Original Article

Combined impact of green coffee bean extract consumption and concurrent training on arterial blood pressure in overweight and obese women

Sajedeh Movaghari[1], Fatemeh Izaddoust[2], Ramin Shabani[1]

[1]Department of Physical Education and Sport Science, [2]Young Researchers and Elite Club, Rasht Branch, Islamic Azad University, Rasht, Iran

Abstract

Context: Green coffee ingestion improves blood pressure in healthy humans, but the interactive effect of green coffee and exercise is unknown.

Aims: The purpose was to determine the combined effect of green coffee bean extract (GCE) consumption and concurrent training (CT) on arterial blood pressure in overweight and obese women.

Setting and Design: This study was an experimental pilot study, which was conducted in 2017.

Materials and Methods: Among overweight and obese women of the Rasht city, 30 participants were allocated to three groups via simple randomization to receive treatment with GCE (125 mg, twice/day, before lunch and dinner), CT (four sessions aerobic-resistance training/week), or both. Systole blood pressure (SBP), diastole blood pressure (DBP), heart rate, and mean arterial pressure (MAP) were measured before and 48 h after interventions.

Statistical Analysis Used: Mean and standard deviation, analysis of covariance, and paired sample *t*-test were used.

Results: Heart rate decreased in all intervention groups ($P < 0.01$). GCE-CT treatment showed significantly decreased SBP ($P = 0.04$). CT group indicated significant reduction for DBP and MAP ($P = 0.03$ and $P = 0.02$, respectively). However, there were no significant difference between study groups for SBP, DBP, and MAP ($P > 0.05$).

Conclusion: It seems that GCE, CT, or combination of both had a little effect for improving arterial blood pressure, and therefore, simultaneous effect of CT-GCE was not more effective than CT or GCE for improving the blood pressure in women with normal blood pressure.

Keywords: Blood pressure, Exercise training, Green coffee bean extraction, Obesity, Overweight

Address for correspondence: Dr. Ramin Shabani, Department of Physical Education and Sport Science, Rasht Branch, Islamic Azad University, Rasht, Iran.
E-mail: shabani_msn@yahoo.com
Received: 19 February 2019; **Accepted:** 20 May 2019; **Published:** 11 July 2019.

INTRODUCTION

The prevalence of adult obesity has increased dramatically worldwide and has now reached epidemic proportions. Each year, 28 million individuals are dying from the consequences of obesity[1] and data indicated that prevalence of obesity among women are more than

Access this article online	
Quick Response Code:	Website: www.jnmsjournal.org
	DOI: 10.4103/JNMS.JNMS_5_19

How to cite this article: Movaghari S, Izaddoust F, Shabani R. Combined impact of green coffee bean extract consumption and concurrent training on arterial blood pressure in overweight and obese women. J Nurs Midwifery Sci 2019;6:105-11.

men,[2] which is related to the fundamental aspects of the control of metabolic homeostasis that are regulated differently in males and females.[3] Obese individuals are at increased risk for diabetes, hyperlipidemia, hypertension, and other cardiovascular diseases. The relationship between obesity and hypertension is well established in clinical and animal studies.[4] It appears several mechanical and hormonal factors likely play contributing role in obesity-hypertension development, including renal salt retention, blood volume expansion, sympathetic activation, hypoadiponectinemia, activation of the renin-angiotensin-aldosterone system, as well as the elevated levels of circulating endothelin and free fatty acids.[5] Studies have demonstrated that interventions aimed at changing modifiable factors such as overweight and obesity, sodium and potassium intake, alcohol consumption, and physical activity might modify blood pressure and even prevent the development of hypertension.[6,7] In addition, antioxidants which found in certain foods and drinks also can have an antihypertension effect.[8,9]

Regular physical activity improves endothelial function, counteracts microvascular rarefaction, and decreases blood pressure which known as a nonpharmacological tool for prevention and treatment of hypertension, involving a decrease in the incidence of cardiovascular events.[10-13] It seems that combined aerobic-resistance training were associated with decreases in systole blood pressure (SBP) and diastole blood pressure (DBP) in participants with normal blood pressure, prehypertension, or hypertensive patients.[14]

Polyphenols are a group of phytochemicals in foods such as tomatoes, orange, coffee, and tea, which are important antioxidants that protect body tissues against damage caused by reactive oxygen species.[15] Chlorogenic acid (CGA) is a phenolic compound in the human diet and an important component of green coffee. Accumulating evidence has demonstrated that CGA exhibits many biological properties, including antibacterial, antioxidant, hypoglycemic, hypolipidemic, and lowering blood pressure.[16-18] Furthermore, green coffee can act as blood pressure regulator via nitric oxide (NO)-mediated vasodilation[19] and suppression of macrophage infiltration.[20]

There are several studies that have shown that green coffee extract bean extract (GCE)[18,19,21-23] and exercise training[14,24,25] can be effective for improving blood pressure. We postulated that, although either exercise training or green coffee can prevent and improving hypertension, combined usage of these factors can accelerate their hypertensive effects. Hence, the aim of this study was to evaluate combined effect of green coffee bean extract consumption and concurrent training (CT) on arterial blood pressure in overweight and obese women.

MATERIALS AND METHODS

This experimental pilot study was performed in Rasht, 2017. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and ethical approval was obtained from the Islamic Azad University-Rasht Branch Ethics Committee (IR.IAU.RASHT.REC.1395.66). The trial registered on Iranian Registry of Clinical Trials, identification number IRCT2017061422498N13, and URL for the registry is http://www.irct.ir/.

Forty healthy overweight and obese women (25–35 years) were volunteers for the study, and among them, 30 participants, who had not metabolic, orthopedic, or musculoskeletal disorder, and diet with body mass index (BMI) 25–35 K/m^2 were selected as the study samples. The individualsts were excluded if they used supplements or weight loss drugs in the last 6 months, had sensitivity or adverse reactions to green coffee, were absent for three training sessions, and not consumed promises of green coffee. The experimental procedures and possible risks associated with the study were explained to each participant and written informed consents were obtained from all of them.

Following baseline measurements of body composition, resting blood pressure and heart rate the participants were divided into three equal groups (n = 10, in each group) via simple randomization: concurrent resistance-aerobic training-green coffee bean extract (CT-GCE), concurrent resistance-aerobic training (CT), and GCE. Two participants in CT-GCE group and one participant in GCE group withdrew from the intervention before completion due to personal reasons or did not consume promises of green coffee. All participants were asked to not change their nutrition practices during the duration of the study. After 6 weeks, all measurements were repeated in all groups.

Members of CT and CT-GCE groups took part in a supervised training program that lasted 6-weeks and conducted four sessions per week on Saturday, Monday, Tuesday, and Thursday by a professional sports physiologist. In each session, participants completed a 10-min warm-up consist of stretching and warm-up running and subsequently completed the prescribed aerobic training, followed by resistance training, and the session was finished by 10-min cool-down/running and stretching exercises. During the 1st week, individuals conducted aerobic training for 20 min at 65% of age-predicted maximum heart rate (220 – age). The intensity of aerobic training was then increased by 5% every 2 weeks, and the duration of aerobic training was also increased 2 min per session each week,[26] so the participants exercised for 30 min at 75% of maximum heart rate by the end of the 6 weeks. The resistance training program involved bench press, leg press, latissimus dorsi, lateral raise, biceps, triceps, front barbell raise, and seated calf raise. These exercises were chosen as they provide a stimulus to all the major muscle groups, which is recommended in the American College of Sports Medicine Position Stand.[27] Participants completed 8–12 repetitions of each exercise at 65%–80% of predicted one-repetition maximum (1RM). Participants executed the resistance training in 2–4 circuits with a separation of 2–3 min.[28] 1RM was assessed in week 4 and lift resistance was altered accordingly.

The CT-GCE and GCE groups consumed two servings of 125 mg (taken before lunch and dinner) per day of GCE combined with hot water (dissolve in 120 ml of hot water) for 6-weeks.

The GCE was then analyzed for polyphenol using by mixed of the 0.5 g of extract with Folin's phenol reagent (0.5 ml) and saturated sodium carbonate solution (7.5 ml). The sample solution was made up to 10 ml with distilled water and the absorbance was measured at 765 nm. Total polyphenol content was expressed as gallic acid equivalents.[29] The results showed that each gram of GCE contains 240 mg of polyphenol. Green coffee is known as one of the main food sources of CGA and about 1% of phenolic compounds different from CGA and related compounds have been identified in green coffee beans.[30] Therefore, it can be concluded that each gram of GCE contains about 420 mg CGA.

Triceps, suprailiac, and thigh skinfolds were measured three times on the right side of the body to the nearest 1 mm with a skinfold caliper (Saehan Skinfold Caliper, SH5020, South Korea). A reliability criterion of 2 mm was established for triplicate measures, and the mean of these measurements was used for analytical purposes. Body fat percent was estimated by the equation of Jackson, Pollock, and Siri.[31]

Body density (Jackson, Pollock) $= 1.0994921 - (0.0009929 \times \text{sum of skinfold}) + (0.0000023 \times \text{sum of skinfold}^2) - (0.0001392 \times \text{age})$

Body fat percent (Siri) $= (495/\text{body density}) - 450$

Weight was measured using scale (Seca 700, Seca GmbH and Co, Hamburg, Germany) and recorded to the nearest 0.1 kg. Height was measured to the 0.1 cm using vertical meters on the wall, without shoes.

Resting heart rate and blood pressure were determined for each participant following a minimum of 5 min of sit rest. Heart rate was determined using a pulse oximetry device (Zyklusmed, model CMS50DL, China) and blood pressure was determined by manual auscultation using an appropriate-sized cuff and handheld aneroid and stethoscope (ALPK2, Saitama, Japan) by a trained investigator. Readings were recorded to the nearest even number. The SBP was recorded at the first appearance of Korotkoff sounds, and the palpatory method was used to check auscultatory systolic readings. The DBP was recorded at the disappearance of Korotkoff sounds. Mean arterial pressure (MAP) was measured using SBP and DBP according to the Wilmore and Costill (1994) equation:[32]

$\text{MAP} = (2/3 \times \text{DBP}) + (1/3 \times \text{SBP})$ (in mmHg)

Data are shown as means ± standard deviation (SD), and Kolmogorov–Smirnov tests for all variables revealed no significant deviations from normal distribution. One-way analysis of covariance was conducted to examine intervention for changes between groups. Least significant difference (LSD) test was applied *post hoc* to determine the source of significance. Within-group changes were done using paired sample *t*-tests. SPSS Version 22 (IBM, Armonk, NY, USA) was used for statistical analysis. $P < 0.05$ was considered statistically significant.

RESULTS

There were no significant differences in any of the baseline characteristics among the study groups. Baseline characteristics are presented in Table 1. Nonconsumed returned GCE was <8% in the GCE and CT-GCE groups. Both CT and CT-GCE groups fully completed their training sessions.

Weight and BMI were significantly improved in all study groups ($P < 0.001$) [Table 1]. There were also significant differences in weight and BMI among the intervention groups ($P < 0.05$). LSD *post hoc* test showed that the decrease in CT-GCE was greater than in GCE and CT for weight ($P = 0.01$ and $P = 0.04$, respectively) and BMI ($P = 0.007$ and $P = 0.02$, respectively).

SBP had trend toward decrease in CT and GCE groups. However, the reduction in CT-GCE was statistically significant ($P = 0.04$). DBP was significant decreased in CT ($P = 0.03$). Nevertheless, there were no significant changes in CT-GCE and GCE group ($P > 0.05$). Heart rate were significantly decreased in CT-GCE, GCE, and CT group ($P = 0.001$, $P < 0.001$, and $P < 0.001$, respectively). MAP significantly decreased in CT group ($P = 0.02$) [Table 1]. Nevertheless, the reduction in GCE and GCE-CT groups was not statistically significant ($P > 0.05$). In addition, there were no significant differences in SBP, DBP, heart rate, and mean atrial pressure among the intervention groups after adjusted for pretest ($P > 0.05$) [Table 2].

DISCUSSION

The aim of this study was to evaluate combined effect of GCE consumption and CT on arterial blood pressure in overweight and obese women. The 6-week CT intervention resulted in significant reductions in heart rate, DBP, and MAP. In line with this study, in a recent meta-analysis reported that CT was significantly reduce DBP (−2.2 mmHg), but not SBP, these results were observed in both participants with normal blood pressure and prehypertension.[14] In this study, the SBP was tending to prehypertension; nevertheless, DBP was in normal range. Hypertension has profound effects on the structure, mechanical behavior, and function of blood vessels, which can be resulted by a reduction in lumen diameter and increase in the wall thickness (structural change), increased vascular stiffness (mechanical change), and impaired NO-dependent vasodilation (functional change).[10] Exercise training is able to reduce vascular changes as a precursor of high blood pressure, such as increases NO availability,[10] increased protective antioxidant defense target,[33] reduce sympathetic nervous system activity and cardiac output, and reduce peripheral vascular resistance.[12,13] In addition, normalization of arterial wall-to-lumen ratio and a great increase in capillary network in skeletal muscle can reduce induced-blood pressure following aerobic training.[34,35] In otherwise, previous studies have suggested that chronic exercise results in decreased MAP.[36,37] It seems that the difference results in this study with other studies can be defined with the intensity, duration, and type, which used in training. Cardiac output and total peripheral resistance or SBP and DBP are used for determining MAP. Chronic exercise is not always decreased the cardiac output; thus, it appears that decreased total peripheral resistance is the primary mechanism, by which resting blood pressure is reduced after exercise training, which can be mediated by neurohumoral and structural adaptations, altered vascular responsiveness to vasoactive stimuli, or both.[38]

We have shown that GCE reduced heart rate, but not SBP, DBP, or MAP. These findings are supported by a study[22] which assessed the effect of GCE ingestion on human vasoreactivity in a sample participants with normal-range blood pressure. The authors suggested that GCE decreased reactive hyperemia ratio, which could be effective for improving vasoreactivity. Green coffee

Table 1: Anthropometric and arterial blood pressure characteristics of the overweight and obese women

Variable	CT-GCE (*n*=7)	GCE (*n*=9)	CT (*n*=10)	Between groups significant
Age (year)				
Pre	28.28±3.09	31.33±3.50	29.50±3.74	0.23
Height (cm)				
Pre	164.86±20.73	161.00±4.79	160.40±4.42	0.09
Weight (kg)				
Pre	78.42±8.34	77.55±9.12	75.00±12.71	0.77
Post	74.14±9.37***	74.55±9.28***	72.10±12.45***	
BMI (kg/m^2)				
Pre	28.89±2.95	29.93±2.71	29.10±4.05	0.79
Post	27.31±3.37***	28.77±2.76***	27.96±3.97***	
Heart rate (beats per min)				
Pre	82.57±8.48	81.44±8.33	77.00±5.51	0.26
Post	79.71±8.01**	78.77±8.62***	74.70±5.55***	
SBP				
Pre	122.8±14.9	118.8±13.6	121.0±11.9	0.84
Post	115.7±11.3*	115.5±13.3	116.0±6.9	
DBP				
Pre	78.5±10.6	73.3±10.0	78.0±10.3	0.52
Post	74.2±9.7	72.2±9.7	74.0±6.9*	
Mean atrial pressure				
Pre	93.33±12.01	88.51±11.06	92.33±10.66	0.65
Post	88.09±10.15	86.66±10.27	88.00±6.70*	

*Significant differences compare to pretest ($P<0.05$), **Significant differences compare to pretest ($P<0.01$), ***Significant differences compare to pretest ($P<0.001$). DBP: Diastole blood pressure, SBP: Systole blood pressure, BMI: Body mass index, CET-GC: Concurrent training-green coffee bean extract

Table 2: Between- and within-group changes of anthropometric, heart rate, and arterial blood pressure parameters in overweight and obese women (*n*=36)

Variable	Levene's test		Between group			LSD *post hoc* test		
	F	Significant	*F*	Partial η^2	Significant	Groups	Mean difference	Significant
Weight	0.94	0.40	5.21	0.32	0.01*	CT-GCE GCE	−1.29	0.01†
						CT-GCE CT	−1.42	0.007†
						GCE CT	−0.12	0.77
BMI	0.12	0.88	3.49	0.24	0.04*	CT-GCE GCE	−0.39	0.04†
						CT-GCE CT	−0.44	0.02†
						GCE CT	−0.05	0.76
Heart rate	2.17	0.13	0.47	0.04	0.62	CT-GCE GCE	-	-
						CT-GCE CT	-	-
						GCE CT	-	-
SBP	0.40	0.67	0.47	0.04	0.63	CT-GCE GCE	-	-
						CT-GCE CT	-	-
						GCE CT	-	-
DBP	0.94	0.40	0.57	0.04	0.57	CT-GCE GCE	-	-
						CT-GCE CT	-	-
						GCE CT	-	-
Mean atrial pressure	1.70	0.20	0.71	0.06	0.50	CT-GCE GCE	-	-
						CT-GCE CT	-	-
						GCE CT	-	-

*Significant differences between the study groups ($P<0.05$), †Significant difference between two groups at LSD *post hoc* test ($P<0.05$). LSD: Least significant difference, CT-GCE: Concurrent training-green coffee extract bean, DBP: Diastole blood pressure, SBP: Systole blood pressure, BMI: Body mass index

is rich in CGA, and it has four main classes including caffeoylquinic acids, dicaffeoylquinic acids, feruloylquinic acids, and p-coumaroylqunic acids, and this polyphenols actually be responsible for the abundant biological action derived from green coffee.[39] It has previously been showed that CGA, as well as the oral administration of GCE, reduced blood pressure in spontaneously hypertensive rats.[19] Recent randomized, double-blind, placebo-controlled studies on existing GCE for treating blood pressure in mildly hypertensive[21] and metabolic syndrome participants,[23] found the significant intervention effects of 46 mg, 93 mg, or 185 mg of GCE once a day for 28 days and 400 mg of GCE twice a day for 8 weeks, respectively, on SBP and DBP. About one-third of CGA absorbs in the small intestine and enter into the blood circulation.[40] It is hypothesized that CGA may be involved in blood vessel remodeling via its effects on the suppression of macrophage infiltration.[20] Furthermore, CGA consumption might induce the production and bioavailability of vasodilators such as NO because ferulic acid, a metabolite of 5-caffeoylquinic.[41] It seems that the conflicting results which seen in the present study might be because the normal blood pressure of the participants.

It seems that this is the first study, which investigated the impacts of GCE with CT in the context of atrial blood pressure. According to the previous study that shows the effective of green coffee and concurrent exercise training on arterial blood pressure, it seems that combined effects of these factors will be more effective for improving arterial blood pressure. The results of the present study indicated that CT-GCE administration improved SBP and heart rate but did not have significant effect on DBP and MAP. In addition, there were no statistically differences between study groups.

This study has some limitations that need to be acknowledged. First, the lack of the control group precluded a correct comparison of these interventions. A second limitation concerns the small number of the study population, not assessed in men participants and the lack of a nutrition evaluation can also be considered a study limitation, to be addressed in future research. In addition, the sample in the current study was small, and further studies with adequate participants are needed to warrants this study results.

CONCLUSION

GCE and CT as well as combination of these can be effective for improving blood pressure. Despite CT was more effective than GCE or CT-GCT for improving DBP and MAP and CT-GCT was more effective than GCE and CT for improving SBP, there was no significant difference between intervention groups. Therefore, simultaneous effect of CT-GCE was not more effective than CT or GCE for improving the blood pressure in women with normal blood pressure.

Conflicts of interest

There are no conflicts of interest.

Authors' contribution

All authors contributed to this research.

Financial support and sponsorship

Nil.

Acknowledgments

The authors would like to appreciate the participants contributing to this study.

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