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The effect of O10plus supplementation during total resistance exercises on serum nitric oxide and H2O2 as vascular endothelial function in inactive overweight females

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Authors:
Mojtaba Eizadi*[1]
Fatemeh Mohammadi[2]
Hamidreza Samarikhalaj[3]
Mohammad Rashidi[4]

1. Assistant Professor, Department of Exercise physiology, Sa.C., Islamic Azad University, Saveh, Iran.
2. Ph.D. Candidate, Department of Exercise physiology, Sa.C., Islamic Azad University, Saveh, Iran
3. Ph.D., Department of Physical Education and Sport Sciences, Sa.C., Islamic Azad University, Saveh, Iran.
4. Ph.D., Department of Exercise physiology, Se.C., Islamic Azad University, Semnan, Iran.

**** Corresponding author:***
Mojtaba Eizadi

ORCID: 0009-0004-3388-2254
E-mail: mojtaba52izadi@iau.ir

ABSTRACT

Introduction: Obesity and overweight is associated with metabolic disorders such as type 2 diabetes and vascular endothelial dysfunction. This study aimed to assess the effect of Q10plus ingestion during total resistance exercises (TRX) training on nitric oxide (NO) and hydrogen peroxide (H2O2) as vascular endothelial function in inactive overweight females.

Methods: In this semi-experimental study, 48 adult overweight females aged 30-40 years were randomly divided into control (no intervention); exercise (TRX training, 8 weeks), supplement (Q10plus, 8 weeks, 100 mg/daily) and combined group (TRX+ Q10plus). Anthropometrical indices and fasting serum NO and H2O2 concentration were measured before and 48 after lasting exercise session and compared by ANCOVA with Bonferroni post hoc test between groups.

Results: Serum NO significantly increased in exercise (p=0.001), supplement (p=0.026) and combination (p=0.001) groups. In addition, H2O2 significantly decreased by exercise and combination groups compared to control group (p=0.028, p=0.019 respectively). No significant difference were observed between other groups (p > 0.05).

Conclusion: Based on these findings, although TRX and Q10Plus consumption are each independently associated with improved vascular endothelial function, their simultaneous implementation is not more effective than either of them alone.

Keywords: Q10plus, TRX training, Vascular function, Overweight, Nitric Oxide.

Introduction

Obesity and overweight lead to cardiac and endothelial vascular dysfunction by impairing the vasodilation properties of the endothelium, which is known to be an early step in the development or exacerbation of cardiovascular diseases (1,2). Obesity is also associated with other factors such as blood vessel constriction, increased sympathetic nervous system activity, overactivity of the renin-angiotensin system, and increased insulin resistance, all of which are associated with endothelial dysfunction and elevated blood pressure (2). Studies have shown that abdominal obesity, especially the accumulation of fat in visceral abdominal tissues, predisposes to hypertension and cardiovascular diseases (3,4). Although the main mechanisms responsible for the association of obesity with endothelial dysfunction have not yet been fully identified, studies conducted on obese individuals have pointed to the influence of proinflammatory factors present in the vessels and oxidative stress on the occurrence of these dysfunctions under the aforementioned conditions.

In the field of medical research, nitric oxide (NO) has also been emphasized as an important marker for measuring cardiovascular health and vascular endothelial function. NO, which is one

of the ten small molecules known in nature with a molecular mass of 30 daltons, is mainly produced by the enzyme nitric oxide synthase (NOS) from L-arginine and is released from vascular endothelial cells. This molecule plays an important role in maintaining the health of vascular walls and regulating the function of dilation and constriction of vessels (5,6). Hydrogen peroxide (H2O2) has also been considered as an indicator, which, although not recognized as a free radical, is in the category of reactive oxygen species (ROS) and plays a significant role in increasing oxidative stress and the production of free radicals. H2O2 is among the indicators that are affected by inactivity (7).

Clinical studies have revealed that the reduction in the ability of the antioxidant defense system, along with other factors such as reduced NO, are markers for assessing cardiovascular health and vascular endothelial function. These abnormalities are associated with cardiovascular diseases and vascular endothelial problems. Accordingly, health scientists are looking for strategies that help improve cardiovascular function by regulating the levels of these components. In this regard, the effect of exercise activities and improving nutritional patterns, especially among healthy and sick obese or overweight individuals, are considered key strategies. Farahati et al in 2013 pointed out that 8 weeks of aerobic exercise significantly increased NO and maximal oxygen consumption, as well as reduced weight and body fat percentage in postmenopausal women (8). In another study, 8 weeks of moderate exercise led to a significant increase in antioxidant levels and a decrease in H2O2 (9). Recently, TRX has also been proposed as a whole-body resistance exercise with the aim of treating hormonal and cardiovascular disorders, although it has also resulted in some contradictory findings. As Gharah Dashkhany et al (2023) have pointed out that 8 weeks of TRX training, although leading to an increase in TAC in obese women, did not affect MPO levels (10). In the study of Housini et al (2020), despite a significant increase in GPx following 8 weeks of TRX training in obese women, H2O2 levels did not change (11).

Some recent studies have investigated the effects of exercise training combined with nutritional supplements, especially antioxidant supplements, on cardiovascular function determinants. Laboratory studies have revealed that increased coenzyme Q10 leads to increase NO levels by increasing NOS expression (12). Among nutritional supplements, Q10plus containing Q10 and other antioxidant compounds such as vitamin C, vitamin E, zinc, and folic acid has recently been marketed. Most studies have supported the cardiovascular pharmacological effects of coenzyme Q10 and other Q10plus compounds (12,13,14). A review of the evidence suggests that some studies have been conducted on the independent effects of exercise training (8, 9, 10, 11) and Q10 Plus (12, 13, 14) on biochemical markers of vascular endothelial function, although some findings are contradictory. Despite this limitation, the simultaneous effect of TRX and Q10 Plus supplementation on NO and H2O2 as markers of vascular endothelial function in overweight women has not been studied so far. Therefore, the present study aimed to determine the effect of Q10 Plus consumption during TRX on these markers in overweight women.

Materials and Methods

Subjects

The statistical population of the study that approved by the Ethics Committee of Islamic Azad University consisted of inactive adult women with overweight ($26 \leq BMI \leq 29$) in the age range of 30 to 40 years of old. Of these, 48 adult overweight women were randomly divided into 4 groups: control (no intervention), exercise, supplement, and combination (exercise + supplement).

Inclusion and exclusion criteria

Overweight ($26 \leq BMI \leq 29$) is main inclusion criteria of study. The women in the study were non-smokers, non-pregnant, and had no history of a controlled diet or regular exercise for at least the past 6 months. They were individuals with a history of chronic metabolic diseases such as cancer, gastrointestinal diseases, diabetes, and kidney disease, and orthopedic abnormalities. The study subjects also did not use nutritional supplements or medications during the study except in cases of temporary illness. Failure to participate in continuous exercise and failure to use the Q10plus supplement during the study were exclusion criteria. The presence of any sports injury, metabolic or digestive discomfort caused by supplement use were also exclusion criteria.

Anthropometry

Anthropometric indices were measured before and after the interventions. Height was measured with the subjects standing without shoes and with the shoulders touching the wall from behind. Weight and body fat percentage were recorded using a body composition measuring device (OMRON model, made in Finland). Abdominal circumference was measured at the most prominent point with a non-elastic tape measure. Using the values of height and weight, the body mass index of each subject was calculated (15).

Interventions and blood sampling

During the intervention, the control group did not experience any intervention. In the supplement group, subjects consumed one capsule of Q10plus Eurovital daily, manufactured by Hakiman Tebkar Company under license from the German company Euro OTC Pharma, for 8 weeks. In the exercise group, subjects performed a TRX training for 8 weeks, 3 sessions weekly (11). In the combination group, subjects performed a TRX training for 8 weeks, 3 sessions weekly, and during the period, they also consumed one capsule of Q10plus Eurovital daily after the training sessions.

The dependent variables were measured in two conditions, pre- and post-test in the group. Blood sampling was performed after an overnight fast (fasting) in the conditions before and 48 hours after the last training session with the aim of measuring and comparing the dependent variables (NO, H2O2). The blood samples were centrifuged immediately after sampling and frozen until the variables were measured. For measuring NO by calorimetric method, a commercial kit from Novin Salamat Company was used, and for measuring H2O2 by calorimetric method, a kit from Zelibo Company, Germany was used.

Statistical Methods

Statistical analysis of the obtained data was performed using SPSS version 22. The Kolmogorov-Smirnov test was used to ensure the normal distribution of the data. The ANCOVA test with Bonferroni post hoc test was used to compare the changes in each variable between groups. Also, a paired t-test was used to determine intra-group changes in each of the anthropometric indices. P value of less than 0.05 was regarded as indicative of a significant difference.

Results

Paired t-test was used to determine within-group changes in each of the anthropometric indices, and the results are summarized in table 1.

The pattern of changes in serum NO and H2O2 in response to exercise and supplementation interventions is shown in Fig 1 and Fig 2, respectively. On the other hand, the findings of the ANCOVA test indicate a significant difference in changes in NO as well as H2O2 between the study groups (p=0.001, p=0.026, respectively).

The significance value of the changes in each variable between the study groups is summarized in table 2 by the Bonferroni post hoc test. Based on the findings of the Bonferroni post hoc test, compared to the control group, NO levels increased significantly in the exercise,

Table 1: Mean and SD of Pre and post intervention of anthropometrical indexes

Variable	Time	Control	Exercise	Supplement	Combine
Weight (kg)	pre	86.17 ± 4.88	75.67 ± 3.42	76.17 ± 2.98	76.50 ± 2.43
	post	76.33 ± 5.53	71.58 ± 3.12	74.75 ± 2.63	71.92 ± 2.71
	p-value	0.638	0.001	0.001	0.001
AC (cm)	pre	94 ± 3.48	94 ± 1.92	94.4 ± 2.78	94.42 ± 1.62
	post	94 ± 3.40	90 ± 2.22	93.8 ± 2.56	89.67 ± 1.44
	p-value	0.438	0.001	0.001	0.001
BMI (k/m2)	pre	27.71 ± 1.86	37.75 ± 3.39	27.93 ± 1.44	27.89 ± 1.29
	post	27.77 ± 2.10	26.26 ± 0.42	27.41 ± 1.40	26.23 ± 1.44
	p-value	0.639	0.001	0.001	0.001
BF (%)	pre	34.25 ± 2.22	35.08 ± 1.38	35.08 ± 1.93	35.83 ± 1.59
	post	34.50 ± 2.02	30.38 ± 1.11	33.17 ± 1.99	30.42 ± 1.24
	p-value	0.339	0.001	0.001	0.001

AC; abdominal circumference, BMI; body mass index , BF; body fat percentage
Data compared by paired t-test

Table 2: Results of the Bonferroni post hoc test for NO and H2O2 between study groups

Group	Group	NO		H2O2	
		p-value	*Mean Difference*	*p-value*	*Mean Difference*
Control	Exercise	0.001	- 4.421	0.028	6.027
Control	Supplement	0.026	- 2.177	0.056	6.976
Control	Combine	0.001	- 4.359	0.019	5.302
Exercise	Supplement	0.147	2.244	0.999	0.949
Exercise	Combine	0.999	0.062	0.854	- 0.725
Supplement	Combine	0.166	- 2.182	0.786	- 1.675

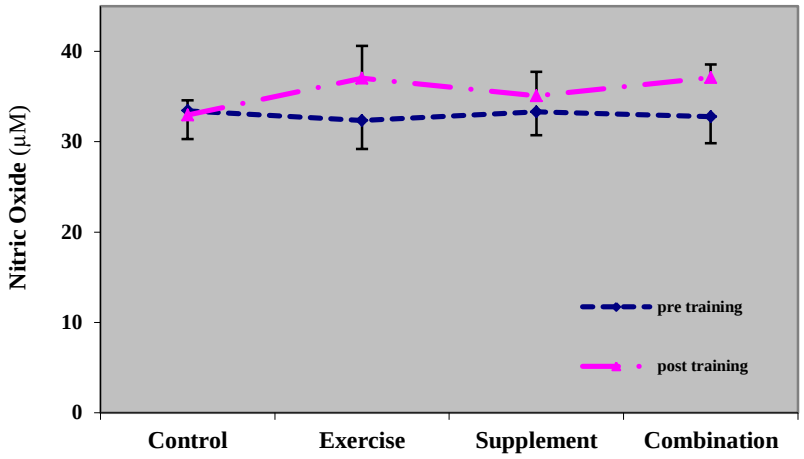

Fig 1: The change pattern of nitric oxide in response to intervention in study groups. Compared to the control group, all three interventions led to an increase in serum NO. There was no difference in NO changes between the combination group and the exercise and supplement groups.

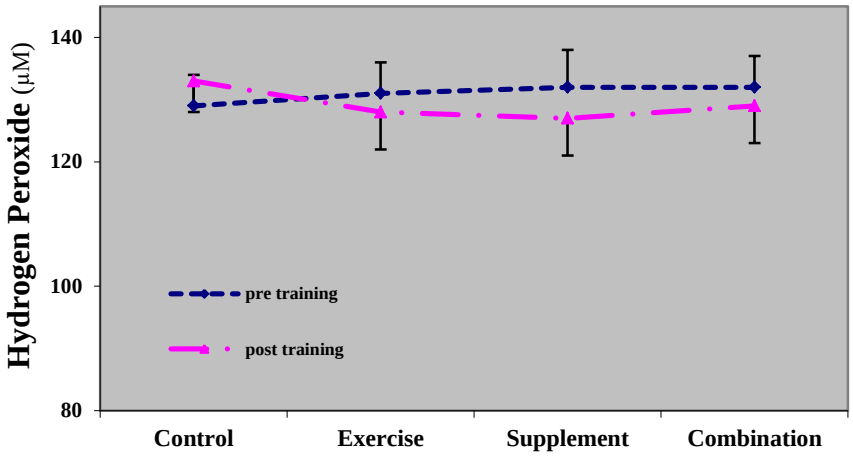

Fig 2: The change pattern of H2O2 in response to intervention in study groups. In response to the control group, serum H2O2 decreased in the exercise and combination groups. No difference in changes was observed between the combination group and the exercise and supplement groups.

supplement, and combination groups. However, no significant difference was observed between the other intervention groups. In other words, the consumption of Q10plus Plus during TRX did not lead to a significant change in serum NO compared to the independent effect of each of them. On the other hand, based on the findings of the Bonferroni post hoc test, a significant difference was observed in H2O2 between the control group and the exercise and combination groups, but the difference in the control group and the supplement group was not significant. In other words, the levels of H2O2 in the exercise and combination groups decreased significantly compared to the control group. However, no significant difference was observed between the

combination group and the exercise and supplement groups. In other words, the consumption of Q10plus Plus during TRX exercises did not lead to a significant change in serum H2O2 compared to the independent effect of each of them.

Discussion

Significant increases in serum NO in response to all 3 interventions and reductions in H2O2 in the exercise and combined groups are the main findings of the present study. In other words, compared to the control group, serum NO increased significantly following TRX and Q10plus supplementation, as well as Q10plus consumption during TRX. However, despite no change in H2O2 in response to Q10plus supplementation, its levels decreased significantly following TRX with and without Q10plus Plus consumption. The response or adaptation of systemic markers of vascular function to exercise training or various antioxidant supplements has been reported many times, although contradictory findings have been noted. In this regard, although Yahyazade et al (2015) reported an increase in antioxidants accompanied by a decrease in H2O2 following 8 weeks of moderate-intensity aerobic training (9), Housini et al (2020) reported no change following 8 weeks of TRX in obese adult women (11). Molnar et al (2006) have indicated that short and long-term resistance exercise leads to a decrease in the amount of H2O2 in skeletal muscle mitochondria in rats (16).

On the other hand, Yahyazade (2015) has pointed out that the consumption of omega-3 during aerobic exercise leads to a significant reduction in H2O2 compared to the independent effect of each of them in young non-athletes (9). These findings are reported while H2O2 is in the category of reactive oxygen species (ROS) and plays a significant role in increasing oxidative stress and producing free radicals and is among the indicators that are affected by inactivity (7). H2O2 is actually an indicator that, although not considered a free radical, is considered a part of ROS and has a direct and effective role in creating oxidative stress and free radicals and increases sharply in response to inactivity (7).

If we want to examine the changes in NO in response to the interventions in this study, although TRX and Q10plus consumption each independently and in combination led to an increase in NO compared to the control group, performing TRX alone or in combination with Q10plus consumption (combination) led to a significant increase in NO compared to the control group. However, Q10plus consumption during TRX (combination group) did not affect NO levels compared to the groups that only did TRX training or Q10plus supplementation. In this regard, Gharah Dashkhany et al (2023) reported no change in NO in response to 8 weeks of TRX training in obese adult women (10). Also, Shekarchizadeh et al (2012) reported no change in response to 4 weeks of resistance training (17). However, in line with the present study, Ghardashi et al (2016) reported a significant increase in response to aerobic interval training in type 2 diabetic women, although no significant change in FMD was observed (18). On the other hand, Akbarzadeh et al (2024) reported a significant increase following 8 weeks of aerobic training in obese women (2). The lack of consistency of studies in this field is controversial, and the contradiction in the findings is probably rooted in the type, duration, intensity of the training program and the number of repetitions of training sessions, as well as changes in weight and body fat mass, initial fitness level and baseline NO levels in the study populations, the dose used and the duration of the supplementation period. Based on this evidence, the increase in NO levels in the present study may be attributed to the reduction in weight or body fat mass in response to TRX.

Increased NO in response to TRX training is reported while clinical studies have indicated its key role in maintaining vascular wall health and regulating vascular constriction and dilation function (19). It is also possible that TRX alone or in combination with Q10plus increases biological NO levels by increasing pulse pressure and pulsatility (20). Laboratory studies have also suggested that activation of ion channels, especially potassium channels, caused by shear stress causes an increase in NO (20). Some researchers have attributed the physiological stimulus for increased NO to exercise-induced shear stress, which leads to increase NO activity for NO synthesis and secretion by increasing blood flow to active muscles through phosphorylation of protein kinase B (21). Another mechanism of increased nitric oxide may

be attributed to the stimulation of fibroblast growth factor 2 (FGF2) (21) as well as the increase in vascular endothelial growth factor (VEGF) (200) induced by exercise as stimuli for the synthesis and secretion of NO from the vascular endothelium.

On the other hand, Larisa et al (2017) have pointed out, citing their findings that intravenous injection of Q10 leads to a rapid increase in NO in the aorta in laboratory mice, which supports the beneficial effects of Q10 consumption in improving vascular endothelial function in cardiovascular patients with endothelial dysfunction (22). However, Akbari et al (2020) have pointed out in their review that although Q10 consumption leads to a decrease in MDA, an increase in total antioxidant capacity (TAC) and SOD, it does not affect NO and glutathione peroxidase (GPx) levels (23). The beneficial effects of Q10 on endothelial dysfunction also play an important role in the pathogenesis of atherosclerosis (24). Q10 is also a potent antioxidant for protecting LDL from oxidation in vitro and is of particular importance in reducing the risk of atherosclerosis and coronary heart disease and other health problems related to free radicals (25). Q10 is also a key component of complex I in the electron transport chain and an important endogenous antioxidant that may play a role in slowing the progression of atherosclerosis and has beneficial effects in atherosclerosis by reducing lipid transport and endothelial inflammation, metabolic abnormalities, and thrombotic processes (26). Although measuring NO and H2O2 in response to Q10Plus consumption during TRX in overweight women is a strength of the present study, measuring them alone does not indicate changes in vascular endothelial function, and the lack of measurement of other vascular endothelial components such as vascular endothelial growth factor (VEGF), homocysteine, malondialdehyde, and antioxidant enzymes, which are limitations of the study, will not yield comprehensive results.

Conclusion

While Q10plus did not independently affect H2O2 levels in overweight women, it was associated with increased serum NO when administered alone or in combination with TRX training. This evidence supports the efficacy of Q10plus and TRX training. However, the evidence from the present study suggests that Q10plus during TRX training is not associated with greater cardiovascular efficacy than either of them alone in overweight women, which is somewhat controversial. This inefficiency may be attributable to the Q10plus dose or duration of training, which suggests the need for further studies in this area.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

No conflict of interest are declared by the author(s).

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