Journal of Research Administration
Society of Research Administrators International

# THE EFFECTS OF LONG-TERM L-CARNITINE SUPPLEMENTATION DURING CONCURRENT TRAINING ON PHYSIOLOGICAL INDICATORS AND ANTHROPOMETRIC CHARACTERISTICS IN OBESE YOUNG WOMEN

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***Abstract*—** Background; Despite extensive research, the effects of L carnitine supplementation in treating obesity are still unclear and equivocal. L-Carnitine transports fatty acids into mitochondria for oxidation and is marketed as a weight loss supplement. The purpose of the present research is to investigate the efficacy of long-term L-Carnitine supplementation during concurrent training on the physiological indicators and anthropometrics characteristics in obese young women.

Methodology; fourthly- five non-active, obese females (age = 22.76 ± 1.45 years, body mass index = 32.74 ± 1.43 kg/m2) participated in this research. Participants were randomly divided into three groups: Experimental group 1 -EXP1: (Concurrent training with L-Carnitine supplementation), Experimental group 2 – EXP2: (L-Carnitine supplementation without training) and Control group (without training or L-Carnitine supplementation). Concurrent training was performed for 12 weeks, four sessions per week, with a training intensity ranging from 60% to 75% of the maximal heart rate reserve and one-repetition maximum. Both experimental groups were supplemented with 35 mg L-Carnitine supplement per kg body weight. Various physiological indicators and anthropometric variables were collected at three time points (pre-test, mid-test and post-test).

Results; A number of variables were significantly improved in the EXP1 after 6 and 12-weeks (blood pressure, weight, body mass index, percentage of body fat and fat free mass) and only after 12-weeks (maximal oxygen consumption, one repetitions maximum, resting heart rate). No significant changes were observed for EXP2 and C group.

Conclusion; L-Carnitine supplementation, in conjunction with concurrent training, emerges as a highly effective approach for enhancing physiological indicators and boosting and anthropometric characteristics in obese young women. Therefore, it is recommended that

overweight female individuals integrate concurrent training into their regimen while taking L-Carnitine.

**Index Terms—** L-Carnitine, Blood pressure, Physiology, Women's Health.

## INTRODUCTION

Overweight, obesity and severe obesity rates have increased markedly in recent decades, particularly in the young [1]. Obesity is a multifactorial and complex disease defined as an excess of body fat resulting from an inadequate energy balance over the long term. It is driven by the interaction between genetic predisposition and environmental factors [2]. Physical activity is recognized as a "pillar" in the management of overweight and obesity, in parallel with dietary counseling, behavioral support. Physical activity is defined in broad terms as "any bodily movement produced by skeletal muscles that results in energy expenditure. Consequently, it is important to recognize physical inactivity as an essential determinant in the context of weight gain and the onset of obesity [3].

L-Carnitine is an amino acid-like compound that plays a role in energy metabolism by supporting transport of fatty acids into the mitochondria, where they can be used for energy production through β-oxidation [4]. L-Carnitine is essential for the transfer of long-chain fatty acids across the inner mitochondrial membrane for subsequent β-oxidation [5]. Therefore, without carnitine most of the dietary lipids cannot be used as an energy source and our body would accumulate fatty-acids promoting obesity [6]. L-Carnitine might decrease body weight through a variety of mechanisms - improving insulin resistance, decreasing appetite and food intake through a direct effect on hypothalamus. L-Carnitine (L-C) transports fatty acids into mitochondria for oxidation and is marketed as a weight loss supplement [7].

Nevertheless, previous clinical studies reported inconsistent data regarding effects of L-carnitine supplementation on obesity-related indexes. A previous meta-analysis conducted by Askarpour et al. [8] showed that l-carnitine supplementation might have a positive effect in achieving an improved body weight and BMI especially in overweight and obese subjects. Similarly, in a research Fielding et al. [9] found that L-Carnitine supplementation could lead to significantly increased muscle mass accompanied by a decrease in body weight and reduced physical and mental fatigue. Another study conducted by Talenezhad et al. [10] investigated the effect of L-carnitine on weight loss in adults. The authors reported significant reductions in fat mass, body weight and BMI compared with the control group especially among adults with overweight/obesity.

However, certain authors have reported conflicting outcomes. In a recent comprehensive systematic review and randomized, double-blind, controlled clinical trial conducted by Sangouni et al. [11] the researchers found that 12-week L-carnitine supplementation in overweight or obese women with PCOS ameliorate insulin resistance, but has no effect on SHBG and lipid profile. Studies with higher dosages and duration of L-carnitine intake are required. The authors proposed that the diversity in study design and the lack to determine the optimal dosage and

duration of L-carnitine supplementation may contribute to the inconsistencies in results concerning weight loss and the facilitation of lipid oxidation, primarily involving the transport of long-chain fatty acids into the inner mitochondrial region [12].

We hypothesized that supplementation with L-carnitine during 12 weeks will result in a significant improvement in physiological indicators and anthropometric variables in obese individuals who are engaged in concurrent training. This study therefore aimed to examine the effect of L-carnitine supplementation on physiological indicators and anthropometric characteristics in obese women during concurrent training.

## Materials and Methods

Study Design

This semi-experimental research study employed purposive sampling to select participants based on specific criteria. Subsequently, the participants were allocated into three groups using the systematic random grouping method, ensuring an equal distribution of male subjects across each group. The experimental groups received L-carnitine supplementation (BIOTECH USA, L-CARNITINE 1000 MG) 30 minutes prior to each exercise session, administered at a dosage of 35 mg/kg of body weight. This supplementation occurred three times per week over an eight-week period, with the L-carnitine dissolved in distilled water [13].

Obtaining written consent from study participants was a crucial step, involving a comprehensive explanation of the research's objectives and methods. This process aimed to ensure participants' thorough comprehension of the study, enabling an informed decision regarding their involvement. Participants were familiarized with various aspects, including concurrent training, research characteristics, variable measurement, training protocol, pretest, midtest, and posttest procedures, as well as instructions, possibilities, and limitations related to the research's time and location.

Subjects engaged in both strength and endurance programs on the same day, with aerobic sessions preceding strength sessions. Training sessions occurred on Mondays, Wednesdays, Fridays and Saturdays, all meticulously supervised by a minimum of two experienced personal trainers. Variable measurements were conducted for all groups before the study initiation, at the 6-week mark, and at the conclusion of the 12-week period. The study protocol comprised four sessions per week, each lasting 70-85 minutes, maintaining an intensity of 60-75 percent of maximal reserve heart rate and one repetition maximum. The concurrent training protocol, integrating strength and endurance training, commenced in the first, second and third weeks at 60% HRR and 1RM for 70 minutes, progressively increasing to 85 minutes with 75% maximum heart rate reserve and 1RM by the study's conclusion. This progression involved the addition of 5 minutes to the duration and a 5% intensity increase every three weeks (refer to Table 1 and 2).

Table 1. Training Protocol (Concurrent Training)

| **Week** | **First Second** | **Third** | **Fourth Fifth** | **Sixth** | **Seventh Eighth** | **Nineth** | **Tenth Eleventh** | **Twelves** |
|---|---|---|---|---|---|---|---|---|
| **Warm-** | **5 Min** | **5** | **5 Min** | **5** | **5 Min** | **5 Min** | **5 Min** | **5 Min** |

| Up | | Min | | Min | | | | |
|---|---|---|---|---|---|---|---|---|
| CT | 30 Min, R + 30 Min, RT | 30 Min, R + 30 Min, RT | 30 Min, R + 35 Min, RT | 30 Min, R + 35 Min, RT | 35 Min, R + 35 Min, RT | 35 Min, R + 35 Min, RT | 35 Min, R + 40 Min, RT | 35 Min, R + 40 Min, RT |
| Duration | 60 Min | 60 Min | 65 Min | 65 Min | 70 Min | 70 Min | 75 Min | 75 Min |
| Intensity | 60 % | 60 % | 65 % | 65 % | 70 % | 70 % | 75 % | 75 % |
| Cool-Down | 5 Min | 5 Min | 5 Min | 5 Min | 5 Min | 5 Min | 5 Min | 5 Min |
| Total | 70 Min | 70 Min | 75 Min | 75 Min | 80 Min | 80 Min | 85 Min | 85 Min |

Table note: Abbreviations: CT; Concurrent Training; R, Running; RT, Resistance Training; Min, Minutes

Table 2. Resistance Training

| Training sessions | Training movements | | | |
|---|---|---|---|---|
| Chest and Biceps (First Session) | Barbell bench press, Incline barbell bench press, Machine fly, Dumbbell bicep curls, Cable curls | | | |
| Back Muscles and Triceps (Second Session) | Lat pull-down, Seated pulley row, T-Bar row, Triceps push-down, Dip | | | |
| Shoulder (Third Session) | Standing Dumbbell Fly, Dumbbell Raise Complex, Clean and Press, Dumbbell shoulder, Lift dumbbell | | | |
| Leg, Abdominal (Fourth Session) | 45-degree leg press, Machine leg extension, Machine leg flexion, ball crunch, Side bend | | | |
| Week | Set | Repeat | 1RM | Rest |
| First, Second, Third | 3 | 12-14 | 60 % | 30 s – 1 min |
| Fourth, Fifth, Sixth | 3 | 12-14 | 65 | 30 s – 1 |

| | | | | |
|---|---|---|---|---|
| | | | **%** | **min** |
| **Seventh, Eighth, Nineth** | **3** | **12-14** | **70%** | **30 s – 1 min** |
| **Tenth, Eleventh, Twelves** | **4** | **13-15** | **75 %** | **1 min – 2 min** |

Sample Size and Sampling Techniques

The study employed the purposive sampling technique to select participants based on predetermined criteria. Inclusion criteria specified sedentary young females aged between 20 and 25 years with a body mass index (BMI) within the range of 30–35 kg/m². Recruitment occurred in the Sari city area in Iran through direct outreach and advertising. Exclusion criteria included allergies to L-carnitine, a lack of recent physical activity, chronic illnesses, and medication use. Prospective participants were also required to have refrained from engaging in conditioning exercises exceeding 2 hours per week for the one year preceding the study.

Initially, 52 sedentary females were recruited based on the sampling technique and criteria. However, seven individuals withdrew from the study for reasons unrelated to the research. Consequently, a cohort of 45 females, with a mean weight of BMI of 32.74 ± 1.43 kg/m², and an average age of 22.76 ± 1.45 years, were enrolled. These participants were randomly assigned to one of three groups: Experimental Group 1 (L-Carnitine + 12 weeks of training), Experimental Group 2 (L-Carnitine + no training), and Control Group (No L-Carnitine + no training). Participant demographics and characteristics are detailed in Table 3.

Table 3. Participant characteristics

| Participant characteristics | EX P1 | EX P2 | Control |
|---|---|---|---|
| Sample Size | 15 | 15 | 15 |
| Age (years) | 23.41 ± 0.65 | 22.07 ± 2.42 | 22.81 ± 1.29 |
| Height (m) | 1.62 ± 1.32 | 1.61 ± 1.20 | 1.64 ± 1.67 |
| Weight (kg) | 86.11 ± 4.36 | 88.12 ± 5.88 | 87.03 ± 3.68 |
| BMI (kg/m2) | 33.08 ± 0.76 | 32.51 ± 1.39 | 32.63 ± 2.14 |
| 1RM | 114.3 ± 6.25 | 115.40 ± 3.79 | 119.8 ± 4.99 |

Table note: Abbreviations: EX P1, Experimental Group 1; EX P2, Experimental Group 2; C G, BMI, Body Mass Index; 1RM; One Repetition Maximum. All values are presented as Mean ± Standard deviation.

Statistical Analysis

All data were set as mean ± standard deviation (SD). The Kolmogorov-Smirnov test was used to examine if variables were normally distributed. For the data analysis, factorial ANOVA with the post-hoc analysis of variance (LSD test) was used, at significance level set on $p \leq 0.05$. All data was processed using SPSS software (IBM SPSS Statistics 22) [14].

## Experimental Measurements

Bioelectrical impedance (BIA) analysis was employed to estimate anthropometric characteristics, involving the passage of a weak electric current through the body, with voltage measurements used to calculate body impedance (resistance). The Tanita TBF-300 Body Composition Analyzer was utilized to measure variables such as weight, Body mass index (BMI), body fat percentage (BF%), and fat-free mass (FFM) [15, 16]. Body height and weight measurements were obtained using a calibrated height-weight digital balance beam scale, with recordings in meters and kilograms, respectively [17].

Resting heart rate (RHR) was assessed in beats per minute using the Polar RS400 Heart Rate Monitor following a 10-minute rest period in the supine position, adhering to standard protocols. Subsequently, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were determined millimeters of mercury through examination of the brachial artery, utilizing a mercurial sphygmomanometer (blood pressure monitor Model BP380A), in accordance with established clinical procedures [14]. Maximal oxygen consumption (VO2 max) was determined through a continuous treadmill test for exhaustion on a motorized treadmill, employing the modified Bruce protocol [18]. Treadmill speed was adjusted during the warm-up phase to achieve a heart rate of approximately 70% of the predicted maximal heart rate. Subsequently, treadmill speed remained constant, and the treadmill grade increased by two percent every two minutes until volitional fatigue. Oxygen saturation was quantified employing pulse oximetry (AccuMed CMS-50DL Fingertip Pulse Oximeter Blood Oxygen SpO2 Sports and Aviation Fingertip Monitor), a measure reflecting the proportion of oxygen-carrying hemoglobin in the blood relative to non-oxygen-carrying hemoglobin [19, 20]. To estimate strength one repetition maximum (1RM), subjects underwent an eight-to-ten-minute warm-up, and the test was conducted under the supervision of a researcher. The 1RM for chest press and leg press was recorded and estimated using the formula proposed by Brzeski [15, 21].

## Results

Anthropometric characteristics of the subjects for pre, mid and posttest based on the mean and standard deviation is shown in (Table 4). The analysis of measure ANOVA in the groups in three stages showed that eight weeks l-Carnitine supplementation during concurrent training significantly effect in experimental group 1 in comparison to experimental group 2 and control group. Research finding has shown that l-Carnitine supplementation in experimental group 1 improved Weight, BMI, BF% and FFM more than experimental group 2 and control group at both midtest and posttest in obese females. These variables were not significant for experimental

group 2 and control group ($p \leq 0.05$).

Table 4. Anthropometric characteristics of study participants

| Variable | Group | Pre-test | Mid-test | Post-test |
|---|---|---|---|---|
| Weight (kg) | EXP1 | 86.11 ± 4.36 | 83.54 ± 5.97*¥ | 79.23 ± 2.66*¥ |
| | EXP2 | 88.12 ± 5.88 | 87.21 ± 4.32 | 86.36 ± 6.46 |
| | Control | 87.03 ± 3.68 | 87.03 ± 3.68 | 88.64 ± 4.36 |
| BMI ($kg/m^2$) | EXP1 | 33.08 ± 0.76 | 31.68 ± 3.26*¥ | 28.46 ± 1.34*¥ |
| | EXP2 | 32.51 ± 1.39 | 32.03 ± 0.56 | 31.82 ± 1.67 |
| | Control | 32.63 ± 2.14 | 32.63 ± 2.14 | 32.86 ± 1.9 |
| BF (%) | EXP1 | 39.42±3.11 | 36.25±2.77*¥ | 32.10±3.08*¥ |
| | EXP2 | 38.56±4.38 | 37.42±3.76 | 38.94±3.83 |
| | Control | 40.10±2.64 | 40.25±3.39 | 39.44±4.68 |
| FFM (kg) | EXP1 | 57.20±5.32 | 54.66±4.29*¥ | 51.7±4.37*¥ |
| | EXP2 | 59.73±5.33 | 58.22±3.88 | 59.19±4.38 |
| | Control | 58.05±4.61 | 58.05±4.61 | 58.81±3.58 |

Note: * significant differences compared to pre-test; ¥ Significant difference compared to the control group; Abbreviations: EXP1, Experimental Group 1; EXP2, Experimental Group 2; BMI, Body Mass Index; BF %, Body Fat Percentage; FFM, Fat Free Mass. All values are presented as Mean ± Standard deviation.

L-carnitine has a significant effect on the development of Physiological indicators in obese females during concurrent training (Table 5). The results of repeated measures ANOVA showed that a significant effect in experimental group 1 in comparison to experimental group 2 and control group for only 1RM at midtest and posttest for RHR, SBP, DBP and VO2max only for posttest and no significant effect for SpO2 for groups. These variables except 1RM were not significant for experimental group2 and control group ($p \leq 0.05$).

Table 5. Physiological indicators of study participants

| Variable | Group | Pre-test | Mid-test | Post-test |
|---|---|---|---|---|
| RHR (bpm) | EXP1 | 77.21±8.65 | 75.36±7.35 | 70.66±9.20*¥ |
| | EXP2 | 80.12±9.35 | 79.52±8.02 | 78.383±9.51 |
| | Control | 79.68±6.55 | 79.44±6.45 | 79.28±6.08 |
| SBP (mmHg) | EXP1 | 122.2±4.29 | 118.56±5.01 | 109.50±6.38*¥ |
| | EXP2 | 119.57±8.23 | 117.08±7.39 | 116.21±5.94 |
| | Control | 122.35±5.36 | 122.55±4.95 | 122.36±5.33 |
| DBP (mmHg) | EXP1 | 80.39±6.24 | 76.59±5.68 | 71.69±6.22*¥ |
| | EXP2 | 82.14±3.87 | 82.24±3.87 | 81.14±6.58 |
| | Control | 80.66±4.97 | 80.02±4.36 | 80.33±4.84 |
| SpO2 (%) | EXP1 | 96.01±2.37 | 96.20±4.33 | 96.07±2.45 |
| | EXP2 | 95.52±3.54 | 95.42±3.54 | 95.62±2.67 |
| | Control | 96.08±2.13 | 96.09±1.39 | 96.11±3.14 |
| $Vo_2Max$ (ml×kg-1×min-1) | EXP1 | 28.23±5.33 | 30.66±4.25 | 32.25±5.33*¥ |
| | EXP2 | 27.64±4.29 | 28.10±6.87 | 28.97±4.69 |
| | Control | 29.08±4.68 | 29.08±4.68 | 29.11±3.55 |
| 1RM (kg) | EXP1 | 114.3 ± 6.25 | 125.25 ± 5.38*¥ | 132.35 ± 2.38*¥ |
| | EXP2 | 115.40 ± 3.79 | 119.23 ± 4.23 | 123.56 ± 3.52*¥ |
| | Control | 119.8 ± 4.99 | 118.23 ± 5.68 | 1120.98 ± 5.22 |

Note: * significant differences compared to pre-test; ¥ Significant difference compared to the control group; Abbreviations: EXP1, Experimental Group 1; EXP2, Experimental Group 2; RHR, Resting Heart Rate; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; SpO2, Oxygen Saturation; Vo2Max, Maximal Oxygen Consumption; 1RM, One Repetitions Maximum. All values are presented as Mean ± Standard deviation.

## Discussion

This research explored the impact of L-Carnitine supplementation in combination with concurrent training on physiological indicators and anthropometric characteristics among obese young women. The primary outcome of this investigation revealed that a 12-weeks regimen of L-Carnitine supplementation paired with concurrent training led to substantial improvements in both physiological indicators and anthropometric characteristics. Contrastingly, in the experimental group that consumed L-Carnitine supplements without engaging in physical exercise, no significant alterations were observed across the measured variables. These results highlight the critical role of physical exercise in eliciting beneficial changes in physiological indicators and anthropometric characteristics, reinforcing the synergy between dietary supplementation and physical training.

In our results, LCR supplementation significantly reduced body weight and BMI, in experimental group1 after six and twelve weeks but the reducing effect was not identified for other groups. This kind of training could help to reduce body weight and fat mass by increasing lean mass and basal metabolic rate. In agreement with this, Talenezhad and Pooyandjoo et al. showed that subjects who received L-carnitine showed significant decrease in weight and body mass index compared with the control group [10, 22]. It is possible that individuals with acquired L-carnitine deficiency manifested by increased deposition of fat in the body may benefit from such supplementation and improve their anthropometric characteristics by consuming appropriate amounts of this substance accompanied by proper exercise [23]. Physical activity seems to be an important component of lifestyle interventions for weight loss and maintenance. The benefits of physical activity on weight loss are also observed in subjects with severe obesity (BMI≥30kg/m2) [24]. Previous publications by Medeiros et al. showed exercise is a strong factor in the treatment of obesity, and when performed with adequate intensity and frequency, it could provide protection against comorbidities of obesity. These findings were also shown in a study by Willis et al. who demonstrated a reduction in weight, body fat percentage, and waist circumference in overweight adults who performed concurrent training 3x/week with an intensity of 65–80% VO2peak. However, in this same study, two other groups that performed strength training or aerobic training only had a decrease in waist circumference, showing the relevance of the type of training [25].

In the present study, there were a significant decrease in anthropometric characteristics (BF% and FFM) after midtest and posttest of concurrent training with LCR and our result was similar to research of Gimenes about the effect of L-carnitine on exercise performance [26] and agreed with Bellicha et al. that was about the effect of exercise training on anthropometric characteristics changes. Their findings showed favorable effects of exercise training on weight loss and anthropometric characteristics changes in adults with overweight or obesity [27]. Ghahramanloo et al. reported a significant decrease in the fat mass of non-trained subjects after eight weeks of resistance training. But several studies have reported contradictory results. For example, Mohammad-Rahimi and Attarzadeh-Hosseini did not report a significant difference after aerobic training. The possible reason for differences in the outcome may be the differences in subjects' characteristics such as sex and training history. In fact, the regular use of carnitine would increase plasma and intracellular concentration of carnitine and increase in fat oxidation and gradually decrease body fat stores [28].

In addition, the results showed that L-carnitine combined with exercise training led to a significant reduction in resting heart rate (RHR) in experimental group 1. It is well known that RHR after exercise could be modified by weight loss and RHR after exercise has been shown to be an independent risk factor for cardiovascular disease and mortality in healthy adults [29]. Brinkworth et al. reported an improvement in RHR after a weight loss program that only involved dieting without any change in physical activity [30] . They found a good correlation of the change in RHR with the reduction of metabolic parameters (weight, BMI, waist circumference, TG, glucose, and the TG/HDL-Chol ratio) [31]. Previous studies by Belayneh et

al. on healthy individuals among students at Haramaya University were compatible with our studies and indicated that L-carnitine ingestion probably improved the heart's ability to pump blood efficiently and that human muscle contains large amounts of carnitine, but this depends on the uptake of this compound from the bloodstream [17]. Regular physical activity had a positive effect on autonomic control of the heart in adults by decreasing the resting heart rate and reduces the risk of cardiovascular disease associated with obesity through enhancing autonomic function [32]. It was hypothesized that L-carnitine supplementation would result in a significant reduction in systolic blood pressure and diastolic blood pressure only after twelve weeks of concurrent training in experimental group 1 compared to experimental group 2 and the control group. With the widespread increase in mortality in related to obese people, more importance has been placed on preventing the disease and finding better ways to manage it. One of the most commonly given adjunct treatments is a lifestyle change, including modifications to diet and exercise. Numerous studies have demonstrated that systemic blood pressure can be decreased and controlled through increased physical activity. Similarly, Jean Tamayo Acosta's research found that continuous training reduces blood pressure, which is consistent with the results of this study [33].

On the other hand, our analysis showed that LCR supplement along with concurrent training significantly increased Vo2max in experimental group 1 after six and twelve weeks. Since oxidation of fat requires more oxygen compared to carbohydrates, the cardiovascular system should receive more oxygen for muscles. In this regard, L-carnitine increases oxygen consumption and lipid oxidation by stimulating the pyruvate dehydrogenase complex and the entry of pyruvate into the beta-oxidation pathway [34]. L-Carnitine protects the cell from acyl-CoA accretion through the generation of acylcarnitine. Mitochondrial fatty acid oxidation represents an important energy source for muscle metabolism, particularly during physical exercise. Considering the important role of fatty acids in muscle bioenergetics, and the limiting effect of free carnitine on fatty acid oxidation during endurance exercise, L-carnitine supplementation has been hypothesized to improve exercise performance. Differences in exercise intensity, training or conditioning of the subjects, amount of L-carnitine administered, route and timing of administration relative to the exercise led to different experimental results [35]. Vecchiet et al. showed that 2 gr of L-carnitine given to athletes one hour prior to the exercise increases the maximal oxygen intake and the energy they spend. Marconi et al showed that 4 gr/day L-Carnitine given for two weeks improved VO2max [36]. Probably, the un-similarities of duration and period of LCR supplement consumption, gender, type of sports field, characteristics and physical qualifications of obesity/overweight people, type of exercises or training in studies could cause the differences.

However, our results failed to report any significant change in oxygen saturation between the groups. This issue was probably due to the low tolerance of lactate in the blood and some changes to intracellular biochemical in relation to subjects [34]. Kashef et al. observed that LCR had a positive relationship with oxygen saturation, because subjects were active subjects and athlete [34] and other studies reported to high level of physical fitness of samples [36, 37].

Our report showed that L-carnitine along with training significantly increased for 1RM in

experimental group 1 after midtest and posttest, and in experimental group 1 only after twelve weeks in compare to control group. It probably was myofibrillar protein synthesis and recruitment of fast twitch motor units that our study was in agreement also with other authors [38]. In comparison with previous studies, Sawicka et al. showed that eight weeks of LCR combined with training, L-leucine, and vitamin D significantly increased in muscle mass and strength due to elevated activation of the mTOR pathway. However, once LCR was tested alone using the same dosage, but for a longer period (i.e., 24 wk.), no significant effect was found [39]. This may be attributed to the nature of the training program at moderate intensity, where the oxidation of long chain fatty acids acts as the predominant source of energy and LCR could increase the fat oxidation rate, thereby preserving muscle glycogen stores [40].

To our knowledge, this is the first reported case that simultaneously analyses for factors of LCR, physiological indicators, anthropometric variables for obesity male in both resistance and endurance trainings and also it would be a reduced cost and effect factor in non-pharmacological. The present study's results cannot be generalized due to the low sample size. The main limitation of this study was the small number of subjects. It is important to be cautious when generalizing the results to other populations since the present study focused on obese women with BMIs above 30 kg/m2. A further limitation of our study was the lack of measuring stress factors associated with the hypothalamus-pituitary-adrenal axis, like corticosterone, could have provided insight into the potential neurophysiological impact of LCR supplementation**.**

## Conclusions

L-Carnitine supplementation, in conjunction with concurrent training, emerges as a highly effective approach for enhancing physiological indicators and anthropometric characteristics in obese young women. This synergistic approach is thus recommended for overweight female's individuals, advocating for the integration of concurrent training into their fitness routines alongside L-Carnitine supplementation. This kind of research could be beneficial for prevention of cardiovascular disease in obese young women and reduced costs and effects of non-pharmacological in related to exercise. Future studies should investigate the potential incremental benefits of this combined protocol (L-Carnitine supplementation with concurrent training) over the sole application of concurrent training. Such investigations will be crucial in further delineating the specific advantages and optimizing intervention strategies for this demographic.

***Disclosure statement;*** *No potential conflict of interest was reported by the authors.*

***Funding;*** *The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.*

***Authors' contributions;*** *All authors contributed equally to the manuscript and read and approved the final version of the manuscript.*

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