Effect of Diet and Aerobic Exercises on Blood Pressure in Prehypertepnsive Individuals

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Abstract: Objective: This study was conducted to evaluate the effect of diet and aerobic exercises on blood pressure in prehypertensive individuals. **Subjects and methods:** 80 prehypertensive individuals (28 men and 52 women) with age ranged from 40-50 years old; diagnosed as prehypertension or high normal blood pressure were selected randomly from the outpatients clinic of the internal department from Desouk General Hospital, Desouk, Kafr El-sheikh Government. They were randomly divided into two groups; group (A) (40 patients; 16 men and 24 women), they were instructed to use the DASH diet eating plan and aerobic exercises for 45 minutes / three times/ week for four weeks as a part of lifestyle modification. Group (B) (40 patients; 12 men and 28 women), they were instructed to follow a selected program of eating (Dietary approach to Stop Hypertension). Systolic and diastolic blood pressure were measured pre treatment and after four weeks. **Results:** Showed that there were statistical significant reductions in systolic and diastolic blood pressure within each group before and after four weeks. There were significant statistical differences between both groups in diastolic blood pressure. Significant difference concerning systolic blood pressure was seen between both groups in favor of group (A). **Conclusion:** Both DASH & Aerobic exercises together as a lifestyle modification was more effective in reducing systolic and diastolic blood pressure in prehypertensive subjects more than the DASH alone.
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1. Introduction

Hypertension (HTN) is the most common cardiovascular disease (CVD) affecting about 20% of adult population and is a leading cause of morbidity and mortality worldwide. It is a major risk factor for heart disease, stroke and kidney disease. It is a major public health problem in both economically developing and developed countries (***Chaudhry et al., 2012).***

Overweight and obesity are important determinants of health and lead to adverse metabolic changes including high BP. Being overweight is associated with two- to six-fold increase in the risk of developing HTN ***(Chaudhry et al., 2012)***.

Prehypertension may not just present a risk for future hypertension but is also associated with the presence of active disease. Some adolescents with prehypertension already demonstrate evidence of target organ damage (TOD). Left ventricular hypertrophy (LVH) is the most widely recognized abnormality attributed to high BP. Individuals with both hypertension and prehypertension were found to have a 3- and 2-fold higher prevalence of LVH, respectively, than their normotensive counterparts. Abnormal pathology is associated with prehypertension; however, it is not limited to LVH. Patients with prehypertension were also noted to have increased carotid artery intimal-media thickness and arterial stiffness ***(Redwine and Daniels, 2012)***.

Research suggested that obesity, physical inactivity, anxiety (psychological tension), and a poor diet are associated with hypertension. Although treatment through medication is most common, behavioral methods might also be effective through improving eating and exercise behaviors, reducing anxiety, and lowering weight, whether or not pharmaceutical treatment is being used. Improve such lifestyle factors is likely to be beneficial. ***(Annesi, 2012).***

Major lifestyle modifications shown to lower BP include weight reduction in those individuals, who are overweight or obese, adoption of the Dietary Approaches to Stop Hypertension (DASH) eating plan, which is rich in potassium and calcium, dietary sodium reduction, physical activity, and moderation of alcohol consumption. Lifestyle modifications reduce BP and decrease cardiovascular risk ***(Sica, 2012)***.

The Dietary Approaches to Stop Hypertension (DASH) – a diet based on a high consumption of fruits, vegetables, fish and foods with low levels of fat, milk products, red meat, cholesterol and sugar substantially reduces the levels of blood pressure. By contrast, an increase only in the consumption of fruits and vegetables, although leading to significant reductions, is only half as successful as the DASH diet found that the DASH diet was effective in reducing SBP in prehypertensive and hypertensive adolescents, principally because of the consumption of fruit and elements such as potassium and magnesium, in addition to the reduction in fat ***(Damasceno et al., 2011).***

The correlation between habitual physical activity and the development of hypertension have been found in numerous studies 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, respectively. Subjects who exercised >3 times/week also showed a significantly lower risk (0.35) of developing hypertension versus those who exercised <3 times/week. In addition, accumulating intermittent bouts of physical activity, as short as 10 min, total 30min walk sessions may reduce systolic BP in prehypertension ***(Zhang and Li, 2011)***.

Purpose of the study: To investigate the effect of diet (Dietary Approach to Stop Hypertension DASH) and aerobic exercises on blood pressure in prehypertensive individuals.

2. Subjects and Methods

80 prehypertensive individuals of both sexes (28 men and 52 women) from the outpatients clinic of the internal department from Desouk General Hospital were included in the study for 4 weeks (3 times/ week), aged from 40- 50 year old. They were referred from the physician and signed a consent form and were divided into two groups, equal in number. The study was performed from May 2012 to December 2012. **Group A** (study group) (40 patients; 16 men and 24 women) received Diet Approach to Stop Hypertension (DASH) and aerobic exercises. **Group B** (control group) (40 patients; 12 men and 28 women) received Diet Approach to Stop Hypertension (DASH).

Inclusion Criteria:

Age range from 40-50 year old**,** BMI range from 35-39.9 kg/m², Blood pressure range from systolic blood pressure of 120–139mmHg and/or a diastolic blood pressure of 80–89mmHg and a signed consent form. Diabetes Mellitus, hypertension and patients with neurological, neuromuscular disorders were excluded from the study.

The Anthropometric Measures:

Weight and height and measurements of BMI= weight (kg) /height (m) square. The blood pressure was evaluated before the treatment and after 4 weeks of treatment. The auscultatory method of BP measurement with a properly calibrated and validated instrument was used. Measurements of BMI, systolic and diastolic blood pressure were measured pre treatment and after four weeks.

Treatment procedures:

Group A: Individuals in the study group received Diet Approach to Stop Hypertension (DASH) and aerobic exercises. Participants had supervised exercise sessions3 times per week at a level of 70% of maximal heart rate. The supervised exercise routine consisted of 10 minutes of warm-up exercises, 30 minutes of walking and 5 minutes of cool-down exercises ***(Blumenthal et al, 2010)***.

The predicted maximum heart rate (220- age) is determined for each subject participated in the aerobic exercise training. Heart rate measured by heart rate monitor related to the electronic treadmill. The session started with warming up for 10 minutes of low intensity of walking on treadmill then increasing intensity of exercise up to 70% of maximal heart rate for 30 minutes after that decreasing intensity for cooling down up to 5 minutes.

Exercise prescription

- Mode: Treadmill walking exercise.
- Duration: 45 minutes: -10 minutes of warming up.

- 30 minutes of walking exercise. -5 minutes of cooling down.

- Intensity: 70% of maximum heart rate.
- Frequency: same subject performed 3 sessions/ week.

Group B: Individuals in the control group received DASH only. Participants in the control group only received instruction in modifying the content of their diet to meet DASH guidelines. Participants in this group were explicitly asked not to exercise or to attempt to lose weight and to focus their attention only on what they eate. 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 ***(Blumenthal et al, 2010)***.

IV- Statistical Analysis:

The data were collected from the individuals and classified into pre and post test values. Data were statistically described in terms of mean ± standard deviation (±SD). Paired (t) test was used to compare the results pre and post treatment in the same group. Unpaired (t) test was used to compare results between the two groups.

3. Results

In this study, 80 patients with prehypertension from the out-patients clinic of the internal department from Desouk General Hospital were assigned into two groups: Group I included (40 patients; 16 men and 24women). The data in table (1) represented their mean age (44.4±2.96) years, mean weight (102.72±13.72) kilograms (Kg), mean height (166.0±10.56) centimeters (cm), and mean BMI (37.14±1.55) Kg/m². Group II included (40 patients; 12 men and 28 women). The data in table (1) represented their mean age (43.75±3.38) years, mean weight (101.4±10.58) kilograms (Kg), mean height (164.35±8.95) centimeters (cm), and mean BMI (37.48±1.49) Kg/m². There was no significant difference between both groups in their ages, weights, heights, and BMI where their t and P-values were (0.64, 0.52), (0.34, 0.73), (0.53, 0.59) and (0.69, 0.49) respectively.

Table (2) demonstrated the systolic blood pressure pre and post treatment for group (A). There was a significant difference in the paired t-test between pre and post treatment systolic blood pressure as the mean value of pre treatment systolic blood pressure was (131.1±5.96 mmHg) and for post treatment systolic blood pressure was (122.35±5.53 mmHg) where the t-value was (17.43) and P-value was (0.0001). The percentage of improvement was 6.67 %. Table (3) demonstrated the systolic blood pressure pre and post treatment for group (B). There was a significant difference in the paired t-test between pre and post treatment systolic blood pressure as the mean value of pre treatment systolic blood pressure was (131.2± 6.23 mmHg) and for post treatment systolic blood pressure was (127.35±6.87 mmHg) where the t-value was (10.35) and P-value was (0.0001). The percentage of improvement was 2.93. Table (4) revealed the independent t-test results for the systolic blood pressure pre and post treatment between groups A and B. There was no significant difference in pre treatment values where the t-value was (0.05) and p-value was (0.95).

Table (1): General characteristics of patients in both groups (A&B)

General characteristics	Group A		Group B		Comparison		S
	Mean	±SD	Mean	±SD	t-value	P-value	
Age (yrs)	44.4	±2.96	43.75	±3.38	**0.64**	**0.52**	**NS**
Weight (Kg)	102.72	±13.72	101.4	±10.58	**0.34**	**0.73**	**NS**
Height (cm)	166.0	±10.56	164.35	±8.95	**0.53**	**0.59**	**NS**
BMI (Kg/m^2)	37.14	±1.55	37.48	±1.49	**0.69**	**0.49**	**NS**

*SD: standard deviation, P: probability, S: significance, NS: non-significant

Table (2): Studied of systolic BP pre and post treatment of group (A)

Group A	Systolic blood pressure	
	Pre treatment	Post treatment
Mean ±SD	**131.1±5.96**	**122.35±5.53**
Mean difference	**8.75**	
Percentage of improvement	**6.67 %**	
t-value	**17.43(S)**	
P-value	**0.0001(S)**	

*SD: standard deviation, P: probability, S: significance, S: significant.

Table (3): Studied of systolic BP and post treatment of group (B)

Group B	Systolic blood pressure	
	Pre treatment	Post treatment
Mean ±SD	**131.2±6.23**	**127.35±6.87**
Mean difference	**3.85**	
Percentage of improvement	**2.93 %**	
t-value	**10.35(S)**	
P-value	**0.0001(S)**	

*SD: standard deviation, P: probability, S: significance, S: significant.

Table (4): Studied of groups A and B for systolic BP pre and post treatment

Independent t-test	Systolic blood pressure			
	Pre treatment		Post	
	Group (A)	Group (B)	Group (A)	Group (B)
Mean ±SD	**131.1±5.96**	**131.2±6.23**	**122.35±5.53**	**127.35±6.87**
Mean difference	**0.1**		**5.0**	
t-value	**0.05**		**2.53**	
P-value	**0.95(NS)**		**0.01(S)**	

*SD: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.

Table (5): Studied of diastolic BP pre and post treatment of group (A)

Group A	Diastolic blood pressure	
	Pre treatment	Post treatment
Mean ±SD	85.35±2.96	81.0±2.88
Mean difference	4.35	
Percentage of improvement	5.09 %	
t-value	23.93(S)	
P-value	0.0001(S)	

*SD: standard deviation, P: probability, S: significance, S: significant.

Table (6): Studied of diastolic BP pre and post treatment of group (B)

Group B	Diastolic blood pressure	
	Pre treatment	Post treatment
Mean	85.25±3.09	83.45±3.39
Mean difference	1.8	
Percentage of improvement	2.11 %	
t-value	8.46(S)	
P-value	0.0001(S)	

*SD: standard deviation, P: probability, S: significance, S: significant.

Table (7): Differences between groups A and B for diastolic BP pre and post treatment

Independent t-test	Diastolic blood pressure			
	Pre treatment		Post	
	Group (A)	Group (B)	Group (A)	Group (B)
Mean ±SD	85.35±2.96	85.25±3.09	81.0±2.88	83.45±2.88
Mean difference	0.1		2.45	
t-value	0.1(NS)		2.46(S)	
P-value	0.91(NS)		0.01(S)	

*SD: standard deviation, P: probability, S: significance, NS: non-significant, S: significant.

Table (5) demonstrated the diastolic blood pressure pre and post treatment for group (A). There was a significant difference in the paired t-test between pre and post treatment diastolic blood pressure as the mean value of pre treatment diastolic blood pressure was (85.35± 2.96 mmHg) and for post treatment diastolic blood pressure was (81.0±2.88 mmHg) where the t-value was (23.93) and P-value was (0.0001). The percentage of improvement was 5.09 %. Table (6) demonstrated the diastolic blood pressure pre and post treatment for group (B). There was a significant difference in the paired t-test between pre and post treatment diastolic blood pressure as the mean value of pre treatment diastolic blood pressure was (85.25± 3.09 mmHg) and for post treatment diastolic blood pressure was (83.45±3.39 mmHg) where the t-value was (8.46) and P-value was (0.0001). Table (7) revealed the independent t-test results for the diastolic blood pressure pre and post treatment between groups A and B. There was a significant difference in the post treatment values ($P<0.05$) where the t-value was (2.46) and p-value was (0.01).

4. Discussion

The present study was designed to study the effect of DASH (Dietary Approach to Stop Hypertension) and aerobic exercise at moderate intensity of 70% of maximal heart rate (45 minutes, 3 times weekly) on blood pressure measurement in prehypertensive subjects, with the hypothesis that There was no significant effect of diet (Dietary approach to Stop Hypertension DASH) and aerobic exercises on blood pressure in prehypertensive individuals.

The results of the present study showed a significant improvement in blood pressure measurement in the two groups. There was no significant difference in pre treatment values. But there was a significant difference in the post treatment values. In group (A) the percentage of improvement for post treatment systolic blood pressure was 6.67 %. While in group (B) the percentage of improvement for post treatment systolic blood pressure was 2.93 %.Whereas; in group (A) the percentage of improvement for post treatment diastolic blood pressure was 5.09 %. In group (B) the percentage of improvement for post treatment diastolic blood pressure was 2.11 %.

The significant improvement in blood pressure measurement in group B (control group receiving DASH) in the present study agreed with **Dohadwala et al., (2010)**, who confirmed the considerable interest in dietary and other nonpharmacologic approaches to improve blood pressure control by using the Dietary Approaches to Stop Hypertension (DASH) which

contained a low-fat diet rich in fruit and vegetables. Also, a substantial body of evidence strongly supports the concept that multiple dietary factors affect blood pressure. Well-established dietary modifications that increase potassium intake and consumption of dietary patterns based on the "DASH diet" have emerged as effective strategies that lower BP. Efforts to reduce BP in both nonhypertensive and hypertensive individuals are warranted. In nonhypertensive individuals, dietary changes can lower BP and prevent hypertension. Dietary changes serve as initial treatment before drug therapy **(Appel et al., 2006).**

The significant improvement in blood pressure measurement in group B (control group receiving DASH) in the present study agreed with **Damasceno et al., (2011)** who confirmed that The Dietary Approaches to Stop Hypertension (DASH) substantially reduces the levels of blood pressure.. The Dietary Approaches to Stop Hypertension (DASH) – a diet based on a high consumption of fruits, vegetables, fish and foods with low levels of fat, milk products, red meat, cholesterol and sugar substantially reduces the levels of blood pressure (BP), during the first eight weeks of compliance. Studies show that this reduction reaches 5.5 mmHg in systolic blood pressure (SBP) and 3.0 mm in diastolic blood pressure (DBP) during this period. In hypertensive individuals, this reduction is even more significant. Fruits and vegetables are rich in such nutrients as potassium, magnesium, fiber and antioxidants, which are related to the prevention of heart disease, especially arterial hypertension, cerebrovascular disease and dyslipidemia. In addition, they have low energy levels and therefore help in the prevention of obesity and, indirectly, in the prevention of non-transmissible chronic diseases such as type 2 diabetes and cancer.

The DASH dietary pattern is rich in potassium, magnesium, calcium, and fiber and was reduced in total fat, saturated fat, and cholesterol. Dietary supplementation of potassium can lower blood pressure in normal and some hypertensive patients. 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 -pump. In the case of skeletal muscle and brain, the increased flow sustains the augmented metabolic needs of the tissues ***(Haddy et al., 2006).***

The results of the present study were contradicted with that reported by **Fuchs. (2010)** who found low effectiveness of non-drug interventions in patients with hypertension and prehypertension. Randomized controlled trials with long follow-up have shown that the efficacy of dietary interventions is lost with time. Randomized clinical trials have shown that many nutritional and behavioral interventions are efficacious to reduce blood pressure; however, the effectiveness of such interventions is unsatisfactory. In a study weight, salt consumption and blood pressure returned to baseline values after 36 months of dietary recommendations. The DASH diet, which was highly efficacious in a strictly controlled trial, was only marginally efficacious in the DASH diet study. The efficacy of low-salt diets was negligible in trials that lasted more than 6 months. In a clinical context, only the recommendation to lose weight had a short-term effect on blood pressure the human nature seems to be playing against healthier behaviors. Two large clinical trials showed that the prevention of hypertension by drug treatment is feasible and well tolerated. In the TROPHY (Trial of Preventing Hypertension) study individuals with prehypertension were randomized to candesartan, 16 mg daily or placebo, beside recommendations to change lifestyle After 2 years, the incidence of hypertension was 66%. In the other study, individuals with prehypertension were randomized to ramipril 5 mg daily or placebo. The relative risk reduction for the incidence of hypertension was 34%.

Lamina. (2010) found that blood pressure measurement reduced with using aerobic exercises either in interval or continuous pattern. Participants in the interval group exercised on a bicycle ergometer at a moderate intensity of between 60% and 79% of their HR max reserve. The duration of the exercise session was 45 minutes in the first 2 weeks of training. This duration was then gradually increased to 60 minutes in the remaining part of the training. Exercise sessions 3 times per week were maintained throughout the 8-week period of training for the interval group. The continuous group; the starting workload was 100 kg /min (17 watts) to obtain the starting point of HR max 60%, which was increased in the first 2 weeks to 79% HR max and maintained throughout the remaining part of the training period. Findings from this study revealed a significant decrease in SBP and DBP in the experimental groups over placebo group.

Baster and Baster-Brooks, (2005), examined the relationship between exercise and hypertension explaining theories improving blood pressure. One 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.

Also, the study conducted by **Collier. (2008)** who studied the effect of 4 weeks of moderate intensity aerobic exercises (30 minutes at 65% of peak oxygen consumption) and moderate intensity resistance exercises(3 sets at 65% of an individual's 10 repetition maximum) exercise training 3 times per week. It was found that both aerobic and anaerobic exercises lowered resting SBP and DBP. The results suggested that anaerobic exercises is not the recommended strategy as a BP lowering treatment as it may increase arterial stiffness but suggested only as a complement to aerobic exercise as it reduces arterial stiffness.

Aerobic exercise has also been shown to markedly alter BP responses to dietary Na. 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 ***(Pescatello et al., 2004).***

The results of the current study came in support with the results stated by **Zhang and Li., (2011)** who reported that prehypertensive patients were not the usual candidates for antihypertensive drug therapy, and prehypertensive individuals should primarily be advised to modify their lifestyle to lower their blood pressure to normal to reduce the risk of developing hypertension. 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. In addition, accumulating intermittent bouts of physical activity, as short as 10 min, total 30min walk sessions may reduce systolic BP in prehypertension.

The significant improvement in blood pressure measurement seen in both groups (DASH and aerobic exercise &DASH) in the present study agreed with **Márquez -Celedonio et al., (2009*)*** who examined the effect of lifestyle modification (DASH and aerobic exercises) on cardiovascular risk in individuals with prehypertension, which is defined as a systolic blood pressure between 120 mm Hg and 139 mm Hg and a diastolic pressure between 80 mm Hg and 89 mm Hg. Following the DASH-type diet and also undertook 3-5 sessions per week for 6 months of aerobic physical exercise. Each session lasted 45 min. The results showed that the subjects who undertook lifestyle changes experienced a reduction in blood pressure, waist measurement and body weight, an improvement in their physical and aerobic condition. 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 with a low sodium diet or weight reduction or a DASH diet alone.

The significant improvement in blood pressure measurement in both groups in the present study agreed with **Hernandez and Anderson. (2012)** who explained different methods of management of prehypertension pharmacological and non pharmacological management methods. That prehypertensive individuals be firmly and unambiguously advised to practice lifestyle modifications in order to reduce their risk of developing hypertension. Diet and physical activity was the foundation of primary prevention in lowering an individual's risk for hypertension. 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.

The results of the present study (reduced blood pressure in prehypertensives) were agreed with **Hong et al., (2008)** who studied evidence suggesting that lifestyle modification may decrease blood pressure in adults as demonstrated by The Dietary Approaches to Stop Hypertension (DASH) trial, weight control and physical activity have a positive effect on blood pressure.

The significant improvement in blood pressure measurement in both groups in the present study agreed with **Blumenthal et al., (2010**) who examined the effects of the DASH diet alone and in combination with exercise and weight loss on blood pressure and cardiovascular biomarkers in men and women with high blood pressure. It was found that the addition of exercise and weight loss 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 determined at the time of the baseline treadmill test. 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 the study conducted for 4 months.

Conclusions:

The results of this study showed that using exercises in combination with DASH had a significant

effect on reduction of blood pressure in prehypertensive cases. That supported the aim of the study; that exercise and DASH are recommended in pre-hypertension line of treatment.

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