Effect of Aerobic Exercise with DASH on Blood Pressure and Lipid Profile in Prehypertensive Women

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ABSTRACT

Purpose *of the present study was to investigate the effect of aerobic exercise with DASH on blood pressure and lipid profile in prehypertensive women.* ***Methods:*** *Forty prehypertensive women aged from 55-65 years old were recruited from outpatient Internal medicine clinics, El-Mataria Teaching Hospitals. They were assigned into two groups: group (A): (n=25) received aerobic exercise (consisted of moderate intensity for 45 min of training per day, 3 days a week, for 12 weeks) with DASH and group (B): (n=15) received DASH only. For all women, blood pressure, and lipid profile were measured before the beginning of the study and after 12 weeks.* ***Results:*** *There were statistical significant decline in systolic, diastolic blood pressure, (TC), (LDL-c) and (TG) levels -7.57%, -8.19%, -14.88%, -20,6%, -31.16% respectively and significant increase of (HDL-c) concentrations by 20.4% in response to aerobic exercise with DASH. Also, There were significant decline in systolic, diastolic blood pressure, (TC), (LDL-c) and (TG) levels -2.98%, -1.93%, -2.77%, -1.4%, -3.36% respectively and significant increase of (HDL-c) concentrations by 2.2% in response to the DASH only.* ***Conclusion:*** *It was concluded that aerobic training with DASH dietary pattern could be used as preventive methods from developing cardiovascular disease such as hypertension and dyslipidemia.*
Key words: *Aerobic exercise, DASH, lipid profile, prehypertension.*

INTRODUCTION

Prehypertension, that included individuals with a systolic BP of 120 – 139 mmHg or a diastolic BP of 80–89 mmHg. Patients with prehypertension were considered at increased risk for progression to hypertension[27]. Many causal factors for elevated BP have been identified, including excess body weight, excess sodium intake, reduced physical activity, inadequate intake of fruit, vegetables, and potassium, and excess alcohol intake[8].

The prevalence of prehypertension is high. Prehypertension is commonly associated with CVD risk factors namely dyslipidemia, dysgylcemia and overweight/obesity. Prehypertension progresses to hypertension at a high rate of 19% over 4 years[7].

Aerobic exercise defined as rhythmic contraction of large muscle groups increases respiratory and heart rates and oxygen consumption. Exercise training affects blood pressure via chronic effects on autonomic control mechanisms and vascular remodeling. Cardiorespiratory fitness, a physiologic attribute related to the efficiency of the oxygenation during sustained physical activity, is also increased by progressive aerobic exercise training. Physical activity and cardiorespiratory fitness are inversely related to BP and the prevalence of hypertension. These trends have been corroborated by randomized trials showing that physical activity can reduce BP in normotensive, prehypertensive and hypertensive individuals[20].

The Dietary Approaches to Stop Hypertension (DASH) dietary pattern is rich in potassium (from fruits and vegetables) and calcium (from dairy), reduced in total and saturated fat, and contains limited amounts of meats and sweets[29].

Higher consumption of fruit and vegetables is associated with lower blood pressure and reduced cardiovascular mortality. In the well-controlled (DASH) study, a low-fat diet rich in fruit and vegetables lowered blood pressure[11]. Dietary modification can lower blood pressure effectively independently of weight loss in individuals with prehypertension. The (DASH) trial studied the effects on blood pressure of a diet rich in vegetables, fruits and low fat dairy products, in individuals with prehypertension or stage 1 hypertension. The DASH diet with a low sodium intake lowered systolic blood pressure by 7.1 mmHg in participants with prehypertension and by 11.5 mmHg in those with hypertension[25].

Blood cholesterol-lowering effects represent an important mechanism that protects against atherosclerosis. Vegetable and fruit fibers, oily seeds, and fish oils have hypocholesterolemic effects in humans, through both inhibition of fat absorption and suppression of hepatic cholesterol synthesis by the blocking of the hydroxymethylglutaryl-CoA reductase enzyme[16].

Aerobic exercise training two to three times/week at an intensity of 60-80% of age-predicted maximal heart rate improved lipid profile at week 16[30].

This study was therefore designed to investigate the effect of aerobic exercise with Dietary Approach to Stop Hypertension (DASH) on blood pressure and lipid profile in prehypertensive women.

MATERIALS AND METHODS

Subjects

Forty sedentary prehypertensive women (systolic blood pressure from 120 to139mmHg and/or a diastolic blood pressure from 80to 89mmHg) aged from 55-65 years old were recruited from outpatient Internal medicine clinics, El-Mataria Teaching Hospitals.

Inclusion Criteria:

<u>Women who had the following features were included in the study:</u>

(1) Blood pressure ranged from systolic blood pressure of 120–139 mmHg and/or a diastolic blood pressure of 80–89mmHg, (2) Abnormality in one or more of lipid profile variables (3) with BMI more than 30kg\ m².

Exclusion Criteria:

<u>Women who had the following features were excluded from the study:</u>

(1) Neuromuscular, musculoskeletal disorders or psychological problems, (2) Cardiac disease, (3) Medication that could affect or interfere with their performance or affect their safe participation.

Full evaluation of each participant was performed prior to the study (including medical history, clinical examination, and electrocardiography (ECG). All women were initially aware about and fully understood the purpose and procedures of the study and so an informed consent was assigned from each patient agreed to participate in the study .The study protocol was approved by the faculty ethics committee before the start of the study.

Women were divided into two groups; group A (n=25) received supervised aerobic exercise training and DASH (Diet Approaches to Stop Hypertension) as a study group and group B(n=15) received supervised DASH diet as a control group. They participated in the study for 12 weeks (3sessions\week).

Evaluation Parameters:

<u>The Anthropometric Characteristics Of Women:</u>

Body weight was measured in light indoor clothes and patient height without shoes using a wall mounted stadiometer was measured using calibrated clinical weight and height scale. Body mass index (BMI) was calculated as the weight (kg) divided by the height squared (m²).

Assessment of Blood Pressure:

- Measurements were taken with a mercury sphygmomanometer and stethoscope. Women rested comfortably in the seated position with back support.
- The arm should be bare and supported with the antecubital fossa at heart level.
- At least two measurements should be taken in the same arm with in the same position, and the mean should be recorded.
- Place the bell or diaphragm of the stethoscope gently and steadily over the brachial artery.
- Open the control valve so that the rate of deflation of the cuff is approximately 2 mm Hg per heart beat (or per second). A cuff deflation rate of 2 mm Hg per beat was necessary for accurate systolic and diastolic estimation.
- Read the systolic level (first appearance of a clear tapping sound) and the diastolic level (the point at which the sounds disappear)[13].

Assessment of lipid profile:

Photometer (PLD 951, made in Italy) was used for estimation of serum lipid profile, after fasting for at least 12 hours, 3mL venous blood was extracted from dorsal hand vein and allowed to clot at 37oC in the water bath, then serum was separated using a centrifuge for estimation of serum lipid.

Interventions:

Exercise training programs were conducted for patients in groups (A) three times per week for twelve weeks in outpatient clinic, Faculty of Physical Therapy, Cairo University.

Aerobic Exercise Intervention:

Each one in group (A) participated in supervised moderate intensity aerobic exercise-training program (The session started with warming up for 5 minutes of low intensity of walking on treadmill then increasing intensity of exercise up to 70% of maximal heart rate for 35 minutes after that decreasing intensity for cooling down up to 5 minutes). Each session lasted for 45 minute, 3 times per week for 12 weeks.

DASH Intervention:

Individuals in the study and control group received DASH only (Appendix1). Participants received instruction in modifying the content of their diet to meet DASH guidelines. Participants received counseling on the DASH diet and were provided feedback on their adherence to the diet. Participants were also learned how to choose and weight the food servings[6].

Statistical Analysis

Data were analyzed using SPSS version 16. Results were expressed in terms of mean ± standard deviation. Two-tailed, paired t-tests were used to determine if the post training-pre training difference within each group was significant. P < 0.05 was considered significant.

RESULTS

Table (1): Characteristics of the subjects.

	Group (A)	Group (B)
Age(yrs.)	58.24±2.8	57.53±2.16
Weight(kg)	103.12±13.14	101.4±11.66
Height (Cm)	166.24±10.71	164.86±10.03
BMI(kg/m^2)	37.23±1.84	37.23± 1.55

Table (2): Lipid profile and blood pressure before and after treatment.

Variables	Group (A)			Group (B)		
	Before	After	P-value	Before	After	P-value
Cholesterol	215.44±13.0	183.64±12.39	0.0001*	220.8±17.48	214.73±18.07	0.001*
Triglyceride	138.16±35.05	95.08±21.12	0.0001*	149.26± 38.12	144.06±37.29	0.004*
HDL	49.2±9.63	59.48±6.96	0.0001*	46.73±6.61	47.8±6.59	0.002*
LDL	136.64±19.49	108.44±13.73	0.0001*	142.86±22.65	140.4±23.19	0.001*
Systolic blood pressure	132.88±4.68	122.44±3.3	0.0001*	134.2±4.94	130.53±5.59	0.001*
Diastolic blood pressure	86.44±2.38	79.36±2.09	0.0001*	86.33±2.43	84.66±2.69	0.001*

Data presented as mean± standard deviation ; *P <0.05(significant).

Table (3): Comparison between 2 groups in Lipid profile and blood pressure before and after treatment.

Variables	Before treatment			After treatment		
	Group (A)	Group (B)	P-value	Group (A)	Group (B)	P-value
Cholesterol	215.44±13.0	220.8±17.48	0.27	183.64±12.39	214.73±18.07	0.0001*
Triglycerides	138.16±35.05	149.26± 38.12	0.35	95.08±21.12	144.06±37.29	0.0001*
HDL	49.2±9.63	46.73±6.61	0.38	59.48±6.96	47.8±6.59	0.0001*
LDL	136.64±19.49	142.86±22.65	0.36	108.44±13.73	140.4±23.19	0.0001*
Systolic blood pressure	132.88±4.68	134.2±4.94	0.4	122.44±3.3	130.53±5.59	0.0001*
Diastolic blood pressure	86.44±2.38	86.33±2.43	0.89	79.36±2.09	84.66±2.69	0.0001*

Data presented as mean± standard deviation ; *P <0.05(significant).

Table (4): Percentage of improvements for both groups in Lipid profile and blood pressure of the women after treatment.

variables	Group (A)	Group (B)
Cholesterol	↓ -14.88%	↓ -2.77%
Triglycerides	↓ -31.16%	↓ -3.36%
HDL	↑ 20.4%	↑ 2.2%
LDL	↓ -20,6%	↓ -1.4%
Systolic blood pressure	↓ -7.57%,	↓ -2.98%
Diastolic blood pressure	↓ -8.19%	↓ -1.93%

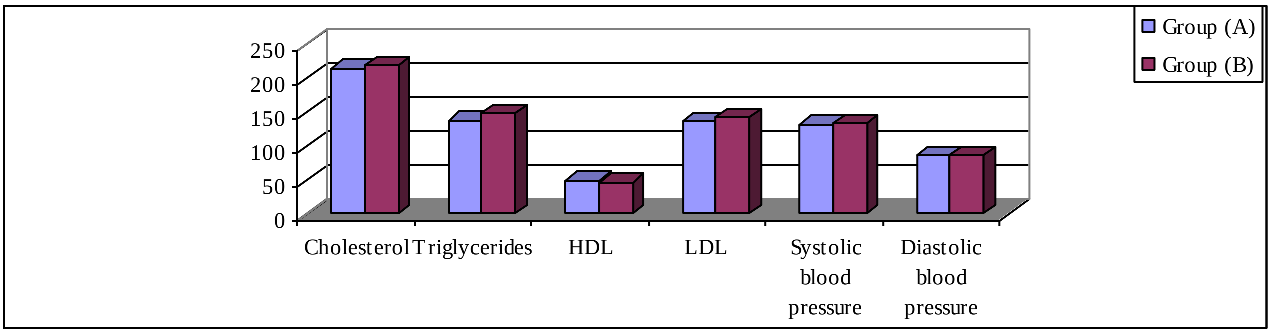

Fig. (1): The mean values of all variables before treatment.

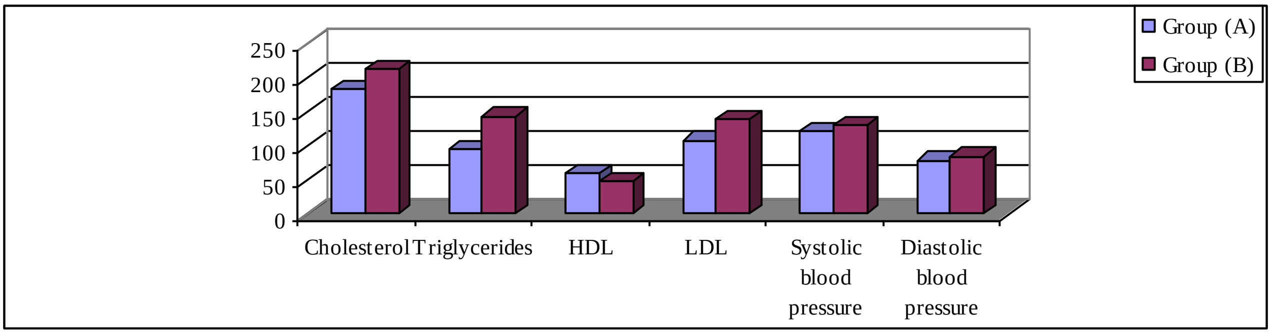

Fig. (2): The mean values of all variables after treatment.

DISCUSSION

The present study demonstrated the effect of 12-weeks aerobic training program with DASH dietary pattern on blood pressure, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c) and triglycerides (TG) levels as well as high-density lipoprotein cholesterol (HDL-c) concentrations in prehypertension women. With regard to aerobic training with DASH dietary pattern on blood pressure, Márquez -Celedonio et al., (2009)[21] examined the effect of the DASH-type diet and also aerobic physical exercise undertook 3-5 sessions per week for 6 months of. Each session lasted 45 min. The results showed that the subjects experienced a reduction in blood pressure. The most significant effect of the exercise program was the 10.6% reduction in systolic blood pressure and 12.9% reduction in diastolic blood pressure recorded, greater reductions than those reported achieved a DASH diet alone.

With regard to blood pressure reduction in response to DASH only, the results of the present study were in line with Damasceno et al. (2011)[10] reported similar findings: who confirmed that the DASH substantially reduced the levels of blood pressure during the first eight weeks of compliance. This reduction reaches 5.5 mmHg in systolic blood pressure (SBP) and 3.0 mm in diastolic blood pressure (DBP) during this period. Also, Hernandez and Anderson, (2012)[17] stated that The DASH diet resulted in a 5.5 mmHg reduction in systolic pressure and 3.0 mmHg reduction in diastolic pressure in adults with mean baseline systolic and diastolic blood pressures of 131.3 ±10.8 and 84.7 ±4.7.

This reduction in blood pressure was due to that the DASH dietary pattern was rich in potassium, magnesium, calcium, and fiber and was reduced in total fat, saturated fat, and cholesterol. Potassium is vasoactive; for example, when infused into the arterial supply of a vascular bed, blood flow increases. The vasodilation results from hyperpolarization of the vascular smooth muscle cell subsequent to potassium stimulation by the ion of the electrogenic Na+-K+pump[15].

The results of this study were contradicted with that reported by Fuchs, (2010)[14] who found low effectiveness of non-drug interventions (DASH) in patients with hypertension and prehypertension because the efficacy of dietary interventions is lost with time.

With regard to decreased blood pressure in response to aerobic exercises, the results stated by Lamina, (2010)[19] who reported similar findings: who found that blood pressure measurement reduced with using aerobic exercises either in interval or continuous pattern.

The underlying mechanisms for the effect of aerobic exercises on blood pressure are based on two theories: the first theory is that physical activity improves endothelial function. The endothelium lining of blood vessel walls maintains normal vasomotor tone, enhances fluidity of blood, and regulates vascular growth. Abnormalities in these functions contribute to many disease processes including angina, myocardial infarction, coronary vasospasm, and hypertension. Another theory proposes that exercise enhances shear stress (a force acting parallel to blood vessels) stimulating the production of nitric oxide (NO) by the endothelium. In healthy blood vessels NO enhance smooth muscle relaxation and maintains the blood vessel in the normal resting state. Small changes in vessel diameter profoundly impacts vascular resistance. Aerobic based training also appears to increase large artery compliance[4]. Decreases in catecholamines and total peripheral resistance, improved insulin sensitivity, and alterations in vasodilators and vasoconstrictors are some of the postulated explanations for the antihypertensive effects of exercise[24].

Aerobic training with DASH in the current study had similar results as Zhang and Li. (2011)[31] who reported that Lifestyle modifications were the main treatment recommended for the prehypertension patients which included the DASH eating plan (the DASH dietary pattern reduced SBP by 5.5mmHg and DBP by 3.0mmHg), Also, promote physical activity; it was found that aerobic exercise was associated with a significant reduction in mean systolic and diastolic blood pressure 3.84 mmHg and 2.58 mmHg. Subjects who exercised >3 times/week also showed a significantly lower risk of developing hypertension. Also, Hong et al. (2008)[18] studied evidence suggesting that lifestyle modification may decrease blood pressure in adults by The (DASH) trial and physical activity have a positive effect on blood pressure.

Moreover, Blumenthal et al. (2010)[6] examined the effects of the DASH diet alone and in combination with exercise on blood pressure and cardiovascular biomarkers in men and women with high blood pressure. It was found that the addition of exercise to the DASH diet resulted in even larger BP reductions, greater improvements in vascular and autonomic function, and reduced left ventricular mass. Participants had supervised exercise sessions 3 times per week at a level of 70% of their initial heart rate reserve. The supervised exercise routine consisted of 10 minutes of warm-up exercises, 30 minutes of biking and/or walking or jogging, and 5 minutes of cool-down exercises for 4 months.

The present study proved that DASH was associated with significant slight increasing in high-density lipoprotein cholesterol (HDL-c) concentrations according to, Crawford and Paden (2006)[9] who reported that Low-carbohydrate diets raised high-density lipoprotein (HDL) cholesterol levels by approximately 10%. Also, Azadbakht et al. (2005)[3] reported that the DASH diet resulted in higher HDL cholesterol, lower triglycerides, SBP, DBP among men and women. In contrast to the current study, HDL cholesterol was reduced more by the DASH diet in individuals with higher baseline HDL-cholesterol concentrations[23].

In the present study aerobic training with DASH is associated with significant reductions in total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c) and triglycerides (TG) levels but with significant markedly increasing in high-density lipoprotein cholesterol (HDL-c) concentrations in study group more than control group. Previous studies in adult populations using similar diet and exercise protocols resulted in significant improvements in BMI, serum lipids, glucose, insulin, inflammatory markers, and oxidative stress[26].

The underlying mechanisms by which exercise improves blood lipid constants, especially HDL cholesterol, as lipid oxidation is the major form of energy generation during moderate and prolonged exercises[5].

The underlying mechanisms by which DASH improves blood lipid constants, is decreasing the low saturated fat, trans fat, and cholesterol content of the diet with high fiber intake and thus decrease in total cholesterol and LDL. The high levels of physical activity and relatively low baseline levels of HDL likely played a role in the maintenance of their HDL levels[22]. The marked improvement in this study observed in serum triglycerides was due to the combination of the high-fiber, unrefined-carbohydrate diet and the regular physical activity[28].

In summary, 12 weeks of aerobic training with DASH dietary pattern had significant effect on blood lipid concentrations and decreased blood pressure in prehypertensive women. It was concluded that aerobic training with DASH dietary pattern could be used as preventive methods from developing cardiovascular disease such as hypertension and dyslipidemia.

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Appendix (1)

Table (5): The DASH Eating Plan (Anderson et al., 2007&Appel, 2003).

Food Group	Servings	Serving Sizes	Significance to the DASH Diet
Grains	7-8 Daily	1 slice bread 1 cup cereal ½ cup cooked rice, pasta, or cereal	Carbohydrates and fiber
Vegetables	4-5 portions Daily	1 cup raw leafy vegetables ½ cup cooked vegetable ½ cup vegetable juice	Potassium, magnesium and fiber
Fruits	4-5 units Daily	1 medium fruit ¼ cup dried fruit ½ cup fresh, frozen or canned fruit ½ cup fruit juice	Potassium, magnesium and fiber
Fat-free or low-fat dairy products	2-3	1 cup milk 1 cup yogurt 1½ ounces cheese	Calcium, protein, potassium and Magnesium
Lean meats, poultry, and fish	2 Daily	cooked meats, poultry, or fish(1portion of 100 g) 1 egg	Protein and magnesium
Nuts, seeds, and Legumes	4-5 per week	⅓ cup or 1½ ounces nuts 2 tablespoons or ½ ounce seeds ½ cup cooked legumes (dried beans or peas)	Magnesium, potassium, protein and fiber
Fats and oils	2-3 Daily	1 teaspoon soft margarine 1 tablespoon low-fat mayonnaise 2 tablespoons light salad dressing 1 teaspoon vegetable oil	
Sweets and added sugars	5 or less per week	1 tablespoon sugar 1 tablespoon jelly or jam ½ cup sorbet, gelatin 1 cup lemonade	

Table (6): Physiological mechanismfor cardiovascular protection (Ferrari, 2007).

Physiological mechanism	Bioactive compound(s)	Foods
Decreasing blood cholesterol	Tocopherols, omega-3 fatty acids, phytosterols, and others	Almonds and nuts
	Omega-3	Fish oil
	Fiber and phytochemicals	Oat cereal
Decreasing blood pressure	Ascorbic acid	Citrus fruits

الملخص العربي

تأثير التمرينات الهوائية مع الحمية الغذائية على ضغط الدم و دهون الدم لدى الأفراد المعرضون لارتفاع ضغط الدم

هدف الدراسة هو دراسة تأثير التمرينات الهوائية مع الحمية الغذائية على ضغط الدم و دهون الدم لدى السيدات المعرضات لارتفاع ضغط الدم . أجرى البحث على أربعين سيدة بدينة من السيدات المعرضات لارتفاع ضغط الدم تم اختيارهن من العيادة الخارجية الخاصة بقسم الباطنة بمستشفى المطرية التعليمي وتراوحت أعمارهن مابين خمسة وخمسين إلى خمسة وستين سنة ، تم تقسيمهن إلى مجموعتين. المجموعة الأولى (25سيدة) تلقت النظام الغذائي والتمرينات الهوائية(بدرجة متوسطة الشدة لمدة 45 دقيقة في الجلسة بمعدل ثلاث مرات أسبوعيا لمدة أثنى عشر أسبوعا) والمجموعة الثانية (15سيدة) تلقت النظام الغذائي فقط. وتم تسجيل بيانات ضغط الدم و دهون الدم لكل السيدات عند البدء وبعد مرور أثنى عشر أسبوعا. النتائج: أظهرت النتائج وجود فروق ذات دلالة إحصائية تشير إلى وجود تقدما ملحوظا في انخفاض مقاييس ضغط الدم الانقباضي والانبساطي ، وأيضا الكوليسترول الكلى,الدهون منخفضة الكثافة ، الدهون الثلاثية بنسبة -7.57% ، -8.19% ، -14.88% ، -20.6% ، -31.16% بالترتيب . وارتفاع في نسب الدهون عالية الكثافة بنسبة 20.14% و ذلك استجابة للتمرينات الهوائية بالإضافة إلى الحمية الغذائية.وأيضا ظهرت فروق ذات دلالة إحصائية تشير إلى وجود تقدما ملحوظا في انخفاض مقاييس ضغط الدم الانقباضي والانبساطي ، وأيضا الكوليسترول الكلى،الدهون منخفضة الكثافة، الدهون الثلاثية بنسبة -2.98% ، -1.93% ، -2.77% ، -1.4% ، -3.36% بالترتيب ، وارتفاع في نسب الدهون عالية الكثافة بنسبة 2,2% وذلك استجابة إلى الحمية الغذائية بمفردها . ولذلك التمرينات الهوائية مع الحمية الغذائية تستخدم كوسيلة وقائية من أمراض القلب والأوعية الدموية مثل ضغط الدم المرتفع وارتفاع دهون الدم .

الكلمات الدالة : التمرينات الهوائية- النظام الغذائي - دهون الدم - المعرضات لضغط الدم المرتفع .