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Original Article

The effects of elastic resistance band training and green coffee bean extract supplement on novel combined indices of cardiometabolic risk in obese women

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Abstract

The main purpose of this study was to investigate the effects of elastic resistance band training (ERBT) and green coffee bean extract (GCBE) supplement on novel cardiometabolic indices in obese women. To this end, a total number of 60 obese women aged 30-50 years with a body mass index of > 30 kg/m^2 were selected for inclusion in this study and then they were randomly assigned to one of the following four groups: placebo (n = 15), GCBE supplement (n = 15), GCBE supplement + ERBT (n = 15), and placebo + ERBT (n = 15). Each commercially prepared GCBE supplement capsule used in this study contained 500 mg of GCBE supplement and it was also claimed by the manufacturer to have 50% chlorogenic acid (CGA) (250 mg). The participants in the placebo + ERBT and GCBE supplement + ERBT groups attended an 8-week ERBT program, 3 sessions / week, and 60 min each session. In the GCBE supplement + ERBT group, Framingham risk score (P = 0.018), atherogenic index of plasma (P = 0.003), and metabolic syndrome severity score (P = 0.001) significantly decreased. Taken together, the results of the present study supported the importance of supplemental and resistance-type training in improving obesity and novel cardiometabolic risk scores, despite the fact that longer nutritional and exercise interventions could enhance some cardiometabolic risk scores in obese women.

Keywords: Cardiometabolic risk factor; Green coffee bean; Elastic resistance band training; Obesity.

INTRODUCTION

Obesity-related development of various cardiometabolic risks is considered as a clinical and pathological condition among obese women (1). Typically, poor adherence to aerobic exercises may be problematic in obese women due to needs for high aerobic capacity as well as early exhaustion (2). Limited data in this field have revealed that the use of resistance-type exercise modality to improve hepatic disorders has become more popular in obese adults (3,4). Lower cardiorespiratory demand is also required by resistance exercises which can be related to similar metabolic benefits (5). Machine and free weight-based resistance exercise training may thus exert excessive stress on musculoskeletal system and joints (6). On the other hand, performing resistance training through elastic bands or tubes can control tensions during loading, provide proper individualized load, and enhance muscle strength (7). In general; free weights and weight machines are not portable inexpensive, and easier to use and they also take up more space. Furthermore, they may not be practical and even cause damage if practiced without proper control (8).

It has been demonstrated that the consumption of green coffee bean extract (GCBE) supplement, which is a rich source of bioactive chlorogenic acid (CGA), has a protective role against the development of cardiometabolic risk factors (9,10). Recently, exercise scientists have suggested the potential synergism of exercises with other herbal medicine (11,12).

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Moreover, it has been evidenced that physical training may accelerate certain adaptations combined with herbal medications that possibly will not be achieved in response to pharmaceuticals alone. Thus, multimodal interventions (exercise training plus use of herbal medications) may enhance the efficacy of physical activities for less-sensitive obese individuals (12). Many researchers have also put much effort into identifying and introducing a large number of novel biomarkers to predict cardiovascular diseases and help with evaluating and monitoring responses to therapeutic strategies. Moreover, it has been reported that Framingham risk score (FRS) (13), atherogenic index of plasma (AIP) (14), and metabolic syndrome severity (MetS) score (15) can be assumed as strong biomarkers to predict the risk of coronary heart disease. In this respect, it has been stated that regular exercises along with CGA composition activates the production and release of some factors involved in mediating its beneficial effects on obesity. Therefore, this study was to investigate the effects of two theoretical interventions, i.e. elastic resistance band training (ERBT) and GCBE supplement, on novel non-invasive cardiometabolic risk factors. It was also hypothesized that biomarkers such as FRS, AIP, and MetS score would be improved from the baseline within 48 h after the last bout of chronic exercise training plus GCBE supplement consumption compared with those in a routine care placebo group in obese women. It should be noted that ERBT was examined in this study since it could induce more robust fitness adaptations compared with aerobic training. GCBE supplement was also selected because it was the recommended herbal medicine prescribed for optimal metabolic benefit in obesity (9). Secondly, it was assumed that both interventions would be associated with metabolic, body fat percentage, and fitness benefits compared with those in the control group. Finally, it was postulated that changes in these factors would be related to the magnitude of cardiometabolic benefits observed. To the best of authors' knowledge, there was no published information on the effects of GCBE supplement consumption and ERBT program on novel non-invasive indices for cardiometabolic risks in obese women. Therefore, the main purpose of this study was to compare the effects of GCBE supplement consumption and ERBT program on novel non-invasive indices for cardiometabolic risks (i.e. FRS, AIP, and MetS scores) in obese women.

MATERIALS AND METHODS

This study was a randomized placebo-controlled clinical trial performed in Shahrekord University, I.R. Iran, on the basis of the CONSORT Statement. The protocol was registered in the Iranian Registry of Clinical Trials, IRCT2017090419995N9. The Ethics Committee of Shahrekord University also granted ethical approval to the study under the Ethic code: 95/125. Information about the study design, objectives, procedures, benefits, and potential risks were presented at the onset of the study and subsequently informed consent was obtained from each participant. The flow diagram of the study design is presented in Fig. 1.

The participants were recruited through brochures and newspaper announcements (Shahrekord, I.R. Iran) according to the following criteria; the selected participants, aged 30-50 years and obese ($40 <$ body mass index (BMI) > 30 kg/m^2). In this study, sedentary was defined as less than 1 h of moderate to strenuous weekly physical activities for the preceding 3 months (16). The exclusion criteria included blood pressure $\geq$ 160/100 mmHg, fasting triglyceride (TG) $\geq$ 500 mg/dL, a history of cardiovascular diseases, hormonal disorders, alcohol abuse, use of teratogenic drugs, metabolic syndromes, and consumption of supplements over the past 3 months as well as any conditions restraining participants' condition would limit the ability to perform the exercise protocol.

The sample size was calculated with regard to the results of two-way analysis of variance (ANOVA), four study groups, type I error = 5%, type II error = 20%, the power of the statistical test = 80%, and (6) effect size = 0.20 (10).

The sample size in this study was measured using G*Power 3, as a statistical power analysis program. With reference to a statistical power of 0.80, an effect size of 1.08, and an alpha value of 0.05; the total sample size was determined to be 80 individuals (20 participants per group) considering the possibility of 15% sample loss. Following the baseline assessments, a total of 60 eligible participants (48 < BMI > 30 kg/m^2) were randomly assigned to one of the four study groups in a ratio of 1:1:1:1 according to a computer-generated randomization list as followed: placebo + ERBT (n = 15), GCBE supplement group (n = 15), GCBE supplement + ERBT group (n = 15), and placebo group (n = 15). The allocation sequence was kept in sealed opaque envelopes and not opened until the baseline assessment was completed. The participants were blinded to group allocation, and only received an 8-week intervention. Two participants in the placebo + ERBT group, two individuals in the placebo group, one participant in the GCBE supplement + ERBT group, and one person in the GCBE supplement group were withdrawn from the trial following randomization. Dropout rates were also calculated as the percentage of participants who failed to follow-up the program during 8 weeks.

Each commercially prepared GCBE supplement capsule used for this study (Sabz Daru Co., Tehran, I.R. Iran) contained 500 mg of GCBE supplement and it was claimed by the manufacturer to have 50% CGA (250 mg). The placebo capsules were also prepared and packaged similar to GCBE supplement capsules and contained the same amount of starch. Capsules were delivered to the participants at the time of randomization per week. The adherence rate was also assessed by counting unused capsules returned to the researchers at each follow-up visit.

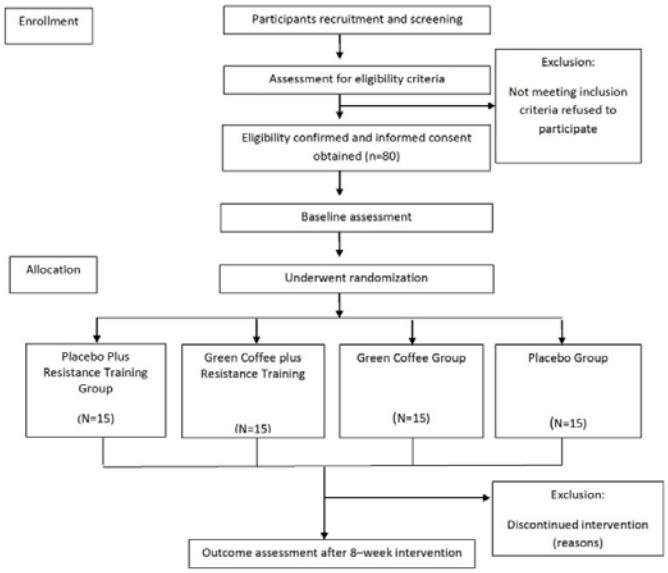

Fig. 1. Consort flow diagram.

Table 1. Elastic resistance band training regime.

Thera-band color	Week							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Yellow	X	X						
Red			X	X				
Green					X	X		
Blue							X	X
Exercise loading								
Repetition	10-15	15-20	10-15	15-20	10-15	15-20	10-15	15-20
Set	3	3	3	3	3	3	3	3
Borg's 15-point rating of perceived exertion	10-13	10-13	10-13	10-13	10-13	10-13	10-13	10-13

Table 2. Exercise progression protocol for one session.

Movements	Intensity (Repetition/set)	Targeted muscle group	Duration (min)
Warm-up			
Mobility exercise of the neck, the upper limbs, and the back		Upper quarter flexors and extensors	5
Global flexion-extension of the lower limbs		Lower quarter flexors and extensors	5
Upper quarter			
Seated chest press	10-20/3	Upper quarter extensors	5-10
Seated row	10-20/3	Upper quarter flexors	5-10
Seated shoulder press	10-20/3	Shoulder gargle muscle groups	5-10
Lower quarter			
Concentric-eccentric hip circumduction	10-20/3	Hip gargle muscle groups	5-10
Leg press	10-20/3	Lower quarter extensors	5-10
Leg curl	10-20/3	Lower quarter flexors	5-10
Cool down			5

Exercise training protocol

ERBT was done using Thera-Band® product (Hygenic Co., Akron, USA) in yellow, red, green, and blue (Table 1). During 8 weeks, all the participants attended three ERBT sessions per week and were then monitored by a licensed senior exercise physiologist blind to the study groups. Each training session included 10 min of general warm-up, resistance training (35-40 min), and finally a cooling approach (Table 2). The Borg's 15-point rating of perceived exertion was also used to assess the perceived focus of the participants from 6 (no action at all) to 20 (maximum action) during training sessions. It should be noted that the given scale is an appropriate measurement tool for describing variation in mental health intensity and it is an easy tool to estimate the severity of individual rehab protocols (17). Participants were also instructed on how to use the exercise device during the first two sessions before beginning the training protocol. In addition, in the first two sessions, the participants became familiar with and also received training to control exercise intensity through a combined use of targeted number of repetitions and OMNI-resistance exercise scale (18). Besides, the participants were required to increase or decrease grip width to adjust the resistance easier. They were also asked to choose a weight or a symmetrical elastic band grip width allowing them to perform a 20 repetitions maximum (18). In addition, the movements were carried out slowly (2 sec for concentric phase and 4 sec for eccentric one). In order to equalize the intensity of both training protocols, targeted number of repetitions was maintained while applying OMNI-resistance exercise scale for the active muscles (18). The same improvement period times as well as inter-set characteristics were applied and the matching procedure was applied to other training parameters. If successive progress was not compatible at the workout level (red to blue), the elastic band color that had been previously used, with an additional set, could be added to each movement to help the participants perform the necessary exercises (19).

Blood analysis

Blood samples (10 mL) from the antecubital vein in a sitting position were collected 24 h before performing the exercise protocol and 48 h after the last session of training program in 12-h fasting state. Fasting blood glucose (FBG) was also measured using glucose oxidase assay kit (Pars Azmoon, Tehran, I.R. Iran), through auto-analyzer devices (Hitachi, Japan). Serum levels of TG and high-density lipoprotein cholesterol (HDL-C) were subsequently measured by Pars Azmoon kits (Pars Azmoon Co., Tehran, I.R. Iran).

Novel cardiometabolic risk scores

Novel cardiometabolic risk scores were calculated using the following equations:

AIP = [Log (TG/(HDL(HDL-C)-total cholesterol)] (20).

MetS Z-Score = waist Z-score + blood pressure Z-score + glucose Z-score + (HDL-(HDLC) Z-score + TG Z-score (21).

A Z- score was calculated for each risk factor (individual mean/standard deviation (SD) of the sample). For the blood pressure, we used the average of systolic blood pressure and diastolic blood pressure was also used for calculating the blood pressure score. Unlike other components, a low value is unfavorable for HDL-C; thus, the calculation of the score was reversed ((mean/SD) value/standard deviation).

FRS was used to estimate cardiovascular risk factor score. This equation included gender, age, systolic blood pressure, smoking status, total cholesterol, HDL-C, and diabetes mellitus status and it was also used to calculate the percentage likelihood of coronary heart disease over a 10-year period (13).

Statistical analyses

All the values are represented as mean ± SD. Besides, Kolmogorov-Smirnov test was performed to evaluate the normality of distribution. In order to compare pre-test and post-test in each group, the data were also analyzed using paired-samples t-test. The two-way ANOVA test was correspondingly conducted to compare the amount of changes in experimental and control training groups after eight weeks. Once a significant F value was achieved, Bonferroni post-hoc test was used to find differences between various groups. Statistical significance was accepted as $P < 0.05$.

RESULTS

At the baseline; no significant differences were observed between the placebo + ERBT, GCBE supplement + ERBT, GCBE supplement, and placebo groups, considering all factors (Table 3). In the placebo + ERBT group, HDL-C ($P = 0.007$), low-density lipoprotein cholesterol (LDL-C) ($P = 0.026$), TG ($P = 0.012$), glucose ($P = 0.001$), FRS ($P = 0.030$), AIP ($P = 0.003$), and MetS Z-score ($P = 0.001$) significantly decreased after eight weeks compared with those in the pretest.

Table 3. Intra- and inter-group comparisons of anthropometric indices after 8 weeks. Data are presented as mean ± SD, n = 15. Paired-samples t-test used for intra-group comparisons (pre-post change) and two-way ANOVA used for inter-group comparisons; $P \leq 0.05$ was considered significant.

Variables	Time	Groups				
		Placebo + ERBT	GCBE +ERBT	GCBE	Placebo	*P* value (Inter-group)
Body mass (kg)	Pre-test	82.55 ± 12.72	86.00 ± 10.08	86.03 ± 8.46	85.72 ± 7.26	0.730
	Post-test	79.73 ± 11.78	83.09 ± 10.44	82.47 ± 9.01	84.18 ± 6.49	
	P value (Intra-group)	0.001	0.001	0.002	0.141	
WC (cm)	Pre-test	99.69 ± 7.80	100.54 ± 7.58	104.0 ± 6.76	102.4 ± 7.07	0.385
	Post-test	97.12 ± 7.11	98.00 ± 7.47	100.9 ± 6.06	101.4 ± 7.26	
	P value (Intra-group)	0.001	0.001	0.001	0.314	
BMI (kg/m^2)	Pre-test	33.12 ± 4.52	34.1 ± 3.31	34.07 ± 3.43	33.09 ± 3.59	0.892
	Post-test	32.0 ± 4.30	32.91 ± 3.01	32.66 ± 3.57	32.51 ± 3.46	
	Intra-group *P* value	0.001	0.001	0.003	0.088	
Body fat (%)	Pre-test	45.59 ± 2.97	46.16 ± 2.37	44.43 ± 3.64	43.93 ± 2.66	0.398
	Post-test	43.27 ± 3.24	43.93 ± 2.22	42.37 ± 3.58	43.20 ± 2.13	
	P value (Intra-group)	0.001	0.001	0.001	0.129	
WHR	Pre-test	0.979 ± 0.12	0.96 ± 0.05	0.89 ± 0.05	0.881 ± 0.06	0.054
	Post-test	0.926 ± 0.09	0.948 ± 0.05	0.888 ± 0.12	0.88 ± 0.06	
	P value (Intra-group)	0.015	0.192	0.786	0.791	

BMI, Body mass index; WC, waist circumference; WHR, waist-hip ratio; ERBT, elastic resistance band training; GCBE, green coffee bean extract.

Table 4. Intra- and inter-group comparisons of HDL-C, LDL-C, TG, total cholesterol, glucose, and novel combined indices of cardiometabolic risk factors after 8-week ERBT and GCBE supplement consumption. Data are presented as mean ± SD, n = 15. Paired-samples t-test used for intra-group comparisons (pre-post change) and two-way ANOVA used for inter-group comparisons; Bonferroni post-hoc test used for paired comparisons; $P \leq 0.05$ was considered significant.

Variables	Time	Groups				
		Placebo + ERBT	GCBE +ERBT	GCBE	Placebo	*P* value (Inter-group)
HDL-C (mg/dL)	Pre-test	48.27 ± 4	48.44 ± 6.95	42.91 ± 4.76	47.17 ± 7.96	0.020*
	Post-test	51.06 ± 3.92	51.41 ± 7.27	43.91 ± 5.81	47.40 ± 7.92	
	P value (Intra-group)	0.007	0.010	0.356	0.885	
LDL-C (mg/dL)	Pre-test	101.4 ± 24.83	87.86 ± 17.74	91.17 ± 23.15	99.47 ± 28.79	0.206
	Post-test	88.63 ± 31.16	78.06 ± 22.29	85.29 ± 21.38	103.05 ± 28.93	
	P value (Intra-group)	0.026	0.074	0.182	0.540	
TG (mg/dL)	Pre-test	159.5 ± 43.59	161.5 ± 35.34	147.4 ± 53.58	151.6 ± 38.6	0.908
	Post-test	150.5 ± 40.35	148.3 ± 34.45	142.2±	150.8 ± 39.8	
	P value (Intra-group)	0.012	0.003	0.071	0.942	
Total cholesterol (mg/dL)	Pre-test	188.6 ± 35.33	172.0 ± 27.39	166.6 ± 26.71	183.4 ±26.41	0.045*
	Post-test	180.1 ± 35.02	160.0 ± 24.08	161.3 ± 25.06	192.24 ± 18.39	
	P value (Intra-group)	0.088	0.015	0.243	0.020	
Glucose (mg/dL)	Pre-test	94.61 ± 8.12	94.36 ± 10.67	94.07 ± 7.39	91.46 ± 10.28	0.058
	Post-test	89.08 ± 9.70	84.5 ± 11.02	91.79 ± 8.50	99.92 ± 20.12	
	P value (Intra-group)	0.001	0.001	0.071	0.053	
FRS	Pre-test	1.57 ± 0.50	1.61± 0.59	1.83 ± 0.54	1.98 ± 0.45	0.399
	Post-test	1.20±0.36	1.29±0.42	1.49 ± 0.44	1.72 ± 0.51	
	P value (Intra-group)	0.030	0.018	0.049	0.233	
AIP	Pre-test	0.492 ± 0.11	0.520 ± 0.14	0.517 ± 0.16	0.496 ± 0.12	0.184
	Post-test	0.483 ± 0.12	0.453 ± 0.13	0.489 ± 0.17	0.487 ± 0.12	
	P value (Intra-group)	0.003	0.003	0.097	0.895	
MetS Z-score	Pre-test	-4.35 ± 1.05	-4.07 ± 0.91	-4.13 ± 1.43	-3.52 ± 1.55	0.170
	Post-test	-5.46 ± 0.93	-4.89 ± 0.59	-4.66 ± 0.93	-3.86 ± 1.25	
	P value (Intra-group)	0.001	0.001	0.049	0.063	

ERBT, Elastic resistance band training; GCBE, green coffee bean extract; BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride; FRS, Framingham risk score; AIP, atherogenic index of plasma; MetS, metabolic syndrome severity. * Represents significant differences between groups after different interventions ($P < 0.05$).

There was also a significant decline in HDL-C ($P = 0.010$), TG ($P = 0.003$), total cholesterol ($P = 0.015$), glucose ($P = 0.001$), FRS ($P = 0.018$), AIP ($P = 0.003$), and MetS Z-score ($P = 0.001$) in the GCBE supplement + ERBT group. In the GCBE supplement group, FRS ($P = 0.049$) significantly declined and MetS Z-score ($P = 0.049$) significantly increased. On the other hand, total cholesterol ($P = 0.020$) significantly increased in placebo group. However, there were no significant differences amongst investigated variables in the placebo group in comparison with corresponding variables in the pretest group.

Furthermore, comparing the four study groups revealed significant differences in HDL-C ($P = 0.02$) and total cholesterol ($P = 0.04$). Following post-hoc comparisons, it was found that HDL-C in the placebo + ERBT and GCBE supplement + ERBT groups had significantly increased compared with that in the placebo group ($P = 0.049$ and $P = 0.032$; respectively). Total cholesterol in the placebo + ERBT, GCBE supplement + ERBT,

and GCBE supplement groups had also significantly decreased compared with that in the placebo group ($P = 0.023$, $P = 0.006$, and $P = 0.041$; respectively) (Table 4).

DISCUSSION

As obesity and cardiometabolic syndrome have similar pathophysiologic mechanisms such as inflammation, insulin resistance, and oxidative stress; it has been hypothesized that obesity is associated with increased cardiometabolic biomarkers (1). However, no studies have been thus far conducted, comparing the effects of ERBT and GCBE supplement consumption on some novel non-invasive cardiometabolic-related equations in obese middle-aged women. To the best of authors' knowledge, this was the first one to evaluate non-invasive indices such as FRS, AIP, and MetS score in obese women and to investigate how they could be affected by ERBT and GCBE supplement consumption.

The present clinical trial was carried out to examine the effects of 500 mg/day of GCBE supplement plus ERBT during 8 weeks in obese women. Accordingly, the results revealed that GCBE supplement plus ERBT had significant effects on serum LDL-C, TG, and FBG, as well as FRS, AIP, MetS score. It should be noted that the GCBE supplement dose used in the present study provided 250 mg of CGBE supplement per day.

Moreover, CGBE supplement in the present trial was not capable of reducing FBG compared with placebo which was not consistent with other findings. For example, Sarria *et al*. evaluated the effect of 8-week consumption of a green/roasted coffee blend and indicated that some cardiometabolic biomarkers such as blood pressure, body fat percentage, glucose levels, insulin resistance, and TG levels had decreased (22).

Furthermore, a significant drop in FBG was observed following 6-week adherence to 100 mg/kg a GCBE supplement and high fat diet (HFD) (23). In addition, these findings were in line with the study suggesting no improvement in insulin resistance following 12 weeks of GCBE supplement consumption (19). However; the present study was not supported by previous findings. For instance; following 14-week consumption of 80 mg/kg of GCBE supplement, there was improvement in HFD-induced insulin resistance (24). In another study, it was revealed that increased coffee consumption was associated with lower liver enzymes as well as liver-related mortality (25,26). No improvements in hepatic non-invasive biomarkers were also observed in three study groups throughout the present study, since aspartate transaminase/alanine transaminase ratio did not decrease significantly. As previously reported; changes in BMI, waist circumference, TG, HDL-C, and total cholesterol among the parameters used for calculation of these cardiometabolic biomarkers, HDL-C did not significantly increase in participants in the experimental groups than placebo ones in this study.

Moreover, GCBE supplement and/or ERBT in the present study were not capable of reducing MetS score in a significant manner and suppressing its rising trend compared with placebo. Moreover, MetS score was considered as the best predictive index for cardiometabolic risk factor (15). It seems that the non-significant decrease in MetS score depends on irreversibility in body composition in obese women, since it has been demonstrated that levels of improvement in MetS score in obese individuals after exercise training intervention could be associated with the degree of abdominal obesity (27). Interestingly, no significant reduction was observed in body composition in all study groups. It seems that multi-intervention depended on changes in body composition; or more precisely, changes in body mass, body fat percentage, and WHR were regarded as important factors in reducing cardiometabolic risk scores in middle-aged obese women (28). One of the strengths of the present study was the use of the novel MetS Z-score to evaluate the effects of different modalities. Confirming the present results, Gates *et al.* also illustrated that 16 weeks of aerobic training did not change the MetS Z-score (29). In addition, Johnson *et al.* had found no superiority of sprint interval training

as compared with moderate intensity training in overweight/obese individuals with metabolic syndrome (30). Furthermore, Earnest *et al.* showed similar reductions in MetS Z-score in high intensity and moderate training in overweight males (31). On account of methodological variances across the related studies such as differences in gender, age, health status, weight and physical fitness status, medications, mode and intensity of exercises, and duration of training programs, as well as interventions (32); drawing general conclusions was difficult (33). It could be speculated that resistance training and/or GCBE supplement consumption might not induce improvements in metabolism, metabolic capacity, and body composition (33,34). These findings were not consistent with the results obtained by Ramos *et al.* reporting that low-volume high-intensity interval training could be as effective as moderate-intensity continuous training in terms of reduction of MetS Z-score (35). In addition, Fisher *et al.* demonstrated that resistance training and/or GCBE supplement consumption were associated with improvements in cardiometabolic risk factors (body fat percentage, total cholesterol, very low-density lipoproteins, HDL-C, TG, and oxygen uptake and consumption (VO_2) peak in overweight men (36). Furthermore, the results of the present study showed that use of resistance training and/or GCBE supplement could not mitigate risks of cardiovascular diseases for 10 years.

No significant improvements in systolic and diastolic blood pressure as well as lipid profile might be reasons for lack of changes in FRS (37), which were in agreement with those obtained by Shokravi *et al*. and Tulley *et al*. (37,38). It seems that the modality types applied in this study were sufficient to bring about changes in FRS.

However, it was possible that no significant differences would have emerged between the four subgroups if treatments were not of longer duration (39). The findings of the present study were not in line with a number of investigations that had provided direct evidence in support of CGA and GCBE supplement as potent compounds improving cardiometabolic risk factors. The discrepancy between the present study and those in the related literature in terms of the effect of CGA in GCBE supplement might be explained by different methods of CGA administration. As well, dose and duration used in these trials might explain some of the variations in findings compared with those of the present study. In agreement with previous reports (40), the present trial did not support the hypothesis that GCBE supplement will improve cardiometabolic complications in obese individuals.

The present study had several potential limitations. First, the small sample size could be considered as a limitation. Second; given the ethical and practical considerations, it was not possible to explore all cardiometabolic biomarkers in the present study. No electrocardiograph was also utilized to detect myocardial disorders, as another limitation. In addition, short duration of the study could be considered as the other limitation of this study. Further work especially on animal and human intervention studies is thus required to determine if GCBE supplement is able to protect against cardiometabolic disorders or not.

CONCLUSION

Taken together, the results of the present study supported the importance of supplemental and resistance-type training in improving HDL-C and total cholesterol. It is possible that longer nutritional and exercise interventions (i.e. ERBT and GCBE supplement) can improve some cardiometabolic risk scores in overweight/obese women.

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