pal, S. (2012). The effect of 12 weeks of aerobic, resistance or combination exercise training on cardiovascular risk factors in the overweight and obese in a randomized trial. *BMC Public Health*, *12*, 1-10.

Hodson, N. (2019). *Investigating novel regulators of mTORC1 activation in human skeletal muscle* University of Birmingham].

Hu, G., Jousilahti, P., Antikainen, R., Katzmarzyk, P. T., & Tuomilehto, J. (2010). Joint Effects of Physical Activity, Body Mass Index, Waist Circumference, and Waist-to-Hip Ratio on the Risk of Heart Failure. *Circulation*, *121*(2), 237-244. https://doi.org/10.1161/CIRCULATIONAHA.109.887893

Juni, M. H. (2015). Obesity: A public health threats in developing countries. *Int. J. Public Health Clin. Sci*, *2*(2).

Khan, M. S., Chandanpreet, S., Kewal, K., Sanjay, D., Ram, K. J., & Atul, S. (2009). Malnutrition, anthropometric, and biochemical abnormalities in patients with diabetic nephropathy. *J Ren Nutr*, *19*(4), 275-282. https://doi.org/10.1053/j.jrn.2009.01.026

Lagerros, Y. T., & Rössner, S. (2013). Obesity management: what brings success? *Therapeutic advances in gastroenterology*, *6*(1), 77-88.

Lavori, P. W., Thomas, A. L., Bailar, J. C., & Polansky, M. (2019). Designs for experiments—parallel comparisons of treatment. In *Medical uses of statistics* (pp. 61-82). CRC Press.

Li, Z., Gong, T., Ren, Z., Li, J., Zhang, Q., Zhang, J., Chen, X., & Zhou, Z. (2025). Impact of sequence in concurrent training on physical activity, body composition, and fitness in obese young males: A 12-week randomized controlled trial. *J Exerc Sci Fit*, *23*(2), 112-121. https://doi.org/10.1016/j.jesf.2025.02.001

Lovato, N. S., Anunciação, P. G., & Polito, M. D. (2012). Blood pressure and heart rate variability after aerobic and weight exercises performed in the same session. *Revista Brasileira de Medicina do Esporte*, *18*, 22-25. https://doi.org/http://doi.org/10.1590/S1517-86922012000100004.

Mazzoccante, R. P., Sousa, I. R. C. d., Pereira, R. M. d. S., Souza, T. M. F., Moraes, J. F. V. N. d., & Campbell, C. S. G. (2016). Effects of the alternance between aerobic and resistance exercise in different concurrent exercise sessions on blood pressure responses of healthy adults : a controlled and randomized study.

Medeiros, N. d. S., de Abreu, F. G., Colato, A. S., de Lemos, L. S., Ramis, T. R., Dorneles, G. P., Funchal, C., & Dani, C. (2015). Effects of Concurrent Training on Oxidative Stress and Insulin Resistance in Obese Individuals. *Oxidative Medicine and Cellular Longevity*, *2015*(1), 697181. https://doi.org/https://doi.org/10.1155/2015/697181

Mengistu, F. A., Lake, Y. A., Andualem, M. E., Miherete, Y. D., & Zewdie, S. A. (2025). Impact of aerobic, resistance, and combined training on cardiometabolic health-related indicators in inactive middle-aged men with excess body weight and obesity [Original Research]. *Frontiers in physiology*, *Volume 16 - 2025*. https://doi.org/10.3389/fphys.2025.1519180

Mohamadzadeh Salamat, K. (2017). The effect of two types of concurrent training on VO2max, maximal strength and body fat percentage in young men. *Report of Health Care*, *3*(1), 17-22.

Møller, N., & Jørgensen, J. O. L. (2009). Effects of growth hormone on glucose, lipid, and protein metabolism in human subjects. *Endocrine reviews*, *30*(2), 152-177.

Murray, D. M. (1998). *Design and analysis of group-randomized trials* (Vol. 29). Monographs in Epidemiology and.

Nevill, A. M., Metsios, G. S., Jackson, A., Wang, J., Thornton, J., & Gallagher, D. (2008). Can we use the Jackson and Pollock equations to predict body density/fat of obese individuals in the 21st century? *International journal of body composition research*, *6*(3), 114.

Ozemek, C., Bonikowske, A., Christle, J., & Gallo, P. (2025). *ACSM's Guidelines for Exercise Testing and Prescription*. Lippincott Williams & Wilkins.

Panissa, V. L. G., Greco, C. C., Ribeiro, N., Julio, U. F., Tricoli, V., & Franchini, E. (2022). Concurrent Training and the Acute Interference Effect on Strength: Reviewing the Relevant Variables. *Strength & Conditioning Journal*, *44*(3). https://journals.lww.com/nsca-scj/fulltext/2022/06000/concurrent_training_and_the_acute_interference.5.aspx

Pescatello, L. S. (2014). *ACSM's guidelines for exercise testing and prescription*. Lippincott Williams & Wilkins.

Petré, H., Löfving, P., & Psilander, N. (2018). The effect of two different concurrent training programs on strength and power gains in highly-trained individuals. *Journal of sports science & medicine*, *17*(2), 167.

Popovic, B., Popovic, D., Macut, D., Antic, I. B., Isailovic, T., Ognjanovic, S., Bogavac, T., Kovacevic, V. E., Ilic, D., & Petrovic, M. (2019). Acute response to endurance exercise stress: focus on catabolic/anabolic interplay between cortisol, testosterone, and sex hormone binding globulin in professional athletes. *Journal of medical biochemistry*, *38*(1), 6.

Ramos, A. M., Senna, G. W., Scudese, E., Dantas, E. H. M., Silva-Grigoletto, M. E. d., Fuqua, J. D., & Pardono, E. (2019). Cardiovascular and strength adaptations in concurrent training in hypertensive women. *Revista Brasileira de Medicina do Esporte*, *25*, 367-371.

Sheikholeslami-Vatani, D., Siahkouhian, M., Hakimi, M., & Ali-Mohammadi, M. (2015). The effect of concurrent training order on hormonal responses and body composition in obese men. *Science & Sports*, *30*(6), 335-341.

Siri, W. E. (1993). Body composition from fluid spaces and density: analysis of methods. 1961. *Nutrition*, *9*(5), 480-491; discussion 480, 492.

Skrypnik, D., Bogdański, P., Mądry, E., Karolkiewicz, J., Ratajczak, M., Kryściak, J., Pupek-Musialik, D., & Walkowiak, J. (2015). Effects of Endurance and Endurance Strength Training on Body Composition and Physical Capacity in Women with Abdominal Obesity. *Obesity Facts*, *8*(3), 175-187. https://doi.org/10.1159/000431002

Tallis, J., James, R. S., & Seebacher, F. (2018). The effects of obesity on skeletal muscle contractile function. *Journal of Experimental Biology*, *221*(13), jeb163840.

Villareal, D. T., Aguirre, L., Gurney, A. B., Waters, D. L., Sinacore, D. R., Colombo, E., Armamento-Villareal, R., & Qualls, C. (2017). Aerobic or resistance exercise, or both, in dieting obese older adults. *New England Journal of Medicine*, *376*(20), 1943-1955.

Weisell, R. C. (2002). Body mass index as an indicator of obesity. *Asia Pacific journal of clinical nutrition*, *11*, S681-S684.

Willis, L. H., Slentz, C. A., Bateman, L. A., Shields, A. T., Piner, L. W., Bales, C. W., Houmard, J. A., & Kraus, W. E. (2012). Effects of aerobic and/or resistance training on body mass and fat mass in overweight or obese adults. *Journal of applied physiology*.

Wilson, J. M., Marin, P. J., Rhea, M. R., Wilson, S. M., Loenneke, J. P., & Anderson, J. C. (2012). Concurrent training: a meta-analysis examining interference of aerobic and resistance exercises. *The Journal of Strength & Conditioning Research*, *26*(8), 2293-2307.