Blood Pressure
Beneficial Roles of Citrus
Executive Summary

Filomena Valim and Sandy Barros

1- Definitions:

Cardiovascular disease (CVD) is a family of diseases affecting the heart or the arterial vascular system of the body. The most common CVDs are coronary heart disease (CHD), stroke, and peripheral arterial disease (PAD)[1]. CHD is the leading cause of death in the US, for which high blood pressure (HBP), smoking, abnormal blood lipid levels, obesity and diabetes are risk factors.

Blood pressure is the force of blood against artery walls. It is measured in millimeters of mercury (mm Hg) and recorded as two numbers: systolic pressure (as the heart contracts) over diastolic pressure (as the heart relaxes between beats). High blood pressure (hypertension) is defined as chronically elevated high blood pressure, with systolic blood pressure (SBP) of 140 mm Hg or greater, and diastolic blood pressure (DBP) of 90 mm Hg or greater. Hypertension can be categorized into 3 types: essential hypertension, secondary hypertension and isolated systolic hypertension.

2- Lifestyle modifications:

Lifestyle modifications such as engaging in regular physical activity, quitting smoking and eating a healthy diet (limiting intake of saturated fat and sodium and increasing consumption of fiber, fruits and vegetables) are advocated for the prevention, treatment, and control of HBP.

2.1- Sodium:

Is the main body ion and its concentration determines the osmotic pressure of our fluids and ultimately blood pressure.

- ✓ Very strong evidence of a causal link between **high salt intake and high blood pressure.**
- ✓ Chronic exposure to a high-salt diet appears to be a major factor involved in the frequent occurrence of hypertension and cardiovascular diseases in human populations.

Florida citrus juices should be included in any low sodium diet as they are sodium free, nutrient dense and a fat-free food.

2.2- Potassium:

Potassium is an important ion in the living cell, affecting almost every cellular function.

- ✓ Cellular ions concentrations are controlled by pumps, which very often cannot allow an ion in if they don't excrete another, called the counter ion. Potassium is the sodium counter ion.

Most American women 31 to 50 years old consume no more than half of the recommended amount of potassium, and men's intake is only moderately higher.

African Americans and Hispanics in the United States generally get less potassium than whites.

[1] PAD: This refers to diseases of blood vessels outside the heart and brain. It is often a narrowing of vessels that carry blood to the legs, arms, stomach or kidneys.

- 2005 Dietary Guidelines for Americans: a potassium-rich diet blunts the effects of sodium on blood pressure, may reduce the risk of developing kidney stones **(an area for additional research)**, and possibly decreases bone loss with age stones **(an area for additional research)**.

The inclusion of orange juice in the diet can help meet recommended levels of potassium intake may contribute to lower BP.

2.3- Folate:

Folate has important beneficial effects on endothelial function and may have beneficial effects on blood pressure.

- Cohort of older women: higher total folate consumption was also associated with a decreased risk of incident hypertension.
- **The US recommended daily allowance for folate is 400 mg**
- Folate plays a key role in homocysteine metabolism.
- Attention has been focused on the direct relationship of plasma homocysteine to blood pressure and hypertension: suggestion that the adverse risk associated with **hyperhomocysteinemia** (high concentration of homocysteine in the plasma) might be mediated in part by the positive association of homocysteine with hypertension.
- In the third National Health and Nutrition Examination Survey (NHANES III), persons in the highest quintile of plasma homocysteine had a 2- to 3-fold increased prevalence of hypertension relative to those in the lowest quintile.

An 8 oz glass of Florida orange juice provides approximately 15% of the Daily Reference Values.

2.4- Magnesium:

- Is an essential element that plays a critical role in cardiac and vascular smooth muscle function.
- May be important in the physiological regulation of blood pressure.
- Although most epidemiological and experimental studies support a pathological role for magnesium in the etiology and development of hypertension, data from clinical studies have been less convincing.

An 8 oz glass of orange juice provides approximately 6% of the Daily Reference Value for magnesium, based on the reference caloric intake of 2,000 calories

2.5- DASH trial:

- The Dietary Approaches to Stop Hypertension (DASH) Trial was designed to assess the relation between diet and hypertension.
- Outpatient controlled feeding study: 459 adults. 27 % had hypertension, 50 % women and 60 % African Americans.
- Study: 11 weeks (all food and beverages in prepared meals and snacks)
- All diets contained the same amount of sodium (3,000 mg/day), and participants were allowed 500 mg of discretionary sodium. Weight was intentionally held constant.
- Trial consisted of three diets: (a)control diet: low in fruits, vegetables, and dairy products, with a fat content typical of the average diet in the United States; (b)combination diet: a diet rich in fruits and vegetables; (c)DASH diet: rich in fruits, vegetables, low-fat dairy products, whole grains, poultry, fish, and nuts and low in fats, red meat, sweets, and sugar-containing beverages.

- The DASH diet reduced systolic blood pressure by 5.5 mm Hg and diastolic blood pressure by 3.0 mm Hg more, than the control diet.
- The fruits-and-vegetables diet reduced systolic blood pressure by 2.8 mm Hg and diastolic blood pressure by 1.1 mm Hg more than the control diet.
- DASH trial findings showed that diet offers an additional nutritional approach to preventing and treating hypertension.

The DASH eating plan recommends drinking 6 oz of orange juice at breakfast.

3- Conclusions:

- Nutrition plays a very important role in influencing blood pressure.
- As multiple factors influence BP, the effects of each factor are typically modest, particularly in normotensive subjects, yet the combined effects can be substantial.
- Florida citrus juices are sodium and fat free foods.
- Florida Citrus juices are a good source of potassium, another important factor in controlling high blood pressure.
- The 2005 Dietary Guidelines for Americans states that the inclusion of orange juice in the diet can help meet recommended levels of potassium intake.
- These facts suggest that Florida citrus juices should be included as part of any low sodium diet and/or any blood pressure reducing eating plan.

For a more detailed and referenced review of this topic, please continued reading below

Blood Pressure
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Literature Review
Filomena Valim and Sandy Barros

1- INTRODUCTION

Cardiovascular disease (CVD) is a family of diseases affecting the heart or the arterial vascular system of the body. The most common CVDs are coronary heart disease (CHD), stroke, and peripheral arterial disease (PAD)[1]. CHD is the leading cause of death in the US, for which high blood pressure (HBP), smoking, abnormal blood lipid levels, obesity and diabetes are risk factors (Gerstenblith & Margolis**,** 2005). High blood pressure is a modifiable risk factor for CHD that affects more than 50 million people in the United States. Although HPB is the most common reason for outpatient visits, its control is often inadequate (Bacon et al, 2004).

Blood pressure is the force of blood against artery walls. It is measured in millimeters of mercury (mm Hg) and recorded as two numbers: systolic pressure (as the heart contracts) over diastolic pressure (as the heart relaxes between beats). High blood pressure (hypertension) is defined as chronically elevated high blood pressure, with systolic blood pressure (SBP) of 140 mm Hg or greater, and diastolic blood pressure (DBP) of 90 mm Hg or greater (NHLBI[2], 2003).

Hypertension can be categorized into 3 types:

Essential hypertension. It is also known as primary hypertension. The causes of essential hypertension are unknown but are certainly based on complex processes in all major organs and systems, including heart, blood vessels, nerves, hormones, and the kidneys. About 90% of all high blood pressure cases are of this type.

Secondary hypertension. The cause of secondary hypertension has been identified as mostly due to kidney problems. It comprises about 5% of high blood pressure cases.

[1] PAD: This refers to diseases of blood vessels outside the heart and brain. It is often a narrowing of vessels that carry blood to the legs, arms, stomach or kidneys.
[2] NHLBI: National Heart, Lung and Blood Institute.

Isolated systolic hypertension. This occurs when systolic blood pressure is over 140 mm Hg, but diastolic blood pressure is normal. It is related to arteriosclerosis.

The causes of essential or primary hypertension are complex and a combination of genetic, environmental, and other factors. A number of genetic factors or interactions between genes play a major role in essential hypertension. Among the genes under study are those that regulate a group of hormones known as the angiotensin-renin-aldosterone system. When blood pressure falls (for systolic, to 100 mm Hg or lower), the kidneys release the enzyme renin into the bloodstream. Renin splits angiotensinogen, a large protein that circulates in the bloodstream, into pieces. One piece is angiotensin I, which is further split into pieces by the angiotensin-converting enzyme (ACE) into angiotensin II. Angiotensin II, a hormone, causes the muscular walls of small arteries (arterioles) to constrict, increasing blood pressure. Angiotensin II also triggers the release of the hormone aldosterone from the adrenal glands and generates oxidants. Aldosterone causes the kidneys to retain salt (sodium) and excrete potassium. The sodium causes water to be retained, thus increasing blood volume and blood pressure. All those events are shown in Figure 1.

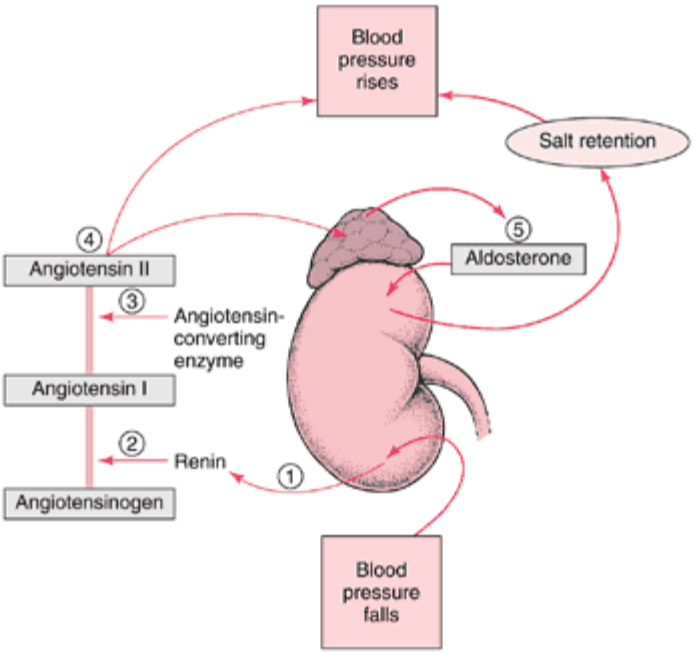

Figure 1 – Angiotensin cycle and blood pressure control

(From: http://www.merck.com/mmhe/sec03/ch022/ch022a.html)

The morbidity and mortality associated with hypertension are substantial, with prospective observational studies estimating that an increase of 5-6 mm Hg in DBP predicts a 35-40% increased risk of stroke and a 20-25% increased risk of CHD (Bacon et al, 2004).

It has been estimated that a 5 mm Hg reduction of SBP in the population would result in a 14% overall reduction in mortality due to stroke, a 9% reduction in mortality due to CHD, and a 7% decrease in all-cause mortality (Whelton et al, 2002).

Strokes occur in a large number of people, whose blood pressure levels are in the high normal range, outside the current classification criteria for hypertension (Nowson, 2003). According to the American Heart Association's Heart Disease and Stroke Statistics – 2005 Update (American Heart Association, 2005), about 700,000 Americans will have a stroke this year. Stroke is the nation's number 3 killer and a leading cause of severe, long-term disability. Strokes account for 17% of cardiovascular disease.

2- REPORT

2.1- Lifestyle and High Blood Pressure:

Lifestyle modifications such as engaging in regular physical activity, quitting smoking and eating a healthy diet (limiting intake of saturated fat and sodium and increasing consumption of fiber, fruits and vegetables) are advocated for the prevention, treatment, and control of HBP (Gerstenblith & Margolis, 2005).

Reducing the prevalence rates of the major risk factors of heart disease (high blood pressure, lack of physical activity, poor nutrition, obesity, tobacco use, and high blood cholesterol) could eliminate much of its burden. Modest reductions in the rates of one or more of these risk factors can have a large public health impact (Centers for Disease Control and Prevention (CDC), 2004).

2.1.1- Exercise:

Exercise programs that primarily involve endurance activities prevent the development of HBP and lower blood pressure (BP) in adults with normal BP and those with HBP. The BP lowering effects of exercise are most pronounced in people with HBP who engage in endurance exercise. Their BP decreases approximately 5–7 mm Hg after an isolated exercise session (acute) or following exercise training (chronic). Moreover, BP is reduced for up to 22 h after an endurance exercise bout (e.g., postexercise hypotension), with the greatest decreases among those with the highest baseline BP (Pescatello et al, 2004)

There is evidence to suggest that these decreases in BP are associated with improvements in left ventricular structure and function, and peripheral vascular health. Both exercise training and weight loss have been shown to decrease left ventricular mass and wall thickness, reduce arterial stiffness and improve endothelial function[3]. These evidences support the role of behavioral interventions in the treatment of patients with elevations in BP (Bacon et al, 2004).

[3] Endothelial function includes the ability of the inner layer of blood vessels to widen when more blood flow is needed.

2.1.2- Dietary approaches to Blood Pressure Reduction:

A recent review of behavioral interventions in the treatment of hypertension, including studies of dietary factors such as: sodium restriction, potassium, magnesium, calcium supplementation and alcohol restriction, concluded that a healthy eating pattern was the optimal dietary approach to blood pressure reduction (Bacon et al, 2004). The effects of some minerals, vitamins and dietary approaches like the DASH (Dietary Approach to Stop Hypertension) diet will be discussed:

– Sodium

Evidence for a relationship between sodium intake and blood pressure has accumulated over the last few years (Bourel & Ardaillou, 2004).

Sodium (Na^+) is the main body ion and its concentration determines the osmotic pressure of our fluids and ultimately blood pressure.

Epidemiological, migration, intervention, and genetic studies in humans and animals provide very strong evidence of a causal link between high salt intake and high blood pressure. The mechanisms by which dietary salt increases arterial pressure are not fully understood, but they seem related to the inability of the kidneys to excrete large amounts of salt. From an evolutionary viewpoint, the human species is adapted to ingest and excrete less than 1 g of salt per day, at least 10 times less than the average values ingested in industrialized and urbanized countries. Independent of the rise in blood pressure, dietary salt also increases cardiac left ventricular mass, arterial thickness and stiffness, the incidence of strokes, and the severity of cardiac failure. Thus chronic exposure to a high-salt diet appears to be a major factor involved in the frequent occurrence of hypertension and cardiovascular diseases in human populations (Meneton et al, 2005).

An additional review has estimated that a 50 mmol[4]/day reduction in sodium intake, in people aged 50-59 years, was associated with a decrease in SBP of 7 mm Hg in hypertensive patients and 5 mm Hg in normotensive patients. In general, however, short-term trials of sodium restriction have been associated with average reductions of 4.9 and 2.6 mm Hg in SBP and DBP,

[4] mmol: millimolar (1/1,000 of a mol); 50 mmol of sodium = 1,150 mg of sodium.

respectively. It should be pointed out that the relationship between sodium and BP is influenced by individual differences in salt-sensitivity, where those people who are salt-resistant do not raise their BP when exposed to salt, but salt-sensitive individuals do exhibit an increase in BP (Bacon et al, 2004).

On average, the natural salt content of food accounts for only about 10 percent of total intake, while discretionary salt use (i.e., salt added at the table or while cooking) provides another 5 to 10 percent of total intake. Approximately 75 percent is derived from salt added by manufacturers. According to the 2005 Dietary Guidelines for Americans (USHHS[5], 2005), the consumption of sodium should be less than 2,300 mg (approximately 1 tablespoon of salt) per day. Individuals with hypertension, blacks, and middle-aged and older adults should consume no more than 1,500 mg of sodium per day. The greatest benefits of sodium reduction are seen in those who are salt-sensitive. **Florida citrus juices should be included in any low sodium diet as they are sodium free, nutrient dense and a fat-free food.**

– Potassium:

Potassium (K^+) is an important ion in the living cell, affecting almost every cellular function. Of the total body K^+ content (3,500 mmol), 90% is sequestered within cells. This compartmentalization depends on active transport through the cell membrane by a Na/K pump, which maintains an intracellular cation ratio of 1:10. Normal serum potassium levels are considered to lie roughly between 3.6 and 5.0 mmol/L (Cohn et al, 2000). As previously mentioned, sodium is the main body ion and its concentration determines the osmotic pressure of our fluids and ultimately blood pressure. Cellular ions concentrations are controlled by pumps, which very often cannot allow an ion in if they don't excrete another, called the counter ion (Figure 2). Potassium (K^+) is the sodium counter ion. The Na/K pump excretes 3 sodium ions for 2 potassium ions it takes in. It has been proposed that the proper ratio Na/K is more important than the absolute amount of sodium ingested.

[5]USHHS: United States Department of Health and Human Services.

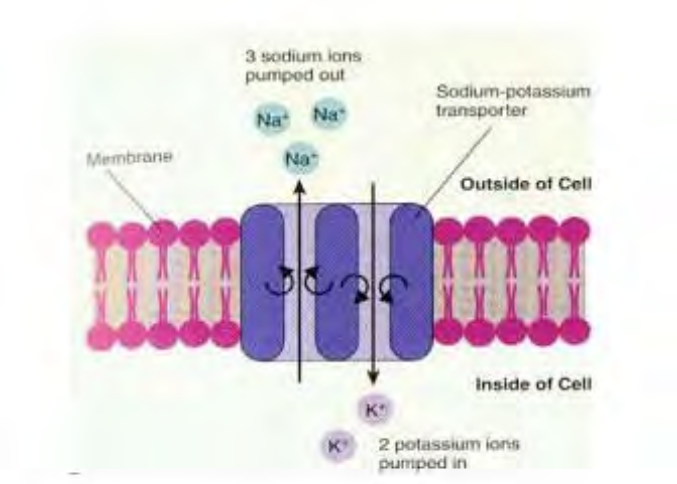

Figure 2 – Sodium/potassium pump

Evidence from epidemiological and clinical studies has implicated potassium depletion in the pathogenesis and maintenance of essential hypertension.

The large-scale Nurses' Health Study (n = 41,541) found that dietary potassium intake was inversely associated with blood pressure. Specifically, intake of potassium-rich fruits and vegetables was inversely related to blood pressure (Ascherio et al, 1996).

Similarly, 24-hour urinary potassium excretion, 24-hour urinary sodium excretion, and the ratio of urinary sodium to potassium were found to be independently related to blood pressure in the INTERSALT study. The International Study of Salt and Blood Pressure (INTERSALT) is a cross-sectional study designed to evaluate both within-population and cross-population hypotheses on the relationship between blood pressure and sodium excretion in >10,000 adults (aged 20 to 59 years) at 52 centers around the world (Elliot, 1988).

Geleijnse et al (1997) examined the association of urinary sodium and potassium excretion with blood pressure in the Rotterdam Study, a population-based study among 7983 men and women aged 55 and over. The analysis included 1006 subjects who did not use antihypertensive drugs and did not report themselves to be hypertensive. The association of electrolyte excretions with BP was studied in a multiple linear regression model with adjustment for age, sex, and body

mass index. When sodium and potassium were entered simultaneously into the multivariate model, a 3,900 mg (100 mmol) increase in potassium was associated with a 9.4 decrease in systolic and a 4.9 mm Hg decrease in diastolic BP. The findings suggest that an increased intake of potassium and a decreased intake of salt may lower BP.

According to Whelton et al (2002), clinical trials and meta-analysis (the systematic analysis of a set of existing evaluations of similar programs in order to draw general conclusions, develop support for hypotheses, and/or produce an estimate of overall program effects) indicate that potassium supplementation lowers blood pressure in both hypertensive and normotensive persons. A meta-analysis study found that on average, supplementation of diets with 2,340 to 4,700 mg (60 to 120 mmol) of potassium per day reduced systolic and diastolic blood pressure, respectively, by 4.4 and 2.5 mm Hg in hypertensive and by 1.8 and 1.0 mm Hg in normotensives. The effects of potassium supplementation appeared greater in those with higher levels of sodium intake.

Nowson et al (2003) examined the effect on blood pressure of altering dietary sodium in the context of a high potassium diet. They concluded that reducing sodium intake (from 140 to 60 mmol/d) significantly decreased SBP in subjects who consumed a self-selected potassium rich diet, and this dietary modification could assist in lowering blood pressure in the general population.

He et al (2005) reported that randomized trials have shown that increasing potassium intake lowers blood pressure. However, most previous trials used potassium chloride, whereas potassium in fruits and vegetables is not a chloride salt. The authors performed a randomized crossover trial comparing potassium chloride with potassium citrate (96 mmol/d, each for 1 week) in 14 hypertensive individuals. After both treatments, blood pressures were significantly lower than at baseline and there was no difference between potassium chloride and potassium citrate. These results support other evidence for an increase in potassium intake and indicate that increasing the consumption of foods high in potassium is likely to have the same effect on blood pressure as potassium chloride.

Other minerals, besides potassium, that have been assessed in relation to BP level are calcium and magnesium. A high dietary intake of potassium, magnesium, and calcium can be achieved from food sources. Due to the fact that diets rich in these minerals provide a variety of other nutrients, the preferred strategy for increasing mineral intake is through foods rather than supplements. One exception to this is in women, who may require supplemental calcium to meet guidelines for osteoporosis prevention or treatment (American Heart Association (AHA), 2005). Calcium fortified Florida orange juice can help meet the guidelines for osteoporosis prevention or treatment.

According to the 2005 Dietary Guidelines for Americans, a potassium-rich diet blunts the effects of sodium on blood pressure, may reduce the risk of developing kidney stones (an area for additional research), and possibly decreases bone loss with age. Metabolic studies have shown that potassium promotes calcium retention by the kidneys and thereby prevents loss through excretion. By improving calcium balance, potassium influences bone health (Borek, 2000).

The recommended intake of potassium for adolescents and adults is 4,700 mg/day. Recommended intakes for potassium for children 1 to 3 years of age is 3,000 mg/day, 4 to 8 years of age is 3,800 mg/day, and 9 to 13 years of age is 4,500 mg/day (USHHS, 2005).

According to the Report from the Panel on Dietary Reference Intakes for Electrolytes and Water, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the National Academies (National Academies Press, 2004), **most American women 31 to 50 years old consume no more than half of the recommended amount of potassium, and men's intake is only moderately higher.** In recent surveys the medium intake of potassium by adults in the United States was approximately 2,800 to 3,300 mg for men and 2,200 to 2,400 mg for women. Canadians typically eat more potassium than their American counterparts. **African Americans in the United States generally get less potassium than non-Hispanic whites**. In addition, a larger proportion of both nonhypertensive and hypertensive African Americans are NaCl sensitive compared with non-Hispanic whites. In response to acute NaCl loads, African Americans excrete sodium less efficiently than whites, and it has been estimated that >50% of hypertensive African Americans in the United States are NaCl sensitive. Therefore, due to the

fact that they have a higher prevalence of elevated blood pressure, increased potassium intake may have particularly significant benefits for them. Another concern is elderly individuals, particularly those living alone or those who are disabled and may not have a sufficient amount of fruits and vegetables in their diets to provide the necessary potassium.

Florida orange juice is a good source of potassium. An 8 oz glass provides approximately 13 % (450 mg/ 11.5 mmol) of the Daily Reference Value, 3,500 mg/day based on the reference caloric intake of 2,000 calories (Gebhardt & Thomas, 2002). The Daily Reference Values are FDA (Food and Drug Administration) product label requirements. **The 2005 Dietary Guidelines for Americans (USHHS, 2005) states that the inclusion of orange juice in the diet can help meet recommended levels of potassium intake.**

- Folate:

Folate has important beneficial effects on endothelial function and may have beneficial effects on blood pressure by increasing nitric oxide synthesis in the endothelial cells, and/or by reducing plasma homocysteine, which itself can cause endothelial cell injury (Forman et al, 2005). Folic acid (folate) is also required for nucleic acid synthesis.

Two small randomized trials have demonstrated that high dose folic acid supplementation may lower systolic and diastolic blood pressure.

In the first study (van Dijk et al, 2001), 130 participants were randomized to high-dose folic acid (5 mg/day) and pyridoxine (250 mg/day) or placebo intake. This was a 2-year, randomized, placebo/control trial. Significant decrements in systolic blood pressure (by 3.7 mm Hg) and diastolic blood pressure (by 1.9 mm Hg) were noted with supplementation but not with placebo. The participants in this trial were relatively young (mean age, 45 years) and only 12% had a history of hypertension at baseline. As pyridoxine (vitamin B_6) was co-administered to the treatment group, the effect seen could not be completely ascribed to folate intake and the authors concluded that a reduction in homocysteine accounted for the decrease in blood pressure.

In a second small randomized trial, of long-term smokers with endothelial dysfunction, Mangoni et al (2002) found that not only did endothelial function improve after treatment with folic acid but the mean systolic and diastolic blood pressure decreased significantly from 121 mm Hg and 71 mm Hg, respectively, to 113 mm Hg and 67 mm Hg. No change in blood pressure was noted in the placebo group. As in the previous trial, the participants were young (mean age, 38 years) and none had a history of hypertension at baseline.

Forman et al (2005) followed 93,803 younger women and 62,260 older women from the Nurse's Health Study for 8 years, to determine whether higher folate intake is associated with a lower risk of incident hypertension. Incident hypertension is defined as either a new physician diagnosis, the initiation of antihypertensive treatment, or self-reported systolic BP of at least 140 mm Hg or a diastolic BP of at least 90 mm Hg (http://www.thedoctorsdoctor.com). Compared with younger women whose total daily folate intake was less than 400 μg, those who consumed a 1,000 μg/day or more of folate had a significant 40% reduction in the risk of incident hypertension. In the cohort of older women, higher total folate consumption was also associated with a decreased risk of incident hypertension (approximately 13%). The US recommended daily allowance for folate is 400 μg (Forman et al, 2005).

As previously mentioned, folate plays a key role in homocysteine metabolism. Serum folate and RBC (red blood cell) folate concentrations are inversely associated with plasma total homocysteine concentrations (Tawakol et al, 2005; Kauwell et al, 2000).

Recently attention has been focused on the direct relationship of plasma homocysteine to blood pressure and hypertension because of the suggestion that the adverse risk associated with hyperhomocysteinemia might be mediated in part by the positive association of homocysteine with hypertension. In the third National Health and Nutrition Examination Survey (NHANES III), persons in the highest quintile of plasma homocysteine had a 2- to 3-fold increased prevalence of hypertension relative to those in the lowest quintile. These observations have been confirmed in other cross-sectional reports and in experimental studies. Additionally, a potential causal role for homocysteine in the pathogenesis of elevated blood pressure is raised by the demonstration that homocysteine-lowering treatment is associated with a reduction in systolic and diastolic blood pressures (Sundstrom et al, 2003; Lim & Cassano, 2002).

Mechanisms by which homocysteine could promote hypertension include increased arterial stiffness, impaired endothelial integrity, reduced vasodilatory capacity, and insulin resistance (Sundstrom et al, 2003).

Orange juice is a good source of folate and is one of the primary contributors of folate in the American diet (Tucker et al, 1996) and should be included in any high folate diet. **An 8 oz glass of Florida orange juice provides approximately 15% of the Daily Reference Values for folate based on the reference caloric intake of 2,000 calories (Gebhardt & Thomas, 2002).**

- Magnesium:

Magnesium is an essential element that plays a critical role in cardiac and vascular smooth muscle function.

Attention is growing for a potential role of magnesium in the pathoetiology of cardiovascular disease. Magnesium modulates mechanical, electrical and structural functions of cardiac and vascular cells, and small changes in extracellular magnesium levels and/or intracellular free magnesium concentration may have significant effects on cardiac excitability and on vascular tone, contractility and reactivity. Thus, magnesium may be important in the physiological regulation of blood pressure whereas changes in cellular magnesium metabolism could contribute to the pathogenesis of blood pressure elevation. Although most epidemiological and experimental studies support a pathological role for magnesium in the etiology and development of hypertension, data from clinical studies have been less convincing. Furthermore, the therapeutic value of magnesium in the management of essential hypertension is unclear (Laurant & Touyz, 2000).

An 8 oz glass of orange juice provides approximately 6% of the Daily Reference Value for magnesium, based on the reference caloric intake of 2,000 calories (Gebhardt & Thomas, 2002).

2.1.3 - DASH Trial:

The Dietary Approaches to Stop Hypertension (DASH) Trial was designed to assess the relation between diet and hypertension. The study aimed to increase the number of non-drug options for people who are at risk of hypertension. The DASH study was organized and sponsored by the National Heart, Lung, and Blood Institute (NHLBI) and conducted at four medical centers: Brigham and Women's Hospital, Boston, MA; Duke University Medical Center, Durham, NC; Johns Hopkins University, Baltimore, MD; Pennington Biomedical Research Center, Louisiana State University, Baton Rouge, LA (NHLBI, 2003).

DASH was an outpatient controlled feeding study, involving 459 adults with systolic blood pressures of less than 160 mm Hg and diastolic pressures of 80–95 mm Hg (prehypertension or stage 1 hypertension). None were taking antihypertensive medications. Nearly 27 percent of the participants had hypertension, 50 percent were women and 60 percent were African Americans. For three weeks, the subjects were fed a control diet that was low in fruits, vegetables, and dairy products, with a fat content typical of the average diet in the United States. They were then randomly assigned to receive the control diet for eight weeks, a diet rich in fruits and vegetables (combination diet) or the DASH diet, which is rich in fruits, vegetables, low-fat dairy products, whole grains, poultry, fish, and nuts and low in fats, red meat, sweets, and sugar-containing beverages. The DASH diet is high in calcium, magnesium, potassium, and fiber. It is low in total fat, particularly saturated fat and cholesterol (Karanja, 2004). The DASH diet includes the consumption of orange juice as part of breakfast and snacks.

Participants received all their food and beverages in prepared meals and snacks for the 11 weeks of the study. All three diets contained the same amount of sodium (3,000 mg/day), and participants were allowed 500 mg of discretionary sodium. Weight was intentionally held constant (Karanja, 2004).

The DASH diet reduced systolic blood pressure by 5.5 mm Hg and diastolic blood pressure by 3.0 mm Hg more, than the control diet. The fruits-and-vegetables diet reduced systolic blood pressure by 2.8 mm Hg and diastolic blood pressure by 1.1 mm Hg more than the control diet.

Reduction in systolic and diastolic blood pressure was higher among the subjects with hypertension than among subjects without hypertension (Appel et al, 1997).

DASH trial findings showed that diet offers an additional nutritional approach to preventing and treating hypertension. Using the USDA food composition databases, the polyphenol, carotenoid, and phytosterol contents of the diets used in the DASH study were estimated. The DASH diet is higher than the control diet in flavanols, flavanones, flavan-3-ols, beta-carotene, beta-cryptoxanthin, lycopene, lutein+zeaxanthin, and phytosterols. Flavone levels are similar, whereas isoflavones are present in a small amount in the DASH diet. The roles of these compounds in disease risk reduction are becoming recognized. It is possible that the health benefits of the DASH diet are partially attributable to the phytochemicals and might extend beyond cardiovascular disease risk reduction (Most, 2004). Orange juice is an excellent food source to enhance circulating concentrations of valuable hydrophilic as well as lipophilic phytochemicals (Franke et al, 2005).

The DASH eating plan recommends drinking 6 oz of orange juice at breakfast or snacks on various days (**NHLBI, 2003**).

3- CONCLUSIONS:

Based on the review of the literature, nutrition plays a very important role in influencing blood pressure. As multiple factors influence BP, the effects of each factor are typically modest, particularly in normotensives, yet the combined effects can be substantial. The BP reductions reported in the DASH studies are better interpreted as a combined effect from multiple dietary factors rather than the effect of a single factor. Studies clearly demonstrate the detrimental role of the current intake of sodium in our diet as being a major factor in regulating blood pressure in populations. Other dietary factors have also been identified as playing an important role, particularly potassium intake and fruits and vegetables consumption. A more healthy diet, such as the DASH diet, with lower salt and increased potassium through an increase in fruit and vegetable consumption, will have beneficial effects on blood pressure reduction. At the same time these types of diets which include a reduction in fat intake and the substitution of saturated by monounsaturated fat, a reduction in meat and dairy products with an increase in fish

consumption will also decrease other cardiovascular risk factors, particularly cholesterol and glucose intolerance (MacGregor, 1999).

Florida citrus juices are sodium and fat free foods. The DASH eating plan recommends drinking 6 oz of orange juice at breakfast or snacks. In addition, Florida Citrus juices are a good source of potassium, another important factor in controlling high blood pressure. The 2005 Dietary Guidelines for Americans states that the inclusion of orange juice in the diet can help meet recommended levels of potassium intake. These facts suggest that Florida citrus juices should be included as part of any low sodium diet and/or any blood pressure reducing eating plan.

Florida citrus juices contain other vitamins and minerals, such as folate and magnesium that have been shown to have beneficial effects on blood pressure, but the information is limited.

The information found however, does not justify a claim that directly relates a reduction in blood pressure to the normal consumption of citrus juice.

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