

Effect of Circuit Weight Training on Tumor Necrosis Factor-Alpha on Essential Hypertensive Patients

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Abstract

Background: Inflammation has been shown to play an important role in the mechanisms involved in the pathogenesis of hypertension.

Aim of Study: To evaluate the effect of circuit weight training on tumor necrosis factor-alpha on essential hypertensive patients.

Material and Methods: Fifty hypertensive men patients participated in this study, their ages ranged from 40 to 50 years old, They were randomly assigned into two groups: Group A (study group) were 30 patients who participated in circuit weight training program performing 3 times per week for 8 weeks in addition to their medical treatment. Group B (control group) were 20 patients who received their medical treatment only.

Results: Systolic blood pressure decreased by 6.46% in study group while was 1.15% in control group. Diastolic blood pressure decreased by 5.39% in study group while was 0.6% in control group. The tumor necrosis factor alpha decreased by 28.21% in study group while was 1.76% in control group. Heart rate decreased by 5.18% in study group while was 0.43% in control group. Rate pressure product decreased by 10.49% in study group while was 0.76% in control group.

Conclusion: Circuit weight training had great effect in decreasing tumor necrosis factor alpha, blood pressure, heart rate and rate pressure product.

Key Words: Hypertension – Circuit weight training – Tumor necrosis factor alpha.

Introduction

WORLDWIDE raised blood pressure is estimated to cause 7.5 million death, about 12.5% of the total annual deaths. This accounts for 57 million DALYS (Disability Adjusted Life Years) [1].

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It is a major risk factor for coronary artery disease, stroke, heart failure, atrial fibrillation, peripheral arterial disease, vision loss, chronic kidney disease, and dementia [2].

Inflammation has been shown to play an important role in the mechanisms involved in the pathogenesis of hypertension [3] inflammatory cytokines, such as tumor necrosis factor alpha (TNF(x)), play a pivotal role in the induction of vascular dysfunction in cardiovascular and metabolic diseases [4], TNF is one of the major cytokines of inflammatory and immunologic response, regulating the differential and growth of cells. It is primarily produced by mastocytes, macrophages as well as granulocytes, endothelial cells, fibroblasts, lymphocytes T, smooth muscle myocytes [5] Metabolic functions of TNF include, among others, influence on the increase of leptin concentration, which may lead to insulin resistance and plays an important role in the dysregulation of macrovascular and microvascular function in metabolic and inflammatory diseases [6].

Circuit weight training is a form of body conditioning or endurance training or resistance training using high intensity. It targets strength building of muscular endurance. An exercise (circuit) is one completion of all prescribed exercises in the program. When one circuit is complete, one begins the first exercise again for the next circuit. Traditionally, the time between exercises in circuit training is short [7]. It utilizes the force of gravity In the form of weighted bars, dumbbells in order to oppose the force generated by muscle through concentric or eccentric contraction. Weight training uses a variety of specialized equipment to target specific muscle groups and types of movement [8].

Subjects and Methods

The current study is a randomized controlled study to identify efficacy of circuit weight training on tumor necrosis factor-alpha on essential hypertensive patients.

This study was conducted at Cairo transport authority hospital from July 2020 till April 2021. The study was approved by research ethical committee of faculty of physical therapy.

A- Fifty hypertensive men patients with age range from 40 to 50 years who fulfilled the inclusion criteria of the study were randomly assigned to Group A (study group) and Group B (control group). Study group (A): 30 patients participated in circuit weight training program performing 3 times per week for 8 weeks. Group B (control group) were 20 patients received their medical treatment only.

Inclusion criteria were as follows:

(1) Patients aged between 40 to 50 years. (2) They suffered from mild to moderate degree of essential hypertension with systolic blood pressure ranges from (140-170) mmHg and diastolic blood pressure ranges from (90-109) mmHg. (3) Body mass index=25 :29.9 Kg/m². (4) Patients following antihypertensive medications.

Exclusion criteria were as follows:

(1) Patients who were medically unstable and complicated with other disorder. (2) Sever cardiovascular disorders. (3) Respiratory disorders. (4) chronic renal impairments. (5) previous stroke. (6) neuromuscular disease. (7) Musculoskeletal diseases which may affect their physical activity. (8) diabetes mellitus.

Blood collection and analysis of TNF:

Venous blood sample will be taken from each patient's antecubital vein before the training program (pre-study) and after 8 weeks from study and control group.

Physical therapy program:

The patients were randomly assigned into two groups:

The patients in study group (Group A):

The patients in this group participated in circuit weight training for 30 minutes, three sessions per week for 8 weeks. They were underwent the proper warm up to minimize the risk of musculoskeletal injury. The training session started by a proper warm up for 5-10min in the form of mild stretching for the involved muscle group to prepare the exercised muscles and improve blood supply for skeletal

muscle to prevent fatigue or injury. Patients in this study group performed resistive exercise (in the form of circuit weight training) which consist of hip flexion, hip abduction and knee extension for lower limb, biceps curl, triceps push-down. All sessions were supervised to ensure correct technique and monitor the appropriate amount of exercise and rest intervals. They started the active phase of resisted exercise by using free weights (dumbbells for upper limb and sand bags for lower limb). The intensity was 40% of 1-RM which graduated to 60% of 1-RM at the end of the eight week with 10-15 repetition for each exercise. The exercises within each circuit were separated by brief, timed rest intervals, and each circuit will be separated by a longer rest period. Alternating between upper and lower body work to allow for adequate rest between exercises about 15 seconds rest between each exercise and 1min between each set in three circuits [9].

While the patients in the control group just received anti hypertensive medication only.

Statistical analysis:

Unpaired *t*-test were conducted for comparison of subject characteristics between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to ensure the homogeneity between groups. Unpaired *t*-test was conducted to compare the mean values of systolic and diastolic blood pressure, TNF, HR and RPP between study and control groups. Paired *t*-test was conducted for comparison between pre and post treatment in each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics:

Table (1) showed the subject characteristics of the study and control groups. There was no significant difference between both groups in the mean age and BMI ($p > 0.05$).

Table (1): Comparison of subject characteristics between study and control groups.

	Group A	Group B	MD	<i>t</i> -value	<i>p</i> -value
	Mean \pm SD	Mean \pm SD			
Age (years)	45.08 \pm 2.96	45.32 \pm 3.23	-0.24	-0.04	0.95
BMI (kg/m ²)	27.25 \pm 1.44	27.68 \pm 1.47	-0.43	-1.03	0.3

SD : Standard deviation. *p*-value: Probability value.
MD: Mean difference.

Effect of treatment on systolic and diastolic blood pressure, TNF, HR and RPP:

- Within group comparison:

There was a significant decrease in systolic and diastolic blood pressure, TNF, HR and RPP in the study group post treatment compared with that pre treatment ($p>0.001$). The percent of change of systolic and diastolic blood pressure, TNF, HR and RPP in the study group was 6.46, 5.39, 28.21, 5.18 and 10.49% respectively. There was no significant change in systolic and diastolic blood pressure,

TNF, HR and RPP between pre and post treatment in both the control group ($p>0.05$). (Table 2).

- Between groups comparison:

There was no significant difference in all variables between groups pre-treatment ($p>0.05$). Comparison between groups post treatment revealed a significant decrease in systolic and diastolic blood pressure, TNF, HR and RPP of the study group compared with that of the control group ($p>0.01$). (Table 2).

Table (2): Mean systolic and diastolic blood pressure, TNF, HR and RPP pre and post treatment of the study and control groups.

	Pre	Post	MD	% of change	<i>t</i> -value	<i>p</i> -value
	Mean \pm SD	Mean \pm SD				
<i>Systolic blood pressure (mmHg):</i>						
Study group	154.08 \pm 8.08	144.13 \pm 7.48	9.95	6.46	13.52	0.001
Control group	152.05 \pm 9.72	150.3 \pm 9	1.75	1.15	1.7	0.1
MD	2.03	-6.17				
<i>t</i> -value	0.8	-2.63				
	$p=0.42$	$p=0.01$				
<i>Diastolic blood pressure (mmHg):</i>						
Study group	95.26 \pm 4.59	90.13 \pm 4.66	5.13	5.39	17.48	0.001
Control group	94.62 \pm 4.04	94.05 \pm 4.14	0.57	0.6	1.57	0.13
MD	0.64	-3.932				
<i>t</i> -value	0.5	-3.03				
	$p=0.61$	$p=0.004$				
<i>TNFα (pg/ml):</i>						
Study group	18.54 \pm 2.39	13.31 \pm 1.84	5.23	28.21	13.18	0.001
Control group	19.35 \pm 2.57	19.01 \pm 2.24	0.34	1.76	1.4	0.17
MD	-0.81	-5.7				
<i>t</i> -value	-1.13	-9.81				
	$p=0.26$	$p=0.001$				
<i>HR (beats/min):</i>						
Study group	86.46 \pm 4.98	81.98 \pm 4.05	4.48	5.18	15.34	0.001
Control group	85.37 \pm 4.14	85 \pm 3.71	0.37	0.43	1.13	0.27
MD	1.09	-3.02				
<i>t</i> -value	0.81	-2.66				
	$p=0.42$	$p=0.01$				
<i>RPP:</i>						
Study group	13.35 \pm 0.98	11.95 \pm 0.88	1.4	10.49	28.87	0.001
Control group	13.11 \pm 0.81	13.01 \pm 1.25	0.1	0.76	0.51	0.61
MD	0.24	-1.06				
<i>t</i> -value	0.87	-3.49				
	$p=0.38$	$p=0.001$				

SD : Standard deviation.
MD: Mean difference.

p-value: Probability values.
TNF α : Tumor necrosis factor alpha.

HR : Heart rate.
RPP : Rate pressure product.

Discussion

At the end of the study, the results revealed that there was no significance difference between groups in age and BMI ($p>0.05$). There was a significant decrease in the systolic blood pressure of study group compared with that of control group post treatment ($p=0.01$). There was a significant decrease in the diastolic blood pressure of study

group compared with that of control group post treatment ($p=0.004$). There was a significant decrease in the TNF α of study group compared with that of control group post treatment ($p=0.0001$). There was a significant decrease in the HR of study group compared with that of control group post treatment ($p=0.01$). There was a significant decrease in the RPP of study group compared with that of control group post treatment ($p=0.001$).

The result of the current study was supported by Eskandari et al., 2021 [10] who showed there is a significant decrease in the level of tumor necrosis factor alpha, systolic blood pressure, diastolic blood pressure after four weeks of short duration Upper limb resistance training and lower limb resistance training compared to the control group, but there was no significant difference between the two experimental groups. TNF-alpha levels were found to significantly positive correlate with SBP, DBP. This study suggested that short duration and moderate-intensity UBRT and LBRT leads to similar changes in the reduction of blood pressure and TNF- (as a risk factor of hypertension). So, these trainings can be a good alternative to each other as an effective strategy for reducing blood pressure in hypertensive middle-aged and elderly men with possible activity limitation or with musculoskeletal disorders in the upper or lower body. It is also recommended that resistance training synergizes with medication to optimize the reduction in the blood pressure and inflammatory risk factor of hypertension.

The results also agreed with that of Macêdo et al., (2018) [11] who demonstrated that eight weeks of resistance training significantly decreased the serum concentrations of IL-6, TNF- α , and CRP in the elderly women.

Balducci et al., 2010 [12] although confirmed that IL-6, and TNF- α reduction is more evident when subjects are trained for 12 months with combined aerobic and resistance training of high intensity compared with subjects trained with aerobic only, on the contrary, that anti-inflammatory cytokines (IL-4 and IL-10) increase more in the mixed exercise group.

Resistance exercise significantly reduced the expression of TNF- α , These effects correlated with increases in lower body muscular strength. This is the first study to demonstrate the beneficial effects of resistance training on the inflammatory profile of breast cancer survivors and suggests that the effect is linked to increases in muscular (Strength-Hagstrom et al., 2016) [13].

Hilawe et al. (2013) [14] also came in the same line of this study and approved that physical exercise in form of circuit weight training could be used as full weapon against local vascular and systemic inflammation. Serum levels of IL-6, TNF- α and CRP were significantly decreased after twelve weeks of circuit weight training program.

Diogo et al., (2020) [15] stated that the circuit training protocol proves effective not only in im-

proving physical fitness but also reducing blood pressure at rest in hypertensive older women.

Trevizani et al., (2018) [16] showed that the resistance training program was effective for muscular endurance and strength gain, promoted acute BP response, with evident reduction of SBP after the resistance exercise sessions.

Kazeminia et al., (2020) [17] indicated that exercise leads to significant reduction in both systolic and diastolic blood pressure. Accordingly, regular exercise can be part of the treatment plan for hypertensive elderly.

Stamou et al. (2020) [18] Also reported that increasing physical activity from low to moderate level significantly decreased heart rate and systolic blood pressure, These findings indicated that the beneficial effect of physical activity on heart rate was stronger.

On the other hand, Taheri & Nikseresht, (2015) [19] indicated that 10 weeks resistance and aerobic training with moderate intensity and volume are not sufficient to reduce inflammatory cytokines (TNF- α and IL 6) in sedentary healthy overweight men. It can be concluded that the probable reason for not reducing of this cytokines is because of the normal concentrations in baseline and the subjects being young.

Mateus et al., (2018) [20] results also come against this study and said that: The combined training protocol was not correlated with changes in the TNF- α ; however, the exercise training was able to improve body composition and functional capabilities and contained the worsening of systemic inflammation associated to obesity.

Conclusion:

In conclusion, circuit weight training had great effect in decreasing tumor necrosis factor alpha, blood pressure, heart rate and rate pressure product.

References

- 1- DEEPASHOKEEN and BANI T. AERI: Risk Factors Associated with the increasing Cardiovascular Diseases Prevalence in india : A Review, J. Nutr. food Sci., 5: 1, 2015.
- 2- LACKLAND D.T. and WEBER M.A.: Global burden of cardiovascular disease and stroke: Hypertension at the core. The Canadian Journal of Cardiology. May, 31 (5): 569-71, 2015.
- 3- HARRISON D.G., GUZIK T.J., LOB H.E., MADHUR M.S., MARVAR P.J., THABET S.R., et al.: Inflammation, immunity, and hypertension. Hyper-tension, 57 (2): 132-40, 2011.

- 4- LIU C., ZHOU M.S., LI Y., et al.: Oral nicotine aggravates endothelial dysfunction and vascular inflammation in diet-induced obese rats: Role of macrophage TNF α , PLoS One, Vol. 12, No. 12, article e0188439, 2017.
- 5- WALLACH D.: The cybernetics of TNF: old views and newer ones. *Semin Cell Dev. Biol.*, 50: 105-14, 2016.
- 6- TAKAGURI A.: Elucidation of a new mechanism of onset of insulin resistance: Effects of statins and tumor necrosis factor- α on insulin signal transduction. *Yakugaku Zasshi*, 138: 1329-34, 2018.
- 7- COMYNS and TOM: Circuit Training. Development of strength & Conditioning (PDF). Coaching Ireland. Retrieved 19 July 2018.
- 8- KEOGH J.W. and WINWOOD P.W.: The epidemiology of injuries across the weight-training sports. *Sports Medicine*, 47 (3): 479-501, 2017.
- 9- PAULO A.C., FORJAZ C.L., MION Jr., D., SILVA G.V., BARROS S. and TRICOLI V.: Blood Pressure Increase in Hypertensive Individuals During Resistance Training Protocols with Equated Work to Rest Ratio. *Frontiers in Physiology*, 481, 2020.
- 10- ESKANDARI M., ASGHARI H., SAGHEBJOO M. and KAZEMI T.: Short duration moderate resistance training reduces blood pressure and plasma TNF- α in hypertensive men: The importance role of upper and lower body training. *Science & Sports*, 36 (1): e1-e11, 2021.
- 11- MACÊDO SANTIAGO L.Â., NETO L.G.L., BORGES PEREIRA G., LEITE R.D., MOSTARDA C.T., DE OLIVEIRA BRITO MONZANI J. and NAVARRO F.: Effects of resistance training on immunoinflammatory response, TNF- α gene expression, and body composition in elderly women. *Journal of Aging Research*, 2018.
- 12- BALDUCCI S., ZANUSO S., NICOLUCCI A., FERNANDO F., CAVALLO S., CARDELLI P. and PUGLIESE G.: Anti-inflammatory effect of exercise training in subjects with type 2 diabetes and the metabolic syndrome is dependent on exercise modalities and independent of weight loss. *Nutrition, Metabolism and Cardiovascular Diseases*, 20 (8): 608-617, 2010.
- 13- STRENGTHHAGSTROM A.D., MARSHALL P.W., LONSDALE C., PAPALIA S., CHEEMA B.S., TOBEN C. and GREEN S.: The effect of resistance training on markers of immune function and inflammation in previously sedentary women recovering from breast cancer: A randomized controlled trial. *Breast cancer research and treatment*, 155 (3): 471-482, 2016.
- 14- HILAWÉ E.H., YATSUYA H., KAWAGUCHI L. and AOYAMA A.: Differences by sex in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in sub-Saharan Africa: A systematic review and meta-analysis. *Bulletin of the World Health Organization*, 91: 671-682D, 2013.
- 15- DIOGO C., DENISE D. and ANA PAULA S.: Effect of Circuit Training on Resting Blood Pressure: An Experimental Study in Hypertensive Older Women. *Journal of endocrinology and thyroid research*, 6 (2): 45-52, 2020.
- 16- TREVIZANI G.A., SEIXAS M.B., BENCHIMOL-BARBOSA P.R., VIANNA J.M., DA SILVA L.P. and NADAL J.: Effect of resistance training on blood pressure and autonomic responses in treated hypertensives. *The Journal of Strength & Conditioning Research*, 32 (5): 1462-1470, 2018.
- 17- KAZEMINIA M., DANESHKHAH A., JALALI R., VAISI-RAYGANI A., SALARI N. and MOHAMMADI M.: The effect of exercise on the older adult's blood pressure suffering hypertension: Systematic review and meta-analysis on clinical trial studies. *International Journal of Hypertension*, 2020.
- 18- STAMOU S.S., MAMALI A. and PAPAGEORGIOU E.: Impact of Physical Activity on Heart Rate, Blood Pressure and Rate-Pressure Product in Healthy Elderly. *Health Science Journal*, 14 (2): 712, 2020.
- 19- TAHERI K.A. and NIKSERESHT M.: The effect of 10 weeks resistance and aerobic training on inflammatory cytokines in sedentary overweight men. *scientific journal of ilam university of medical sciences*, 23 (5): 17-26, 2015.
- 20- MATEUS K., BRUNELLI D.T., GÁSPARI A.F., BONGANHA V., BONFANTE I.L., CHACON-MIKAHIL M. and CAVAGLIERI C.R.: Effects of combined training on total ghrelin and tumor necrosis factor- α in obese middle-aged men. *Motriz: Revista de Educação Física*, 24, 2018.

تأثير التدريب بحلقة الاوزان على عامل النخر الورمى ألفا فى مرضى ارتفاع ضغط الدم

الخلفية : ثبت أن الالتهاب يلعب دوراً مهماً فى الآليات المشاركة فى التسبب فى ارتفاع ضغط الدم، والغرض: تقييم تأثير تدريب الوزن الدائرى على عامل نخر الورم ألفا على مرضى ارتفاع ضغط الدم الأساسيين.

الطريقة : شارك فى هذه الدراسة خمسون مريضاً يعانون من ارتفاع ضغط الدم، تراوحت أعمارهم بين ٤٠ و ٥٠ عاماً، تم اختيارهم من مستشفى هيئة النقل بالقاهرة، وتم تقسيمهم عشوائياً إلى مجموعتين: المجموعة أ (مجموعة الدراسة) كانت ٣٠ مريضاً شاركوا فى برنامج تدريبيى للأنقال ينفذ ٣ مرات فى الأسبوع. لمدة ٨ أسابيع بالإضافة إلى العلاج الطبى. المجموعة ب (المجموعة الضابطة) كانت ٢٠ مريضاً تلقوا العلاج الطبى فقط.

النتائج : انخفض ضغط الدم الانقباضى بنسبة ٦.٤٦٪ فى مجموعة الدراسة بينما كان ١.١٥٪ فى المجموعة الضابطة. انخفض ضغط الدم الانبساطى بنسبة ٥.٣٩٪ فى مجموعة الدراسة بينما كان ٠.٦٪ فى المجموعة الضابطة. انخفض عامل نخر الورم ألفا بنسبة ٢٨.٢١٪ فى مجموعة الدراسة بينما كان ١.٧٦٪ فى المجموعة الضابطة. انخفض معدل ضربات القلب بنسبة ٥.١٨٪ فى مجموعة الدراسة بينما كان ٠.٤٣٪ فى المجموعة الضابطة. انخفض معدل ضغط المنتج بنسبة ١٠.٤٩٪ فى مجموعة الدراسة بينما كان ٠.٧٦٪ فى المجموعة الضابطة.

الخلاصة : كان للتدريب بحلقة الأوزان له تأثير كبير فى تقليل عامل نخر الورم ألفا وضغط الدم ومعدل ضربات القلب ومنتج ضغط المعدل.