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A SYSTEMATIC REVIEW ON THE EFFECTIVENESS OF LIFESTYLE MODIFICATIONS IN THE MANAGEMENT OF HYPERTENSION

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ABSTRACT

Hypertension remains the greatest risk factor for stroke, coronary heart disease, heart failure, and kidney failure. This is one of the 10 leading risk factors influencing the global burden of disease, and is estimated to lead to over 7 million deaths each year, about 13% of the total deaths worldwide. Lifestyle modifications are critical components for preventing and treating hypertension. This study provides an updated and evidence-based systematic review of the effects of lifestyle modifications on the management of hypertension. The Medline, Academia, Google Scholar, Embase, PubMed, PMC, Cochrane Library, American College of Physicians (ACP), American Association of Clinical Endocrinologist (AACE) and International Journal of Hypertension (IJH) were searched for studies on hypertension and lifestyle modifications from year 2000 to present, and potentially relevant studies was identified. Nineteen of

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51,063 retrieved studies met the inclusion criteria. Overall, the studies found revealed significant decrease in the blood pressure as a result of lifestyle modifications. No predictable pattern on the change in the blood pressure readings because results vary in all lifestyle interventions, findings also revealed that lifestyle modifications result to decrease in blood pressure especially multiple interventions. It is therefore concluded that lifestyle modifications are effective in reducing the systolic and diastolic blood pressure.

INTRODUCTION

Hypertension is defined as a diastolic blood pressure of 90 mmHg or greater, or a systolic blood pressure of 140 mmHg or greater [1]. According to Krishnan (2019), high blood pressure is the greatest risk factor for cardiovascular disease. It remains an extraordinarily common and important risk factor for cardiovascular and renal diseases, including stroke, coronary heart disease, heart failure, and kidney failure [2].

This is one of the 10 leading risk factors influencing the global burden of disease, and is estimated to lead to over 7 million deaths each year, about 13% of the total deaths worldwide [1]. The Philippines has the highest death rate for hypertension in Southeast Asia. According to World Health Organization (2000), by 2020, annual deaths resulting from heart disease and stroke as a complication of uncontrolled hypertension could go as high as 20 million [2,3].

Moreover, hypertension is the number one leading cause of death in the Philippines. It is a major public health challenge because of its high prevalence and associated cardiovascular disease and premature death. Despite treatment advances and the availability of low-cost efficacious medicines, prevalence of hypertension continues to increase [3].

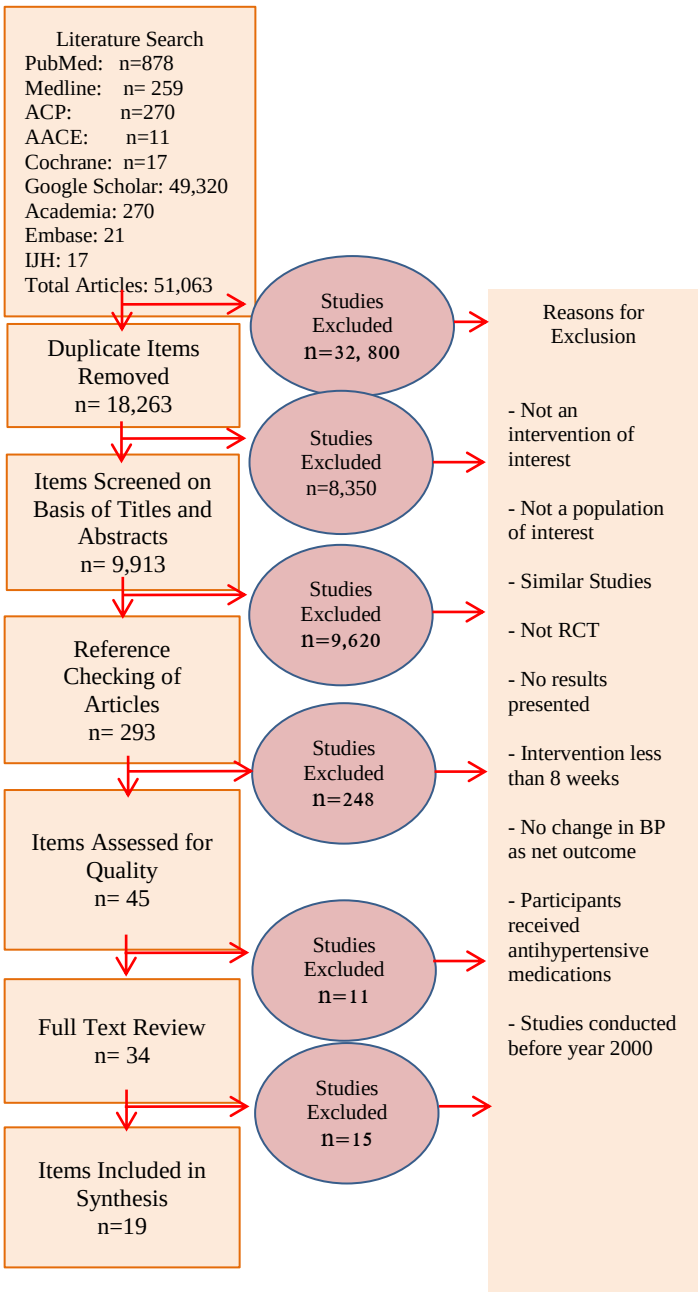
Lifestyle modifications are of proven efficacy in lowering blood pressure in unmedicated patients with hypertension and are often recommended as the first step for treating hypertension. It is a critical component for preventing and treating hypertension. Recommended lifestyle modifications include weight control, Dietary Approaches to Stop Hypertension (DASH) diet, reduction of sodium consumption, moderation of alcohol consumption, and regular exercise. Lifestyle modifications are effective in improving hypertension control [4].

A vast literature describes an apparent relationship between raised blood pressure and lifestyle choices and habits. However, it can be difficult to ascertain which specific factors have clinically important influences on blood pressure, as lifestyle factors are often interrelated. This study provides an updated and evidence-based systematic review of the effects of lifestyle modifications on the management of hypertension.

DATA SOURCES

The Medline, Academia, Google Scholar, Embase, PubMed, PMC, Cochrane Library, American College of Physicians (ACP), American Association of Clinical Endocrinologist (AACE) and International Journal of Hypertension (IJH) were searched for studies on hypertension and lifestyle modifications from year 2000 to present and potentially relevant studies was identified. The reference lists of retrieved studies were also examined for additional studies. Theoretical and purely descriptive studies including participants receiving antihypertensive medications were excluded in this review.

Figure 1. Evidence Search and Selection.



A study was eligible for inclusion if 1) it was a randomized controlled trial on the effectiveness of lifestyle modifications among hypertensive patients; 2) study participants were adults with hypertension defined as average systolic BP ≥ 140 mmHg, average diastolic BP ≥ 90 mmHg, 3) a main outcome was the net change in systolic BP or diastolic BP; and 4) the trial duration was at least eight weeks.

Nineteen of 51,063 retrieved studies met our inclusion criteria. As shown in the flow diagram (Figure 1), the initial literature search identified PubMed, Medline, ACP, AACE, IJH, Cochrane Library, Google Scholar, Academia and Embase as the sources of articles. From 51,053 total articles, 32,800 were initially excluded based on the criteria set. Duplicate items then removed, titles and abstracts were screened including references and quality of articles was examined that resulted to 19 studies for synthesis.

This systematic review included only randomized controlled trials studies, lifestyle modifications was used as an intervention on the management of hypertension, should have presented change in systolic or diastolic blood pressure after an intervention of not less than 8 weeks, participants must not receive antihypertensive medications which might affect blood pressure readings and studies must be conducted starting year 2000 up to present.

Most studies on lifestyle changes were excluded because participants were not randomly selected and assigned. Some studies also have no reports on the change in blood pressure presented or the intervention is less than 8 weeks. Furthermore, studies were excluded because they were not randomized controlled trials, and not the population and intervention of interest. Some studies were on lifestyle changes among patients with diabetes mellitus, arthritis, and other lifestyle related diseases.

DISCUSSION

This review allows us to answer the usefulness of lifestyle modifications in the management of hypertension. Overall, the studies found revealed significant changes in the blood pressure as a result of lifestyle modifications.

Role of Weight Control

Weight gain increases blood pressure, and weight loss appears to reduce it. Overweight is an increasingly prevalent condition throughout the world. Current estimates, which are probably conservative, indicate that at least 500 million people worldwide are overweight as defined by a body mass index (BMI) of between 25.0 and 29.9 and an additional 250 million are obese with a BMI of 30.0 or higher [5].

There is a positive association between overweight and blood pressure because overweight is a significant and independent predictor of the level of blood pressure. Numerous trials have shown that weight loss is an effective lifestyle intervention for lowering blood pressure in overweight and obese individuals [6, 7].

Upon literature review, 3 studies proved that weight control has a significant influence in the blood pressure. According the study conducted by Dickey & Janick (2001), 18 months of weight control interventions resulted to decrease in systolic blood pressure of 2.9 mmHg and 2.3 mmHg in the diastolic blood pressure [41]. Meanwhile, in the study conducted by Keyserling et al. (2016), weight loss maintenance interventions for 2 months resulted to change in mean systolic blood pressure of 6.4 mmHg and 3.7 mmHg in the diastolic blood pressure [24]. Lastly, the study of Brill (2011) to 810 participants randomly assigned to established lifestyle recommendations revealed that a 10-kg weight reduction resulted to decrease of 5-20 mmHg in systolic blood pressure [29].

Role of Dietary Modifications (DASH Diet)

Numerous dietary components have been identified as potentially impacting blood pressure. It was possible that some aspects of diet, when altered, were the true determinants of blood pressure reduction. Dietary Approaches to Stop Hypertension (DASH) diet clearly showed the benefits of eating pattern low in fat, high in fruit, vegetables, low-fat dairy products, whole-grain foods, lean meats, fish, poultry, nuts and low in sodium and sugar [8].

A DASH diet called for nine or more servings of fruits and vegetables daily, two or more servings of dairy products and lower fat consumption of hypertensive patients. This dietary pattern lowered blood pressure. In this systematic review, 7 studies tested the impact of DASH diet in the blood pressure [9].

In a study conducted by Dickenson et al (2006), after 8 weeks of interventions, diet resulted to decrease in mean systolic blood pressure of 6 mmHg and 4.8 mmHg in the diastolic blood pressure [35]. Svetkey, et al (2004) also tested DASH diet to 810 individuals, findings revealed that there is a mean decrease of 4.3 mmHg for systolic blood pressure and 2.6 mmHg diastolic [38]. Furthermore, Lien et al (2007) conducted an analysis on the impact of DASH diet as intervention in blood pressure control through a 6-month intensive lifestyle intervention .Findings revealed that there is a mean change in blood pressure of 8.4 mmHg systolic and 3.18 mmHg in the diastolic blood pressure [34].

Role of Sodium Consumption

The role of dietary salt in increasing blood pressure levels is now well-established. Salt (sodium chloride) saturates the food supply, with the average man consuming 10.4g of salt per day. This amount vastly exceeds the maximum daily amount of 2300 mg of sodium currently recommended. It should be noted that most of the sodium in our diet, approximately 80% comes from daily intake of processed and restaurant foods [10].

Decreasing sodium consumption would result in a decline of blood pressure. Restricting sodium intake in hypertensive patients over short periods of time reduced blood pressure. Randomized trials assessing the effect of salt reduction on blood pressure showed that the lower the salt intake, the lower the blood pressure reduction in individuals with high blood pressure. On the study conducted by Dickenson et al (2006), 8 weeks of sodium restriction resulted to decrease in systolic blood pressure of 4.7 mmHg and 2.5 mmHg in the diastolic blood pressure [35]. Meanwhile, Dickey and Janick (2001) stated that low sodium intake resulted to mean change in systolic blood pressure of 3.7 mmHg and 2.0 mmHg diastolic pressure [41].

Role of Alcohol Consumption

Drinking too much alcohol could raise blood pressure to unhealthy levels. One of the major contributors to high blood pressure was the consistent consumption of alcohol. Regular alcohol drinkers increased the risks of elevated blood pressure because it affected the normal functioning of the body by reversing what it needed to remain healthy. Although hypertensive patients were taking blood pressure medications, the alcohol had a tendency to alter the effectiveness of the medications. Alcohol has a consistent and independent effect on systolic and diastolic blood pressure. Studies have shown that it was much more difficult to control blood pressure if a person drank heavily. A reduction in alcohol consumption could help lower blood pressure. Even modest alcohol consumption could cause blood pressure to increase [11].

Three studies were conducted to determine the change in blood pressure if alcohol intake is reduced. According to recent study conducted by Dickenson et al (2006), reduced alcohol consumption resulted to decrease of 3.8 mmHg in systolic blood pressure and 3.2 mmHg in diastolic blood pressure [35]. Additionally, Dickey and Janick (2001) on a study conducted to determine the roles of obesity and overweight, nutritional factors, alcohol and physical activity in the prevention and treatment of hypertension found out that there is a decrease of 1.0 mmHg in systolic and 0.5 mmHg in diastolic blood pressure if alcohol consumption is reduced [41]. Lastly, Viera, et al (2008) in a 2007 study of 1245 hypertensive patients 45 years and older found out that there is a change in systolic pressure of 5.0 mmHg while 2.5 mmHg in diastolic blood pressure [33].

Role of Exercise Pattern

Physical activity is associated with decrease in blood pressure level [12]. Developing a routine of regular exercise can have variety of beneficial long-term effects on blood pressure. According to Texas Heart Institute, exercise improved and regulated blood pressure in several different ways, such as increased cardiac output, lower heart rate, improved fluid regulation, increased capillary formation, and improved body composition. For some people, regular exercise could reduce the need for blood pressure medications [13]

Additionally, many investigators have reported that exercise had antihypertensive effects. According to Hypertension Journal, 2005, nitric oxide which might be increased by exercise has been reported to play a crucial role in preserving vessel homeostasis both by regulating vascular tone, and by exerting anti-atherosclerotic effects. On the result of the study of Ohta, Nanri, Matsushima, Sato & Ikeda (2005), it was revealed that exercise had a blood pressure lowering effect.

Furthermore, physically active individuals had a lower risk of hypertension compared with their sedentary counterparts. Importantly, the risk of hypertension associated with weight gain also appeared to be lower in physically active individuals. As such, regular physical activity was recommended for individuals with elevated blood pressure [14].

In this systematic review, eight (8) studies were conducted to determine the impact of exercise in the blood pressure. Robbins et al (2011) on the randomized controlled trials conducted to women of reproductive stage revealed that exercise reduced mean systolic blood pressure of 12.4 mmHg and 2.6 mmHg diastolic [30]. Brill (2011) on the other hand found out that exercise reduced 6.9 mmHg in systolic blood pressure and 4.9 mmHg in diastolic blood pressure [29]. Additionally, Stewart (2015) in 6-month randomized controlled trials of aerobic training of participants with untreated hypertension revealed that regular exercise reduced 5.3 mmHg in systolic blood pressure and 3.7 mmHg in diastolic blood pressure [27]. Viera, et al (2008) in their study to individuals 45 years old and above revealed that there is a change of 5.0 mmHg in systolic and 4.0 in diastolic blood pressure [33]. Dickenson et al (2006) in the 8 weeks randomized controlled trials revealed that there is a reduction of the mean systolic blood pressure to 6.0 mmHg and 3.0 mmHg diastolic [35]. Moreover, Elley, Kerse, Arroll, & Robinson (2003) in their study conducted in New Zealand revealed that exercise

reduced 2.58 mmHg in the mean systolic blood pressure and 2.62 mmHg in the diastolic [39].

Multiple Lifestyle Modifications

Multiple factors influence blood pressure. The effects of each factor are typically modest, yet the combined effects can be substantial. Several studies were conducted to examine the effects of multiple lifestyle modifications on the blood pressure.

Various studies revealed that multiple lifestyle modifications reduced the systolic and diastolic blood pressure. In a study conducted by Goldberg et al (2014) in a 6-week culturally adapted behavioral lifestyle interventions resulted to decrease of 10.4 mmHg in systolic blood pressure and 9.0 mmHg in the diastolic blood pressure [28]. A study of Dusek (2008) in an 8-week RCT reduced 5.2 mmHg in systolic blood pressure and 7.1 mmHg in diastolic [32]. Moreover, the study of Marquez (2009) in Mexico found out that combined lifestyle modifications resulted to decreased of 4.84 mmHg systolic and 2.84 mmHg in the diastolic blood pressure [31] while Blumenthal, et al (2015) revealed that 5.4 mmHg reduction in the mean systolic blood pressure and 6.3 mmHg in the diastolic in their study on the efficacy of center-based lifestyle interventions [25]. Furthermore, Hasandokht, et al (2015) in their study in Iran to 161 women revealed that multiple lifestyle modifications reduced 13.2 mmHg in the mean systolic blood pressure and 9.8 mmHg in the diastolic blood pressure after 6 months of lifestyle modifications [26]. Furthermore, , a randomized controlled trials conducted by Matilla et al (2003) to 731 hypertensives resulted to 2.1 mmHg reduction in systolic and 1.6 mmHg in the diastolic blood pressure [40]. Krishnan et al (2019) in a community-based management of hypertension in Nepal reported reduction of 6.6 mmHg in the systolic blood pressure [23]. Lastly, Goldberg, et al (2014) in culturally adapted behavioral interventions revealed reduction of 10.4 mmHg in the systolic and 9.0 in the diastolic blood pressure [28].

CONCLUSION

Individual and multiple lifestyle modifications reduce blood pressure but there is no predictable pattern of change in the readings because results vary in all lifestyle interventions. It is therefore concluded that lifestyle modifications are effective in reducing the systolic and diastolic blood pressure.

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Table 1. Studies Conducted on the Effectiveness of Lifestyle Modifications in the Management of Hypertension.

Author	Study Description	Intervention	Findings
Krishnan et al [23] (2019)	The community-based management of hypertension in Nepal (COBIN) conducted in a 12-month management program of blood pressure monitoring and lifestyle interventions.	Multiple Lifestyle Modifications	Mean Change in BP Systolic: -6.6 mmHg
Keyserling, et al [24] (2016)	The intervention, given in eastern North Carolina, was evaluated in a 2-year prospective cohort study with an embedded randomized controlled trial (RCT) of a weight loss maintenance intervention 12 months.	Weight Reduction	Mean Change in BP Systolic: -6.4 mmHg Diastolic:-3.7 mmHg
Blumenthal, et al[25] (2015)	A randomized clinical trial was conducted to evaluate the efficacy of a center-based lifestyle intervention consisting of exercise training, reduced sodium and calorie DASH eating plan, and weight management in a 4-month supervised lifestyle intervention.	Combined Lifestyle Modifications	Mean Change in BP Systolic: - 5.4 mmHg Diastolic: - 6.3 mmHg
Hasandokht,et al [26]	The object of this	Combined Lifestyle	Mean Change in BP

Author	Study Description	Intervention	Findings
(2015)	study was to assess the effectiveness of a multicomponent lifestyle intervention on high blood pressure (BP) of Iranian women. This randomized controlled trial was conducted in four health centers by recruiting 161 women aged 35-65 years with high BP and randomizing them to a 4-week lifestyle modification (n = 80) or control group (n = 81). BP level and other health behavioral factors were assessed before and after the 4-week intervention and also after 6 months.	Modifications	(4 weeks) Systolic: - 5.6 mmHg Diastolic:-4.07 mmHg Mean Change in BP (6 months) Systolic: - 13.2 mmHg Diastolic:-9.8 mmHg
Stewart [27] (2015)	A 6-month randomized controlled trial of aerobic training of participants (aged 55-75 years) with untreated systolic BP (SBP) of 130 to 159 mm Hg or diastolic BP (DBP) of 85 to 99 mm Hg.	Exercise	Mean Change in BP Systolic: -5.3 mmHg Diastolic:-3.7 mmHg
Goldberg,et al[28] (2014)	The culturally adapted behavioral interventions consisted of six-week group sessions incorporating motivational interviewing techniques. Goals included weight loss if overweight, adoption of the Dietary Approaches to Stop Hypertension dietary pattern, and increased physical	Multiple Lifestyle Modifications	Mean Change in BP Systolic: -10.4 mmHg Diastolic:- 9.0 mmHg

Author	Study Description	Intervention	Findings
	activity. Participants were also encouraged to monitor their daily intake of fruits, vegetables, dairy and fat, and to record physical activity.		
Brill (2011) [29]	Participants (810 men and women) were randomly assigned to 1 of 2 groups: (1) a composite of established lifestyle recommendations (weight loss, sodium restriction, exercise, and moderation of alcohol consumption), (2) DASH diet plus established lifestyle recommendations, and an "advice-only" comparison group consisting of diet and lifestyle advice given in a single 30-minute sessions for 6 months.	Weight Reduction Alcohol Consumption Exercise	Mean Change in BP Systolic: -5-20 mmHg per 10kg Weight Loss Mean Change in BP Systolic: -3.1 mmHg Diastolic: 2.04 Mean Change in BP Systolic: -6.9 mmHg Diastolic:- 4.9 mmHg
Robbins et al [30] (2011)	A randomized controlled trial on the impact of lifestyle interventions on cardiovascular disease risk factors in women of reproductive age was conducted.	Diet Exercise	Mean Change in BP Systolic: None Diastolic:- 4.4 mmHg Mean Change in BP Systolic: -12.4 mmHg Diastolic:-2.6 mmHg
Marquez [31] (2009)	This study was conducted involving hypertensive individuals who agreed to make lifestyle changes, and a second group of subjects who received standard management at primary health care clinics in Mexico. Thirty eight completed the study in the treatment	Combined Lifestyle Modifications	Mean Change in BP Systolic: -4.86 mmHg Diastolic: - 2.84 mmHg

Author	Study Description	Intervention	Findings
	group, as did 43 in the control group.		
Dusek (2008) [32]	An 8-week randomized controlled trial study was conducted comparing stress management versus lifestyle modification in the management of hypertension.	Combined Lifestyle Modifications	Mean Change in BP Systolic: -5.2 mmHg Diastolic: - 7.1 mmHg
Viera, Kshirsagar, & Hinderliter [33] (2008)	A 2007 study of 1245 hypertensive individuals 45 years and older conducted for the Hypertension Education Foundation (HEF).	Exercise Alcohol Weight Control DASH Diet	Mean Change in BP Systolic: -5.0 mmHg Diastolic: - 4.0 mmHg Mean Change in BP Systolic: -5.0 mmHg Diastolic: - 2.5 mmHg Mean Change in BP Systolic: -3.0 mmHg Diastolic: - 3.0 mmHg Mean Change in BP Systolic: -11..0 mmHg Diastolic: - 5.5 mmHg
Lien et al [34] (2007)	An analysis was done to assess the interventions' impact of DASH diet in blood pressure through 6-month intensive lifestyle interventions.	DASH Diet	Mean Change in BP Systolic: - 8.4 mmHg Diastolic:-3.18 mmHg
Dickinson et al [35] (2006)	Randomized Controlled Trials with at least 8 weeks' follow-up was conducted comparing lifestyle with control interventions. Primary outcome measures were systolic and diastolic blood pressure changes.	Diet Exercise Alcohol	Mean Change in BP Systolic: -6.0 mmHg Diastolic: -4.8 mmHg Mean Change in BP Systolic: -6.1 mmHg Diastolic: -3.0 mmHg

Author	Study Description	Intervention	Findings
		Sodium Restriction	Mean Change in BP Systolic: -3.8 mmHg Diastolic: -3.2 mmHg Mean Change in BP Systolic: -4.7 mmHg Diastolic: - 2.5 mmHg
Kastarinen et al[36] (2006)	A study was conducted in Finland where 341 subjects (48% male in intervention group and 46% male in control group) aged 25-74 y with primary hypertension was recruited in primary care. Mean age was 54.4 y (SD 10.1 y) in the intervention group and 54.2 y (SD 9.9 y) in the control group.		Mean Change in BP Systolic: -2.0 mmHg Diastolic:-2.4 mmHg
McGuire, et al[37] (2004)	The PREMIER trial assessed the aggregate effect on blood pressure (BP) of nationally recommended lifestyle modifications in free-living adults with high-normal (stage 1) hypertension. Participants (N=810) were randomized to the advice-only group; the established group (consisting of weight loss, increased physical activity, and reduced sodium and alcohol intake); or the established plus Dietary Approaches to Stop Hypertension (DASH) diet group	DASH Diet	Mean Change in BP Systolic: -11..1 mmHg Diastolic: - 6.4 mmHg

Author	Study Description	Intervention	Findings
	(consisting of the established interventions in addition to the DASH dietary pattern). The primary outcome was change in systolic BP at 6 months.		
McGuire, et al[37] (2004)	The PREMIER trial assessed the aggregate effect on blood pressure (BP) of nationally recommended lifestyle modifications in free-living adults with high-normal (stage 1) hypertension. Participants (N=810) were randomized to the advice-only group; the established group (consisting of weight loss, increased physical activity, and reduced sodium and alcohol intake); or the established plus Dietary Approaches to Stop Hypertension (DASH) diet group (consisting of the established interventions in addition to the DASH dietary pattern). The primary outcome was change in systolic BP at 6 months.	DASH Diet	Mean Change in BP Systolic: -11..1 mmHg Diastolic: - 6.4 mmHg
Svetkey,et al [38] (2004)	A randomized trial tested the Dietary Approaches to Stop Hypertension (DASH) dietary pattern in reducing the blood pressure. The study population was 810 individuals with an average age of 50	Diet	Mean Change in BP Systolic: -4.3 mmHg Diastolic: -2.6 mmHg

Author	Study Description	Intervention	Findings
	years, 62% women, 34% African American, 95% overweight/obese, and 38% hypertensive. Blood pressure at 6 months was evaluated.		
Elley, C. [39] (2003)	Cluster randomized controlled trial study was conducted to all sedentary 40-79 year old patients in New Zealand visiting their general practitioner. General practitioners give oral and written advice on physical activity during usual consultations during a 12-month period. Exercise specialists continued support by telephone and post.	Exercise	Mean Change in BP Systolic: - 2.58 mmHg Diastolic: -2.62 mmHg
Matilla,et al [40] (2003)	A total of 731 hypertensives from 45 worksites were randomized to lifestyle intervention in a rehabilitation center or to usual care in an occupational or primary health-care center for 12 months.	Multiple Lifestyle Modifications	Mean Change in BP Systolic: -2.1 mmHg Diastolic:-1.6 mmHg
Dickey and Janick [41] (2001)	A study was conducted to determine the roles of obesity and overweight, nutritional factors, alcohol and physical activity in the prevention and treatment of hypertension.	Weight Control	Mean Change in BP Systolic: -2.9 mmHg Diastolic: - 2.3 mmHg
		Low Sodium Intake	
		Alcohol Consumption	Mean Change in BP Systolic: -3.7 mmHg Diastolic: - 2.0 mmHg
	.		Mean Change in BP Systolic: -1.0 mmHg

Author	Study Description	Intervention	Findings
			Diastolic: - 0.5 mmHg