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Randomized Controlled Trial of Combined L-Carnitine Supplementation and Moderate-Intensity Exercises on Cardiovascular Markers and Bone Health Status in Overweight and Obese Individuals

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ABSTRACT

This article aimed to determine effects of 12 weeks of combined L-carnitine supplementation and moderate-intensity exercise on cardiovascular markers and bone health status in overweight and obese individuals. Sixty-eight participants (mean age: 29.03 ± 6.02 years old) were divided into control (C), L-carnitine supplement (S), exercise (E), combined L-carnitine and exercise (SE) groups. Participants in S and SE groups consumed 1 tablet of 1000mg L-carnitine daily. Participants in E and SE groups performed 30 minutes of brisk walking (50% HRmax), and continued with 10 to 20 minutes of Tabata exercise per session, 3 times per week. After 12 weeks of intervention, there were significant reduction in body weight ($p< 0.05$), body mass index ($p< 0.05$), fat percentage ($p< 0.05$), fat mass ($p< 0.05$), and increases fat free mass ($p< 0.01$) in S, E and SE groups. Regarding waist to hip ratio, blood glucose and total cholesterol, only E and SE groups showed improvements ($p<0.05$) and the greatest reduction was observed in SE group. No significant changes in insulin resistance in any groups. Additionally, S, E and SE groups also showed enhancement in both dominant and non-dominant radial and tibial speed of sound ($p< 0.05$) within and between the groups.

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KEYWORDS: Weight, glucose, bone, insulin resistance, cholesterol

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I. INTRODUCTION

Malaysia has been reported as one of the countries with the highest rate of obesity among ASEAN countries and has been ranked as the country with the second-highest prevalence of overweight in East and Southeast Asia (WHO, 2017). Body mass index (BMI) classification for overweight and class 1 obese in the Asian population is between 23-24.9 kg/m2 and 25-30 kg/m2 respectively (WHO, 2004). Physical inactivity and sedentary behaviour have been identified as the primary contributing factor of overweight and obesity, which are leading modifiable risk factors for cardiovascular disease (Peltzer et al., 2014).

American College of Sports Medicine Position Stand (1998) reported that recent recommendations suggest that adults should exercise in a continuous or intermittent, with a minimum of 10-min bouts for 20-60 min, of 3-5 days per week at 55-90% of maximum heart rate. In this study, moderate-intensity training was prescribed to the targeted group based on the fact that for reducing body weight and body fat, brisk walking is one of the favourable types of moderate exercises (Keating et al. 2014). Nevertheless, it has been reported that brisk walking exercise may take a long period of intervention to show any significant beneficial effects in most of the parameters, such as 10 months (Santiago et al., 1995), 12 months (Jakicic et al., 2003) and 13 months (Hardman et al. 1992).

In the present study, the participants performed brisk walking and followed by Tabata exercise in the same session of workout. Tabata exercise involves multiple numbers of modes and activities that are conducted in a 20-second all-out effort followed by a 10-second rest period (Tabata et al. 1996). Emberts et al. (2013) reported that several rounds of Tabata sessions could raise energy expenditure by 240 to 360 kcals compared to 54 kcals in a single session (4-minutes). Therefore, it is believed that Tabata exercise is beneficial in enhancing the health status of overweight and obese individuals.

Besides exercise, nutrition is one of the important cofactors to achieve peak performance and improve the health status of an individual. Ergogenic aid supplements are essential to improve sports performance as well as for weight loss and health maintenance (Odo et al. 2013). L-carnitine has gained a lot of popularity in the health food products sector as a weight-loss dietary supplement in the treatment of obesity (Pekala et al. 2011). L-carnitine is the bioactive form of carnitine, an endogenous branched of the essential amino acid derivative of lysine and methionine, and dietary carnitine that is absorbed in the small intestine and then enters the bloodstream (Eckerson, 2015). L-carnitine supplement is a popular and preferred product as a potential ergogenic aid due to its role in converting fatty acids to energy in β-oxidation process and their beneficial effects on general health improvements, triggering weight loss and transporting fatty acids to the mitochondrial matrix (Stevens et al. 2002). In addition, the enhancement of fat-oxidation induced by L-carnitine would generate more ATP for energy production.

It is generally known that exercise could enhance bone health status (Ooi, Rabindarjeet & Harbindarjeet, 2009). Lei & Chuan (2015) reported that 2 years of L-carnitine supplementation could enhance bone mineral density in men. Nevertheless, to date, there is no published data on the combined effects of L-carnitine supplementation and moderate exercise (brisk walking and Tabata training) on body composition, cardiovascular risks such as blood glucose, insulin resistance (HOMA-IR) and total cholesterol levels, and bone health status. Thus, the effect of combining L-carnitine supplementation with moderate-intensity of brisk walking and Tabata training on these parameters among overweight and obese individuals was investigated in the present study.

II. METHODS

A. Experimental design and participants

This is a randomised controlled trial intervention study with pre- and post -tests. Sixty-eight male and female overweight and obese participants aged between 18 – 40 years old (BMI classification for overweight and class 1 obesity were between 23-30.0 kg/m^2) participated in this study. Body composition, blood glucose, insulin and total cholesterol concentrations, and bone health status were all recorded for participants, and blood samples were collected at pre- and post- tests. Bone sonometer was used to measure radial and tibial bone speed of sound (SOS) of the participants' dominant and non-dominant arms and legs. The study was conducted in accordance with the Declaration of Helsinki and the International Committee of Medical Journal Editors and has been approved by the Human Research Ethics Committee of the Universiti Sains Malaysia (USM/JEPeM/19100617). Participants were informed regarding the benefits and risks of the intervention before signing an informed consent form.

B. Participants

Participants were randomly assigned into sedentary control (C), L-carnitine supplementation alone (S), exercise alone (E) and combined L-carnitine supplement and exercise (SE) groups with 17 participants in each group. They were healthy and physically non-active with exercise not more than three times per week. The participants were required to refrain at least 3 months from any other supplements and activities. Participation in any other sporting activity, even recreational, was set as criterion of exclusion as well. Participants of S and SE groups consumed 1 tablet of 1000mg L-carnitine every day. Participants in E and SE groups performed approximately 60 minutes of moderate-intensity exercise (5 minutes warm-up, 30 minutes of brisk walking, 10 to 20 minutes of Tabata exercise and 5 minutes cooling down), 3 times per week for 12 weeks. Participant's daily diet was recorded for monitoring their calories intake.

C. Exercise program protocol

The exercise program consisted of approximately 60 minutes of exercise per session, 3 sessions per week for 12 weeks. Each exercise session was started with 5 minutes of warm-up (stretching activities), and then followed by 30 minutes of brisk walking at 50% HRmax, and continued with 10 minutes (two segments) of Tabata exercise in the first 4 weeks, followed by 15 minutes (three segments) in the subsequent weeks and lastly increased to 20 minutes (four segments) in the final 4 weeks. The exercise included in the 20-minute Tabata workout is shown in Table 1. While performing Tabata exercise, the participants were required to repeat twice at a ratio of 20-sec exercise/10-sec rest. All types of exercise were alternately changed between upper and lower limbs with intensity controlled by heart rate (40-60% heart rate reserve).

D. Blood sampling

Blood samples were withdrawn from the participants after a 10-hour of overnight fasting. 5 mL of blood was drawn from the antecubital vein and placed in a clotting activator tube. After that, the samples were centrifuged for 15 minutes at 3000 rpm at 4oC (Hettich Zentrifuger-Rotina 46RS, Germany). Serum was separated and stored at -40oC (ThermoForma Model 705, USA) for subsequent analysis of glucose, insulin and total cholesterol.

Table I. Type of exercises included in the 20-minute Tabata workout (modified from study of Emberts et al., 2013)

	Minute 1	Minute 2	Minute 3	Minute 4
Segment 1	Donkey kick	Inch worms	Alternate touchdown	Slide Skaters
Segment 2	Jump Rope	Seated knee tucks	Basic crunches	Shoulder tap
Segment 3	Burpees	Russian twist	Squats	Lunges
Segment 4	Mountain Climbers	Shoulder tap	Leg raises	Bicycle crunches
Exercise training program that prescribed for the participants (Emberts et al., 2013)				
Weeks	Number of segment	Total duration (minute)	List of Segment (refer to Table 1)	
Week 1- week 4	2	10	Segment 1 Segment 2	
Week 5- week 8	3	15	Segment 1 Segment 2 Segment 3	
Week 9- week 12	4	20	Segment 1 Segment 2 Segment 3 Segment 4	

E. Cardiovascular parameters

I. Anthropometric and body composition measurement:

A stadiometer (Seca 220, Hamburg, Germany) was used to measure body height and a weighing scale (Tanita model TBF-140, Japan) was used to determine body weight, body mass index (BMI), body fat (%), fat mass (FM) and fat-free mass (FFM). The waist hip ratio was determined by measuring the participants' circumference of the waist and hip using a measuring tape.

II. Quantitative ultrasound measurements of bone speed of sound (SOS):

Bone sonometer (Sunlight Mini OmniTM, Israel) was used to determine the participants' bone SOS (which can reflect bone mineral density, i.e. bone health status) of both dominant and non-dominant legs at the middle shaft tibia of the legs (Norsuriani & Ooi, 2018).

III. Biochemical analysis of the blood:

The participants' serum was analysed for blood glucose, insulin and serum total cholesterol level. The sample was sent to the BP Healthcare laboratory for further analysis. The serum was processed using ARCHITECT Analyzer for the quantitative determination of glucose, insulin resistance and total cholesterol. The results obtained are reported in mmol/L.

F. Statistical analysis

Statistical Package for Social Science (SPSS) version 26.0 was used for statistical analysis. The distribution of the data normality was assessed using the Shapiro-Wilk test. Two-way mixed ANOVA was performed on all the measured parameters for determining significant differences within and between groups. Significant differences in Two-way mixed ANOVA were followed up by post-hoc Bonferroni' test. Data are presented as mean and standard deviation (mean ± SD), except mean and standard error (mean ± SE) for blood parameters. Statistical significance is accepted at p-value < 0.05.

III. RESULT

A. Cardiovascular markers of the participants

A total of 68 male and female overweight and obese participants completed this study. Participant's mean age was 29.0 ± 6.0 years old, mean body height: 160.6 ± 1.0 cm, mean body weight: 70.0 ± 1.3 kg, and mean BMI: 27.0 ± 0.3 kg/m2. There were no significant differences among all the groups in terms of baseline characteristics which include means age, body height, body weight, body mass index (BMI), fat-free mass (FFM), percentage of body fat (%BF), waist to hip ratio, blood glucose, total cholesterol and insulin resistance.

At the end of the study, there was a significant increase ($p < 0.01$) of body weight, body mass index, body fat percentage and fat mass in C group, however, there were significant reductions ($p < 0.01$) in S, E and SE groups after 12 weeks of the intervention period. Moreover, in comparison with C group, there were significantly greater in all cardiovascular markers ($p < 0.05$) in S, E and SE groups during post-test. In term of body fat percentage and fat mass, SE group expressed greater reduction compared to C and E groups. Furthermore, there were significant increments ($p < 0.05$) in S, E and SE groups of fat-free mass, however, C group showed a significant reduction at post-test after 12 weeks intervention period. Overall, SE group showed the highest improvement in all cardiovascular markers compared to other groups.

The result showed that there were a significant reduction ($p < 0.05$) in E and SE groups in waist to hip at post-test. Within group analysis demonstrated that there were significant increments ($p < 0.01$) of blood glucose in the E and SE groups after intervention. SE group showed the highest increment among all the groups, while C group showed no change in mean difference at post-test. Regarding total cholesterol, the analysis of within group demonstrated that there were a significant reduction ($p < 0.01$) of total cholesterol in the E and SE groups. E group showed a greater reduction ($p < 0.05$) compared to C group. Moreover, there was a significant reduction of total cholesterol in SE group ($p < 0.05$) compared to S groups. Meanwhile, SE group elicited the greatest reduction in total cholesterol after 12 weeks of intervention. Other than that, no statistically significant changes were observed in all the groups for insulin resistance.

B. Quantitative Ultrasound Measurement of Bone Speed of Sound (SOS)

I. Bone speed of sound of dominant and non-dominant arm:

Table 2 showed the results of bone speed of sound (SOS) measured at distal radius of the dominant and non-dominant arms of the participants during pre- and post-tests in all the groups. Based on the within group analysis, it demonstrated that there were significant increments ($p < 0.05$) of bone SOS of dominant and non-dominant arms in the S, E and SE groups after intervention. In addition, there were also statistically significant differences ($p < 0.05$) between the groups on bone SOS of dominant and non-dominant arms. Generally, S, E and SE groups elicited higher bone SOS ($p < 0.05$) compared to C group. Overall, SE group showed the highest increment in bone SOS ($p < 0.05$) of the dominant and non-dominant arms compared to other groups.

II. Bone speed of sound of dominant and non-dominant leg:

The results of bone speed of sound (SOS) measured at midshaft tibia of the dominant and non-dominant legs of the participants during pre- and post-tests in all the groups across time are shown in Table 2 and Fig. 2. S, E and SE groups exhibited significant increment ($p < 0.05$) in bone SOS of dominant and non-dominant legs at post-test. Meanwhile, for between group analysis, S, E, and SE groups showed greater increment of bone SOS of dominant and non-dominant legs when compared to C group. Besides, SE group showed the highest improvement ($p < 0.05$) of bone SOS of dominant and non-dominant legs among all the groups.

Table II. Bone speed of sound (SOS) of dominant and non-dominant arms and legs within all the groups

Variables	Groups			
	C	**S**	**E**	**SE**
Dominant arm				
Pre-test	3550 ± 55.4	4062 ± 113.2	4069 ± 138.0	4072 ± 114.1
Post-test	3556 ± 55.4	4120 ± 100.1[a]	4167 ± 136.5[a]	4260 ± 92.0[a]
* P-value	0.514	0.016	< 0.001	< 0.001
Non-dominant arm				
Pre-test	3612 ± 62.8	3930 ± 72.7	4083 ± 127.4	4053 ± 115.0
Post-test	3617 ± 48.2	3978 ± 73.4[a]	4162 ± 135.9[a]	4188 ± 117.4[a]
*P-value	0.425	< 0.001	< 0.001	< 0.001
Dominant leg				
Pre test	3752 ± 129.7	3788 ± 130.2	3790 ± 142.2	3856 ± 158.0
Post test	3757 ± 94.5	3903 ± 129.4[a]	3901 ± 166.2[a]	4037 ± 160.1[a]
* P-value	0.922	< 0.001	0.001	< 0.001
Non-dominant leg				

Pre-test	3626 ± 44.1	3779 ± 141.7	3763 ± 114	3832 ± 175.4
Post test	3647 ± 99.2	3864 ± 125.9[a]	3837 ± 114.3[a]	4027 ± 174.3[a]
* P-value	0.413	0.011	< 0.001	< 0.001

Note: Values are expressed as means ± standard deviations (SD); C, control group; S, L-carnitine supplement group; E, exercise group; SE, combined

L-carnitine supplement with exercise. n=17 per group.

*p-value from Paired t-test by comparing the change from pre-test within each group

[a], significantly different from pre-test ($p < 0.05$).

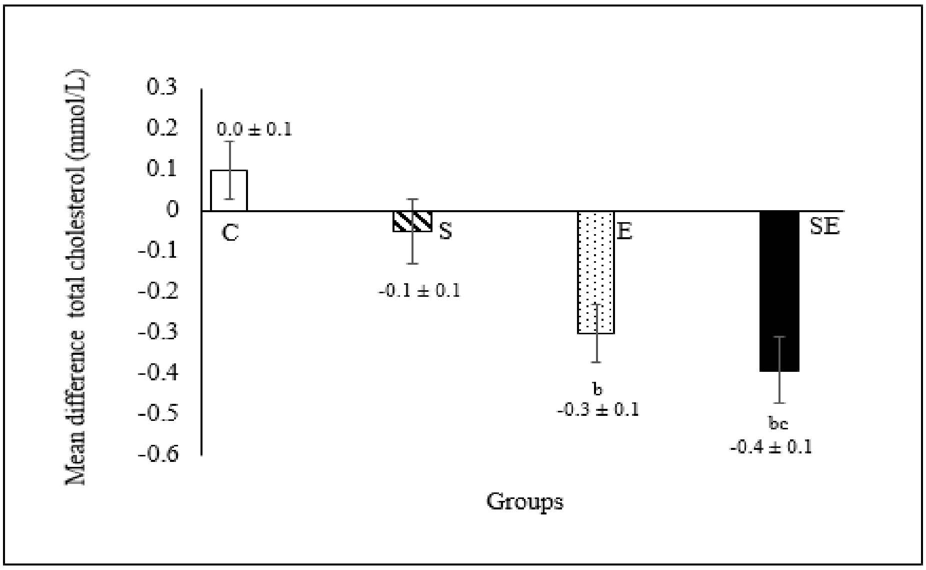

Figure I. Mean difference of total cholesterol between the all groups

Data are presented in mean difference and expressed as means ± standard error (SE). C, control group; S, L carnitine supplement group; E, exercise group; SE, combined L-carnitine supplement with exercise. Result from One Way ANOVA analysis.

[b], significantly different from C group ($p < 0.05$)

[c], significantly different from S group ($p < 0.05$)

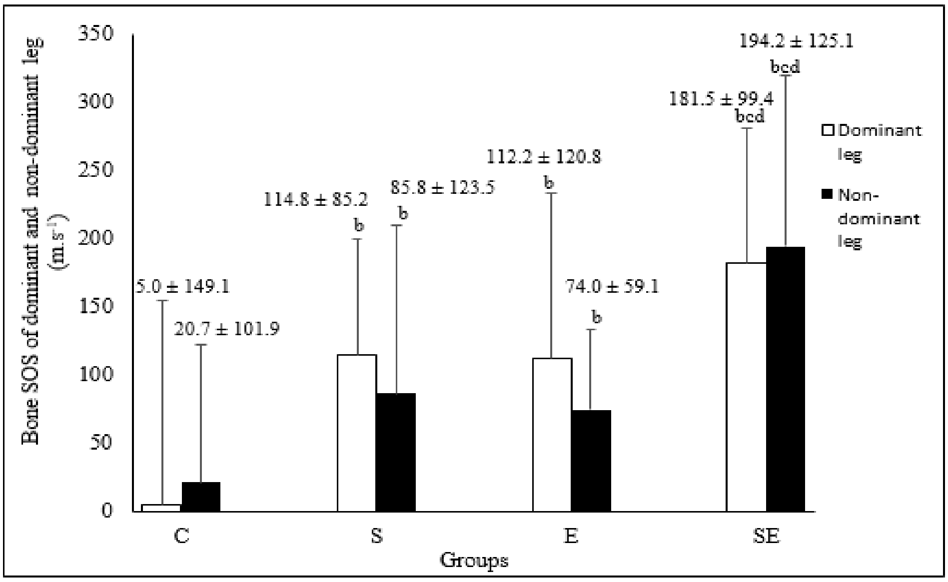

Figure II. Means difference of bone SOS of dominant and non-dominant legs in all the groups

Data are presented in mean difference and expressed as means ± standard deviation (SD).C, control group; S, L-carnitine supplement group; E, exercise group; SE, combined L-carnitine supplement with exercise. Result from One Way ANOVA analysis.

[b], significantly different from C group ($p < 0.05$)

[c], significantly different from S group ($p < 0.05$)
[d], significantly different from E group ($p < 0.05$)

IV. DISCUSSION

The notable finding in the present study was that consumption of L-carnitine supplementation and exercise prescription for 12 weeks significantly reduced body weight, BMI, percentage body fat and significantly increased fat-free mass compared to C group. It is hypothesised that it could be due to the frequency and intensity of training prescribed in this study were adequate to elicit beneficial effects on these body composition parameters, which are contributing factors for cardiovascular diseases. Moderate intensity of physical activity, such as brisk walking, is important for weight control because it helps to burn calories. It is estimated that 30 minutes of brisk walking could burn about 150 more calories a day (Azeem, 2011). Azeem (2011) found that a 12-week brisk walking programme at a frequency of 5 times per week, 45 minutes per session resulted in significant reductions in weight and BMI in obese males. Consistently, the positive finding in this study confirmed that moderate-intensity brisk walking is an appropriate and feasible exercise modality for overweight and obese individuals. Nevertheless, the present study also found that more positive effects can be observed when brisk walking was combined with Tabata exercise on improving body weight, BMI, percentage of body fat and fat mass.

It is showed that Tabata training is time-efficient that could reduce the body composition in short period. The combination of brisk walking and Tabata training lead in reduction in waist to hip ratio in this study in E and SE groups in line with improvement of body composition. These findings implying that a combination of both brisk walking and Tabata training, as prescribed in this present study could burn more calories and have greater impact on body composition and waist hip ratio. Consistently, Karimi et al. (2016) also reported that four weeks of interval training combined with L-carnitine consumption had a significant effect on lowering the percentage of body fat in overweight trained women.

Metabolically, L-carnitine has been reported to spare muscle glycogen and improve fat oxidation during exercise, and a proposed conversion of fat into energy and work as a fat burner to help weight loss (Pistone et al., 2003; Gnoni et al., 2020). As a result, the working muscles can generate more energy than oxidized through fat oxidation which gives extra energy to exercise. Subsequently, more fat will burn efficiently and trigger body weight and fat loss. It is expected that despite fat oxidation activities, the dynamic loading movement created by repetitive movements in the brisk walking and Tabata exercise could enhance participants' absorption of nutrients in L-carnitine into the blood and transport it into the working muscle. In fact, the Tabata exercise has been proven to be effective to improve muscle mass due to a significant increase in Type IIa fibres (Richards et al. 2010), which could improve muscle function and produce skeletal muscle adaptations that resulted in an increased fat and glucose oxidation (Hood et al., 2011). In addition, the high level of amino acid contained in L-carnitine could help to promote muscle growth. L-carnitine supplementation has been demonstrated to spare amino acids which potentially improve protein synthesis (Varney et al., 2017). These effects are related to increase muscle mass (Evans et al., 2017). These are the reasons that might contribute to the increases in the muscle mass and the alternately decrease in the percentage of body fat among overweight and obese people in the combination of L-carnitine, brisk walking and Tabata training.

In terms of brisk walking, Chen et al. (2016) also reported that there were significant improvements in free fat mass in the brisk walking group. It is speculated that brisk walking may facilitate protein retention in skeletal muscles and retards its breakdown rate. In addition, Tabata training requires the participants to perform in all-out efforts during training, the movements of repetitive weight-bearing impact, accelerating or decelerating movements and multidirectional body movement was expected could elicit beneficial albeit on fat free mass, i.e. muscle mass. Daily intake of 1000 mg of L-carnitine supplementation for 12 weeks could promote muscle growth in S and SE groups. After all, the combination of L-carnitine supplement with exercise in SE group elicited the greatest benefits on fat-free mass as it the highest value among all the study groups.

Regular exercise has been reported could improve glucose homeostasis and enhance blood glucose disposal by transporting the glucose transporter isoform 4 (GLUT4) from intracellular locations to the sarcolemma, where it mediates glucose uptake without the use of insulin, and GLUT4 levels are thought to be a key factor in insulin sensitivity (Koranyi et al., 1991). Skeletal muscle, which is the most active tissue during exercise, absorbs up to 80% of blood glucose (Goodwin 2010). The present study found that 12 weeks of intervention resulted in significant improvements in fasting blood glucose in the E and SE groups. Collectively, based on this positive finding, it is speculated that exercise helps muscles absorb blood sugar, preventing it from accumulating in the bloodstream. This observation is supported fact that muscular contractions and circulating insulin levels work together to generate signals for GLUT4 translocation to the sarcolemma and t-tubule membranes (Richter & Hargreaves 2013), which may result in increased glucose absorption by the cell during exercise.

L-carnitine may promote blood glucose but with smaller attributes compared to the exercise on blood glucose, based on the present finding that both brisk walking and Tabata exercise greatly cause improvement in blood glucose but not L-carnitine supplementation alone. The probability of this observation could be increased total level of carnitine content in skeletal muscle cannot be achieved in a short period, and a long duration of oral carnitine supplementation is needed to show improvement in blood glucose. Hence, future study is recommended with a longer duration of L-carnitine supplementation to obtain a relevant outcome on blood glucose metabolism.

HOMA-IR is a useful index in evaluating insulin resistance, it is a key component of risk factor for diabetes mellitus and cardiovascular disease. In this study, the result showed that there were no significant differences in insulin resistance among all the groups after 12 weeks period. It was hypothesized that in this study the participants were still young and healthy and do not have risk of diabetes mellitus and cardiovascular problem.

Another notable outcome of the present study is on total cholesterol. There was a significantly greater substantial reduction in total cholesterol levels in SE group compared to C and S groups, meanwhile E group showed higher value than C group. This positive finding confirmed that moderate exercise training consisted of brisk walking and Tabata training played a role on improving total cholesterol. Considering the exercise' effect, this finding was in a line with a previous study which found that a brisk 30-minute walk 3 times per week for 12 weeks is enough to improve the total cholesterol levels in the body (Tully et al., 2007). Coghill & Cooper (2008) reported that total cholesterol was significantly lower in the brisk walking group which burned at least 300 kcal for each walk, and Tabata training might burn up to 400 kcal. It is a fact, that more calories burn in the body will lead to more fat burning, and subsequently, it will lower cholesterol in the body.

L-carnitine has been shown to improve plasma lipids and lipoprotein levels in the blood (Malaguarnera et al., 2007). This conversion could reduce triglyceride synthesis while increasing fatty acid beta-oxidation in mitochondria. Regarding the supplement's effect, the insignificant results may be due to the dosage and duration of carnitine supplementation as well as absorption efficiency involved in this study. This observation was supported by Askarpour et al. (2019) who stated that longer duration and higher doses of L-carnitine showed a greater reducing effect on total cholesterol, but not when supplemented less than 2000 mg per day. It is well reported that oral L-carnitine supplement has a low absorption rate and bioavailability of L-carnitine from oral supplements of 500-6000 mg doses ranges from 14 to 18% of the total dose (Rebouche, 2004), hence, only a small amount can be absorbed from the body.

Regarding the aspect of bone health status measurements, physical activity and bone mineral density (BMD) are primarily related to the mechanisms of mechanical loading that impose on the skeleton (Zernicke et al., 2006; Ooi et al., 2009). High impact loading can have a greater influence on bone mass and tend to be effective in osteogenic stimuli. In this study, S, E and SE groups showed increases in both dominant and non-dominant radial and tibial speed of sound which reflect enhancement in bone health status. Meanwhile, SE group elicited a more beneficial effect on bone health status as it can be seen a significantly greatest increase in both dominant and non-dominant radial and tibial speed of sound compared to other groups.

During intervention the participants experienced great mechanical loading at the leg from the stress induced by strong contractions of the leg and hip musculature during jumping, and repetitive movement of lower limbs in conjuction with the upper limbs were mostly loaded by impact during the training. Impact on bone is considered as the main factor to induce a remarkable osteogenic stimulation at the proximal hip and femur as well as both arms, therefore, a high level of bone speed of sound or bone health status of both the arms and legs could be observed in the participants in the present study. The present study finding supported our hypothesis that participants who performed 12 weeks of brisk walking and Tabata training are stimulated with repetitive muscle contractions caused by jumping movements and high-impact loading forces which impose great force on the bone (Stensvold et al., 2010; Alghadir et al., 2014). The rhythmic nature of dynamic loading of high impact loading exercise may increase delivering of blood volume to working muscle compared to low impact loading exercise (Nybo et al., 2010).

Generally, it is well known that L-carnitine could also increase calcium absorption and reducing bone resorption, which implying that ingestion of L-carnitine has the potential to enhance bone mineralization and organic reflux reflected by the SOS measurements in this study. It was in line with a previous study by Lei & Chuan (2015) which showed that men who received 4000mg per day of L-carnitine over 2 years had gained more substantially in the lumbar spine, femoral neck, and total hip BMD than those who received placebo. Therefore, the positive finding in the present study on bone SOS in overweight and obese individuals in SE groups might be due to a high level of calcium absorption after supplementation. This finding supported our hypothesis that a combination of regular weight-bearing activity and nutritional supplements, such as L-carnitine supplementation, can improve bone health status.

V. CONCLUSION

In conclusion, consumption of L-carnitine supplementation alone, brisk walking and Tabata training alone and combined of L-carnitine supplementation, brisk walking and Tabata training have the potential to improve body weight, BMI, percentage of body fat, fat mass, fat free mass, waist to hip ratio, as well as bone health status of dominant and non-dominant arms and legs after 12 weeks of intervention compared to sedentary control group in overweight and obese individuals. When compared to C and S group, the E group and SE groups, had greater effects on blood glucose and total cholesterol measurement. These results imply 12 weeks regimen of L-carnitine supplement with brisk walking, and Tabata exercise can be recommended for overweight and obese individuals in order to reduce cardiovascular risk and strengthen the bones.

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