The effect of natural ACE inhibitors, diuretics and temperature changes on systolic blood pressure in humans.

Submitted to:

Concordia University College of Alberta Science Department of Biology and Environmental Science in partial fulfillment of the requirements for BIO 489

Submitted by:

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ABSTRACT

Blood pressure is the pressure exerted by circulating blood upon the walls of blood vessels, and hypertension occurs when blood is forced through the arteries at an increased pressure. The aim of the study examines the relationship between blood pressure and blood viscosity, and to examine the effectiveness of lowering high blood pressures with natural, non-pharmaceutical treatments. Twelve subjects between the ages of 18 and 25 were selectively chosen for the fourteen day duration of the study. The subjects were divided into two groups, group A and B. Group A comprised of individuals who train more than 3 times a week, and Group B consists of individuals who train less than 3 times a month. The subjects in the study had their blood pressures determined after a variety of treatments including temperature (hot, cold and room temperature water), natural diuretics (lemon juice with warm water, parsley tea), natural ace inhibitors (pomegranate juice) and a cardiovascular fitness test (10 minute run on a spin bike at 50 rpm). Systolic blood pressure plays a role in returning heart rates back to a normal state quicker in normotensive subjects than in hypertensive. The results show that fit individuals (Group A) showed lower pulse rates and blood pressures as compared to less fit individuals (Group B) after a fitness test. Also, their pulse rates returned more quickly to the resting condition after exercise than in a less fit individual. Colder temperatures stimulated an increase in systolic blood pressure in normotensive subjects. The natural diuretic and ACE inhibitor treatment significantly lowered systolic readings in group B. Natural ACE inhibitors and diuretics were shown to be an effective, natural, non-pharmaceutical treatment on lowering systolic blood pressures in hypertensive subjects. The future goal of this study is to develop natural treatments and therapies to assist individuals with high blood pressure. Future aims of this study also seek to increase life expectancy and quality of life for patients with hypertension through the use of natural blood pressure lowering treatments.

ETHICAL STATEMENT

Title of the study: The effect of natural ACE inhibitors, diuretics and temperature changes on systolic blood pressure in humans.

*Complete copies of CUCA consent ethic forms for each subject is available upon request.

On behalf of, and having referenced work from all the authors used in this report, I declare that:

(a) The material has not been published in whole or in part elsewhere;
(b) The paper is not currently being considered for publication elsewhere;
(c) All authors have been personally and actively involved in substantive work leading to the report, and will hold themselves jointly and individually responsible for its content;
(d) All relevant ethical safeguards have been met in relation to patient or subject protection, or animal experimentation.

There is no connection with tobacco, alcohol, pharmaceuticals or gaming industry with this study. There are no major known risks, dangers or side effects with the use of a sphygmomanometer to measure blood pressure. Some people report temporary arm tightness in the tested arm. The natural diuretic and ace inhibitor treatment will be a low dosage required to see expected results, and subjects exposed to it will be required to sign a document listing the researcher (Dino Ganic) to be not responsible for any known side effects, or responsible for any harm. Subjects will be asked to take part in the experiment, but can willingly decline. Subjects will be asked if they are allergic to the ace inhibitor (pomegranate juice) and natural diuretics (lemon juice with warm water, parsley tea). There will be careful transcription and analysis of scientific results to avoid error, and honesty in reporting scientific results. Independent analysis and interpretation will be performed on the results based on data and not on the influence of external sources. Open sharing of methods, data, and interpretations through publication and presentation will be obliged. Also it is my moral obligation to society in general, and, in some disciplines, responsibility in weighing the rights of human subjects. In rare cases, pomegranate juice may inhibit the metabolism and activity of carbamazepine, a drug used to treat bipolar disorder and epilepsy, according to Muneaki Hidaka, of the School of Pharmaceutical Sciences at Kyushu University of Health and Welfare in Japan. Like many fruits, it has some sugar content which could marginally increase blood sugar level. Therefore, diabetic subjects will not be used in this experiment as it is a blood sugar level disease. According to the U.S. Food and Drug Administration there is a small risk that lemons may have pesticide residues on their peels. According to the Journal of Environmental Health, peels can also hold mold. Lemons also have a high citric acid content that may irritate the stomach, particularly if a subject has an ulcer. This acid, even if diluted in water, can also damage tooth enamel if consumed in large quantities. A rare side effect for parsley tea in pregnant women is it can cause uterine bleeding that can increase the risk of miscarriage. Other minor side effects are seen the tea is overdosed, which could lead to weight loss, nausea, renal damage, loss of balance, convulsions of muscles. People who are suffering with kidney diseases or are pregnant will not be tested in this experiment.

I testify to the accuracy of the above on behalf of all the authors.

Name: Dino Ganic

Today’s Date November 13, 2013

INTRODUCTION

Blood pressure is the pressure exerted by circulating blood upon the walls of blood vessels, and arterial pressure is measured with a sphygmomanometer. Hypertension occurs when blood is forced through the arteries at an increased pressure. There is now more and more evidence, especially for diabetics, that blood pressure should be as low as possible. In this context, it is important to stress that there is a J-shaped relationship between blood pressure and mortality (Mogensen 2003). Elevated blood pressure, casual or basal, labile or fixed, systolic or diastolic, at any age in either sex, is a potent contributor to all forms of cardiovascular disease (Kannel 1974). A person's blood pressure is usually expressed in terms of the systolic pressure over diastolic pressure (mmHg), for example 140/90. Systolic blood pressure (SBP) is a more reliable predictor of cardiovascular disease (CVD) events than is diastolic blood pressure (DBP) (Black 1999). Therefore, typically more attention is given to the systolic blood pressure as a major risk factor for cardiovascular disease. In most individuals, systolic blood pressure rises steadily with age due to increasing stiffness of large arteries, long-term build-up of plaque, and increased incidence of cardiac and vascular disease. A study in 1998 showed the importance of maintaining a normal systolic level as it is a predictor of death from coronary heart disease, stroke, cardiovascular disease and all causes in men and women aged 45-64 years (Antikainen and others 1998).

Elevated blood pressure is associated with hyperlipidemia, hyperglycemia, hyperuricemia, excessive weight, elevated fibrinogen, and electrocardiogram (ECG) abnormalities, which enhance its impact. Those at risk for hypertensive stroke can have atrial fibrillation, cardiac failure, coronary disease, diabetes, or a cigarette habit. Cardiovascular risk ratios for hypertension diminish with advancing age, but this is offset by a higher absolute risk, making hypertension an important precursor of cardiovascular disease in the elderly (Kannel 1993). The table below shows the classification of blood pressure adopted by the American Heart Association for adults who are 18 years and older. It assumes the values are a result of averaging blood pressure readings measured at two or more visits to the doctor.

Table 1.0 Classification of Blood Pressure for Adults (18+ years of age) According to the American Heart Association (American heart association, 2011)

Category	Systolic (mmHg)	Diastolic (mmHg)
Hypotension	< 90	< 60
Desirable	90–119	60–79
Prehypertension	120–139	or 80–89
Stage 1 Hypertension	140–159	or 90–99
Stage 2 Hypertension	160–179	or 100–119
Hypertensive Crisis	≥ 180	or ≥ 120

i. Blood pressure and pulse

Blood rushing through the body's blood vessels exerts pressure against the vessel walls. This blood pressure is highest in the aorta region of the heart. It decreases as the blood moves through the arterioles, capillaries, venules, and veins. With each contraction of the heart, the elastic arteries expand and recoil when they pass near the surface of the skin. The heart rate, or pulse, is the number of times the heart beats per unit of time. Heart rate can vary with the body's need to absorb oxygen and excrete carbon dioxide, such as during physical exercise or sleep. The table below classifies normal pulse rate ranges from the American Heart Association.

Table 2.0 Classification of Normal Heart Rates (beats per minute) for According to The American Heart Association (American heart association, 2011)

Age	Target HR Zone 50-85%	Average Maximum Heart Rate, 100%
16-20 years	100-170 beats per minute	200 beats per minute
30 years	95-162 beats per minute	190 beats per minute
35 years	93-157 beats per minute	185 beats per minute
40 years	90-153 beats per minute	180 beats per minute
45 years	88-149 beats per minute	175 beats per minute
50 years	85-145 beats per minute	170 beats per minute
55 years	83-140 beats per minute	165 beats per minute
60 years	80-136 beats per minute	160 beats per minute
65 years	78-132 beats per minute	155 beats per minute
70 years	75-128 beats per minute	150 beats per minute

Aerobic exercise and fitness can affect blood pressure, and pulse rates can give information about fitness level, health and blood pressure. Resting heart rates that are consistently high tachycardia or resting heart rates that are below the normal values (bradycardia) may indicate blockages in an artery (Solti and others 1980; Palatini and others 1997). These blockages are common in people with diabetes or atherosclerosis resulting from high cholesterol. Aerobic exercise (refers to the use of oxygen to adequately meet energy demands during exercise) increases the body's demand for energy and therefore pulse rate rises. The level to which an individual's pulse rate returns to normal was measured after an aerobic fitness treatment. This test can demonstrate how quickly blood pressure plays a role in returning pulse rates back to a normal state. By examining the differences in pulse rate and blood pressure in these subjects, it can give insight on how their lifestyles can change to benefit their cardiovascular fitness, and for them to have less chance of having future cardiac problems.

ii. Blood pressure and it's relation to temperature changes

When measuring blood pressures, systolic measures the pressure in the arteries when the heart beats or when the heart muscle contracts. Diastolic measures the pressure in the arteries between heartbeats, or when the heart muscle is resting between beats and refilling with blood, and is lower of the two categories. Typically more attention is given to the systolic blood pressure as a major risk factor for cardiovascular disease for people over 60 years old (Alpérovitch and others 2009). In most people, systolic blood pressure rises steadily with age due to increasing stiffness of large arteries, long-term buildup of plaque, and increased incidence of cardiac and vascular disease (Aronow and others 1987; Kannel 2000; Gensini and Corradi 2000; Hall 1999; Astrup and Kjeldsen 1974; Kocemba and others 1998; Kuller 1976; Widimsky 2009).

The second part of the experiment examined the relationship between temperature fluctuations and blood pressure. According to Kristal-Boneh and her research team, in 1996 they published a paper which demonstrated that blood pressure increases in the winter and decreases in the summer in most people. Colder temperatures cause the diameter of blood vessels to constrict, causing the heart to work harder to push blood through the veins and arteries. Systolic (blood pressure when the heart contracts) and diastolic (blood pressure reading while the heart is at rest) measurements were found to increase during colder weather (Minami and others 1996). Colder weather activates the sympathetic nervous system, which controls how the body responds to stress to the body (temperature in this case), according to a French research study in 2009, in the Archives of Internal Medicine (Alperovitch and others 2009). Lower temperatures stress the body, causing this system to activate the acute stress response. The body reacts with a variety of symptoms, including acceleration of heart and lung action, constriction of blood vessels, an increased heart rate, and increased blood pressure.

Homeostasis is the ability of the body to maintain an internal environment that is constant, regardless of outside influences. The body controls blood pressure, temperature, respiration and even blood glucose levels by using several internal mechanisms to keep things constant (Luna and others 1998). Blood pressure is constantly changing to maintain homeostasis within the body (Gianuzzi and Eleuteri 2000). Temperature change can disrupt homeostasis, and therefore blood pressure in the subjects' bodies will have to adjust to maintain constant internal body heat. A French article published in 1997 by Verdon and his research team reported seasonal variations of blood pressure in subjects. An increase in blood pressure is expected when temperatures drop in our subjects and a decrease in blood pressure when temperatures rise. To test this, the subject's blood pressures will be measured while they seated with their right hand in a beaker of cold water (~4.0°C), hot water (~40.0°C), and room temperature water (~22.0°C). Heart rate will not be measured or recorded. Increasing blood pressure without having to increase heart rate prevents loss of body heat and helps sustain homeostasis. The purpose of this experiment is beneficial to individuals to control their hypertension by avoiding environments that may be too warm or to cold that could lead to complications. The temperature fluctuations will stimulate the sympathetic nervous system to go to work and adjust blood pressure depending on the stress temperature exposed to the subjects. By examining the relationship between blood pressure and temperature changes, scientists have previously shown that the type of clothing in winter months may be beneficial in controlling hypertension, preventing it from escalating in the winter months (Li and others 2009). Blood pressure management is crucial in elderly patients (80+) during colder temperatures, as they are more likely to see an increase in blood pressure (Alperovitch and others 2009). Symptoms of orthostatic hypotension and increased risk of malaise makes it important to study effects of temperature changes on blood pressure (Verdon and others 1997).

iii. Natural ace inhibitor treatment and lowering of blood pressure

Studies have shown that ace inhibitors (or angiotensin converting enzyme inhibitor) can cause regulation of blood vessels and arterial pressure, suggesting a possible relationship to blood pressure (Dzau 1990; Powers and others 2012; Morgan and others 2001). Ace inhibitors use angiotensin converting enzyme inhibitors to reduce the activity of the renin angiotensin aldosterone system (Morgan and others 2001; Atlas 2007). This system is a protein and hormone system that regulates dilation of blood vessels and fluid balance. The renin angiotensin aldosterone system is activated when there is a loss of blood volume or a drop in blood pressure (hypotension) (Werner and others 2010). Renin protein is released by this system into the kidney in an attempt to regulate blood pressure. Renin carries out the conversion of angiotensinogen released by the liver to angiotensin I and II, which causes blood vessels to constrict, resulting in increased blood pressure (Atlas 2007; Werner and others 2010). Ace inhibitors block the conversion of angiotensin I to angiotensin II (Jafar and others 2001). By blocking this conversion, ace inhibitors increase arterial pressure and renovascular resistance, therefore increasing blood pressure.

The angiotensin aldosterone system is activated in response to an increase in arterial pressure (Atlas 2007). The renin release produces an angiotensin protein, which signals the adrenal gland to produce a hormone called aldosterone. If the renin angiotensin aldosterone system is too active, blood pressure will be too high. Renin will increase in concentration in the blood due to negative feedback of conversion of angiotensin I to angiotensin II (Rao 2010). Angiotensin I will increase, while angiotensin II and aldosterone decrease. An ace inhibitor will decrease angiotensin II production leading to lowering of blood pressure II by widening the blood vessels (Rao 2010). Ace inhibitors are typically in the form of pharmaceutical medication such as Benazepril, Captopril, Enalapril, or Fosinopril. No pharmaceutical medication will be used for the purpose of this study. A natural ace inhibitor treatment in the form of pomegranate juice will be used to determine its effect on lowering high blood pressures. In the healthy subjects we would expect the renin angiotensin aldosterone system to have no significant effect on regulating normal blood pressures. In the group of subjects with higher blood pressures we expect the angiotensin aldosterone system to decrease angiotensin II production, and lower the systolic and diastolic blood pressures. The ACE inhibitor treatment will dilate blood vessels and decrease blood viscosity and blood pressure in subjects with high blood pressures.

iv. Natural diuretic treatment and lowering of blood pressure

A diuretic provides a means of forced diuresis which elevates the rate of urination and excretion of water and salt from the kidneys. Diuretics stimulate the kidneys to release excess sodium into the urine. The sodium removes water with it from the blood, decreasing the amount of fluid flowing through the blood vessels, and reducing pressure on the walls of the arteries. Removal of excess salt and fluid helps lower blood pressure by relieving pressure on the hearts arteries and vessels. Loop diuretics are primarily used in medicine to treat hypertension and edema often due to congestive heart failure or renal insufficiency, and have been shown to cause modest blood pressure lowering (Musini et al 2012). Diuretics also cause the walls of a blood vessel to relax and widen, which make it easier for the blood to flow through which also lowers blood pressure. Pharmaceutical diuretics like acetazolamide help make the urine more alkaline and are helpful in increasing excretion of toxic substances like alcohol (Fan and others 2012). In this study, subjects were exposed to lemon juice in warm water and parsley tea, both considered natural diuretics. Like parsley, lemons are rich in Vitamin C, an antioxidant that aids in thinning the blood. In previous studies, vitamin C has been shown to contribute to decreased risk of cardiovascular disease and strokes through a small reduction in systolic blood pressure in elderly patients (Fortherby and others 2000). Lemon juice is also a source of Vitamin P, found in the peel as well as the juice, which prevents fragility of capillaries and helps absorption of Vitamin C effectively. Parsley, botanically known as *Petroselinum crispum,* is a good source of luteolin, folic acid, vitamin C, and used as an anti-inflammatory (Nielsen and others 1999). The two groups of subjects will use a combination of two natural diuretics simultaneously to study the effect it has on their blood pressures. This double action is a way to ensure the kidneys are stimulated enough to elevate urination levels and excrete water and salt in the subjects. We expect the combination of the two natural diuretics to effectively lower blood viscosity and blood pressure in the subject group with high blood pressures.

v. Relationship between blood pressure and blood viscosity

Blood viscosity is a measure of the resistance of blood to flow or thickness of the blood. Blood viscosity is influenced by four main characteristics. There are other less significant factors that can influence blood viscosity such as a bacterial infection, but they will not be tested in the experiment. Hematocrit, temperature change, change in flow rate, or vessel diameter alteration, can all play a role in determining thickness of the blood. With a higher hematocrit, or percentage of red blood cells, the blood becomes more viscous (Letcher and others 1981; Salazar Vázquez 2000). For each one degree Celsius increased in temperature, viscosity of the blood can increase in a predicted manner (Barbee 1973; Eckmann and others 2000). Eckmann and others in 2000 demonstrated that decreasing hematocrit levels, especially to less than 22.5%, decreased blood viscosity. Blood that flows slower causes an increase in viscosity as a result of aggregation of red blood cells and protein to cell adhesions (Martini and others 2005). Smaller diameter vessels will have less viscous blood because of decreased hematocrit levels (Martini and others 2006). The blood is less viscous because it is more likely to cause turbulence; turbulence increases the energy required to drive blood flow because it increases the loss of energy in the form of friction, which generates heat (Cho and others 1985).

There have been several scientific articles published outlining the relationship between blood pressure and blood viscosity. The study in 1981 by Letcher and his research team showed a correlation between blood pressure and blood viscosity among both forty nine normotensive and forty nine hypertensive subjects ($p < 0.001$). Systolic blood viscosity was 8% to 10% higher and diastolic blood viscosity was 16% to 28% higher in hypertensive patients compared with normotensive controls (Letcher and others 1981). Eleven years later in 1992, a British study published in the European Heart Journal by Fowkes and his research department demonstrated that systolic blood pressure correlated to blood viscosity in males ($p < 0.001$), and diastolic blood pressure correlated to blood viscosity in both sexes ($p < 0.001$). Hematocrit blood viscosity levels were also significantly related to systolic and diastolic blood pressure in both sexes (Fowkes and others 1992). Five years after the publication on relationship between blood viscosity and blood pressure, the same research team (Lowe as the principle investigator) with the addition of some new members, further expanded on their previous research yet confirmed that hematocrit counts were related to blood pressure in both sexes (46.2 - 45.7%) (Lowe and others 1997). These previous studies suggest there are apparent correlations between blood pressure and blood viscosity, and the results from this study will further build on that.

Studies done by Salazar Vázquez and his research team have shown evidence that blood viscosity is primarily dependent on hematocrit count, which is a determinant of peripheral vascular resistance, directly linking it to blood pressure (Salazar Vázquez 2000; Salazar Vázquez and others 2009; Salazar Vázquez and others 2010). All of the tests on the subjects are related to blood viscosity. A high pulse rate may indicate blockages in the artery which is a result of increased blood viscosity. As temperature increases or decreases it stress the body, causing the sympathetic nervous system to activate the acute stress response. The body responds by accelerating the activity of the heart, constricting blood vessels and increasing heart rate and blood pressure. With this the blood also becomes more viscous, and is suggestive that it is correlated with increasing blood pressure. Finally, the natural diuretic and ace inhibitor treatments are expected to lower blood pressure temporarily would predictably lower blood viscosity. By further understanding the role of blood viscosity, more effective treatments and therapies could be developed to reverse viscous blood, and potentially lower higher blood pressures.

The goal of the study was to compare high blood pressure to blood viscosity, and determine if there are natural treatments to lower hypertension. A fit individual’s pulse and blood pressure would be lower and would return more quickly to the resting condition after exercise than in a less fit individual. Also, subjects with higher blood pressures are expected to be less fit (pulse rate returns slower) to these aerobic tests. Colder temperatures cause the diameter of blood vessels to constrict, causing the heart to work harder to push blood through the veins and arteries. We know that colder weather activates the sympathetic nervous system, which controls how the body responds to stress to the body (temperature in this case), according to a French research report in 2009 in the Archives of Internal Medicine (Alperovitch and others 2009). Lower temperatures stress the body, causing this system to activate the acute stress response. The body reacts with a variety of symptoms, including acceleration of heart and lung action, constriction of blood vessels, an increased heart rate, and increased blood pressure. The hot and cold water treatments are expected to produce an acute stress response in our subjects trigger some of the mentioned symptoms. An increase in blood pressure is expected with a cold temperatures treatment in our subjects and a decrease in blood pressure is expected with an increase in temperature. The natural diuretic and ACE inhibitor treatments are expected to lower both systolic and diastolic readings in both Groups, but more significantly in Group B. Blood pressures are expected to be lower after the treatments as it is expected that the subject's blood will thin as less water and salt is retained in the kidneys. Based on the results from these treatments, blood pressure and blood viscosity connections will be made, using previously published scientific work. The goal of this study aims to increase life expectancy and quality of life for patients with hypertension. Another goal of the study is to examine the use of non-pharmaceutical methods to lower blood pressure, such as long term exercise, avoiding cold temperatures and consumption of natural ACE inhibitors and diuretics.

STUDY DESIGN AND METHODOLOGY

This study was a controlled experiment comparing the results obtained from an experimental sample against a control sample. The subjects were asked to give their consent to undergo various blood pressure treatments by signing a written statement understanding and agreeing to the potential risks of the study, which is available upon request to view. There is no incentive for accepting to be part of this study, other than knowing ones blood pressure and overall cardiovascular fitness. The duration of study of blood pressure treatments on the subjects is fourteen days. No placebos were used in the experiment, and all of the tests administered on the subjects were performed by Dino Ganic. Twelve subjects, between the ages of 18 and 25, were selected at the discretion of the researcher for the course of the study. The subjects were further divided into two groups, A and B. Group A consisted of individuals that train more than 3 times a week, and Group B consists of individuals that train less than 3 times a month. Training in this study is defined by any aerobic exercise, weightlifting or physical activity in sports. The control for this experiment measured each subject's blood pressure (systolic and diastolic readings) and pulse rate (heart beats per minute) prior to any experimental tests. These values were tabulated and used in comparison with the treatment results. The signed consent forms are available to be reviewed and are safely locked in Dr. Dalton's office. To review, permission must be granted from Dr. Dalton or Dino Ganic.

1. Blood pressure and pulse

The first test measured the relationship between blood pressure and pulse. The level to which an individual's pulse rate returns to normal will be measured after exposure to a fitness treatment. This test demonstrates how quickly blood pressure plays a role in returning pulse rates back to a normal state. The two groups of subjects had their pulse rates measured (athletes train >3 times a week, individuals who train <3 times a month) over fourteen days. The fitness treatment is a ten minute run on a spin bike at 50 rpm. One minute after the fitness treatment (giving time for the subject to get off the spin bike, and put on the sphygmomanometer) the pulse rate was measured, following by a blood pressure reading. Pulse rates were measured by placing the index and middle finger over the underside of the right wrist, below the base of the thumb. The wrist was pressed firmly with flat fingers until a pulse was felt. In these areas, an artery passes close to the skin. Once the pulse was found, the number of heart beats was counted for one minute, giving the beats per minute (bpm). The subjects control systolic blood pressure and pulse rates were compared to their post fitness test treatment scores. The results were graphed, clearly showing the subjects differences in blood pressure (systolic and diastolic rates) and pulse rates (beats per minute) after the fitness treatment. Groups A and B were subdivided on the figures to observe the differences of cardiovascular fitness.

2. Blood pressure and it's relation to temperature

The second part of the experiment tested the relationships between temperature and blood pressure. Systolic and diastolic readings were graphed against temperature changes. The temperature treatments are used to determine if they can produce an acute stress response, which could be helpful for individuals with hypertension so they could adapt their lifestyles around temperature changes. To test this relationship, the subject's blood pressures were measured while they were seated with their right hand in a beaker of cold water (~4.0°C), hot water (~40.0°C), and room temperature water (~22.0°C) for ten minutes. These results were compared to the subject's control systolic blood pressures. Figures were produced based on the cold, hot and room temperature water. Heart rate was not measured or recorded. Temperature (hot, cold, room) treatments were plotted against heart rate (beats per minute) and against blood pressure (systolic and diastolic), to test predictions that blood pressure changes with temperature fluctuations. Groups A and B were further subdivided on the figures.

3. Natural ACE inhibitor treatment and lowering of blood pressure

Pomegranate juices were given to the subjects as the natural ACE inhibitor treatment. Each subject from the two study groups drank 2 glasses of pomegranate juice supplied by the researcher for 3 days, and systolic blood pressures were recorded after the 3 day consumption. Each glass consisted of 250 mL of pomegranate juice. The first glass should be taken at noon with a meal, and the second glass taken 6 hours later with an evening meal.

4. Natural diuretic treatment and lowering of blood pressure

Parsley tea and lemon juice with no added sugars or preservatives was used on the subjects as the natural diuretic treatments. Each subject from the two study groups drank 1 glass of lemon juice in warm water and 1 glass of parsley tea supplied by the researcher for 3 days, and systolic blood pressures were recorded after the 3 day consumption.

Each glass consisted of 250 mL of parsley tea and 200 mL of lemon juice in 50 mL of warm water. The lemon juice was warmed in a microwave for 30 seconds to limit the bitter taste of the lemon. The first glass of parsley tea and lemon juice was taken at noon with a meal, and the second glasses be taken 6 hours later with an evening meal.

RESULTS

I) Preliminary Results (Controls) of systolic and diastolic blood pressure

The figure below shows initial preliminary testing of systolic blood pressures between groups A and B used as controls.

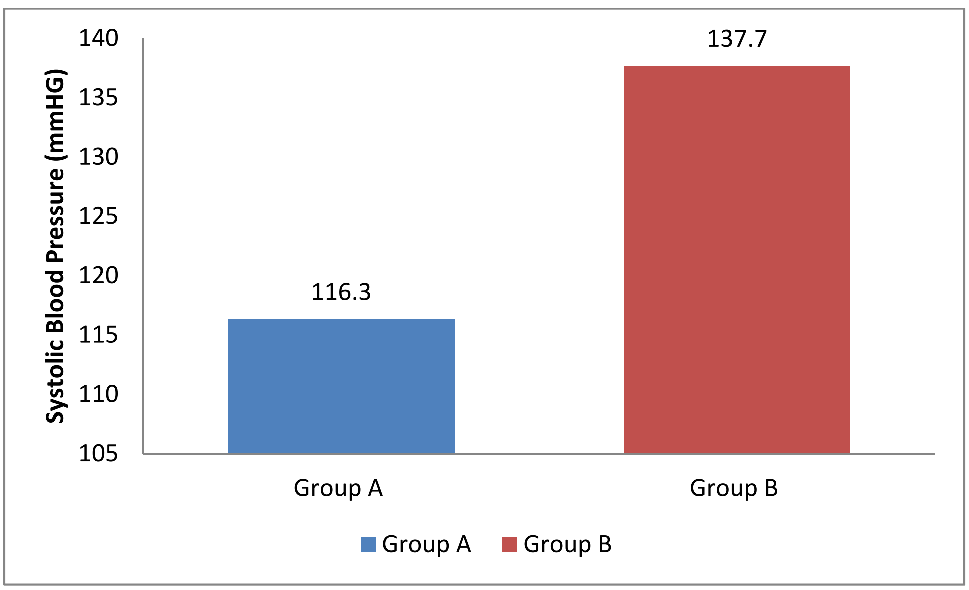

Figure 1. Comparison of Average Systolic Blood Pressures between groups A and B used as a control.

Figure 1 demonstrates that subjects in group A have lower systolic blood pressures (mmHG) than those in group 2. All of the subjects (6/6) from group A had lower systolic blood pressure readings than those in group B. Group A had an average systolic blood pressure of 116.3, and group B had an average of 137.67. There is a 0.87 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.

Figure 2 is also part of the preliminary results and shows comparison of diastolic blood pressures between groups A and B used as controls.

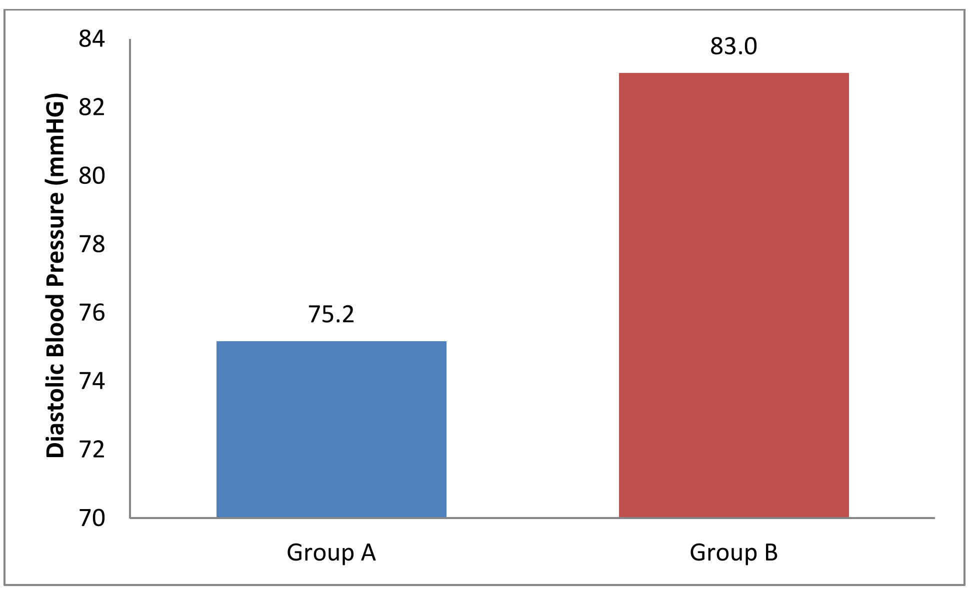

Figure 2. Comparison of Average Diastolic Blood Pressures between groups A and B

In figure 2, all individuals from group A show a lower diastolic blood pressure reading (mmHG) than individuals in group B. Group A had an average diastolic blood pressure of 75.17, and group B had an average of 83.

ii) **Stage 1 - Fitness treatment and heartbeats per minute**

Figure 3 below compares pulse rates (heart beats per minute) between groups A and B after a ten minute fitness test on a spin bike at 50 rpm.

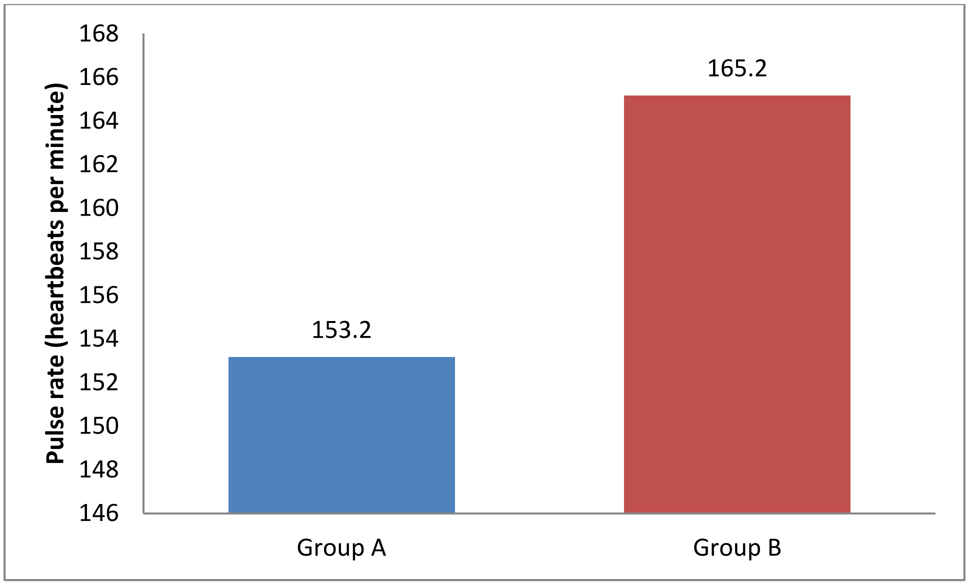

Figure 3. Comparison of average pulse rates between groups A and B after a 10 minute fitness test at 50 rpm

Based on the above figure, individuals from group A showed a pattern of having a lower pulse rate after the fitness treatment than individuals in group B. One of the individuals from group A had a pulse rate higher than two individuals from group B. The average pulse rate for individuals from group A is 153.17 beats per minute, and group B had an average of 165.17 bpm.

Immediately after the pulse rate measurement, systolic blood pressure was measured for each subject in the two test groups.

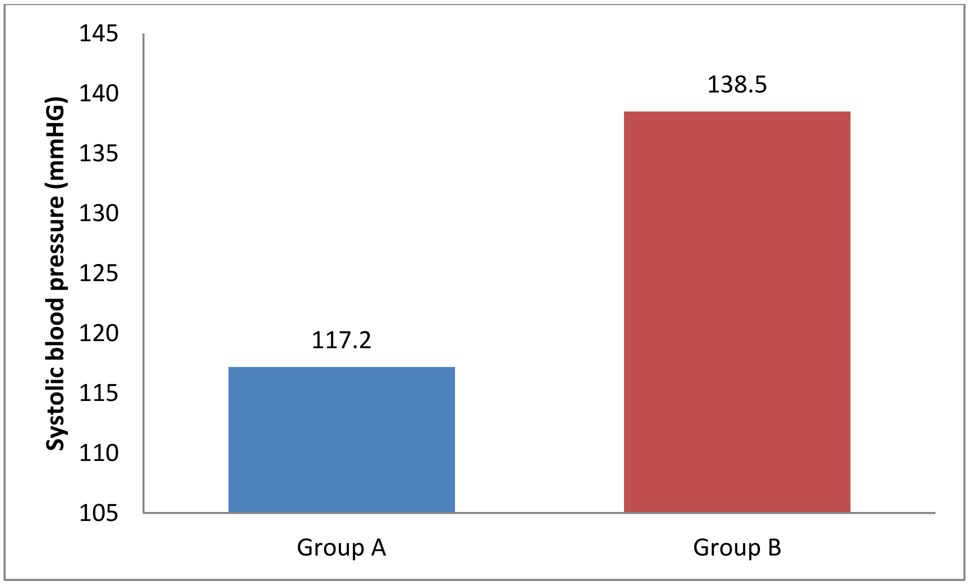

Figure 4 - Comparison of average systolic blood pressures between groups A and B after a 10 minute Fitness Test at 50 rpm.

Figure 4 demonstrates that group A had lower systolic blood pressure readings after the 10 minute fitness treatment at 50 rpm. There was not a significant jump in systolic blood pressures based on the raw results for either group if compared to the control figure. Figure 4 demonstrates that individuals from group A had an average systolic blood pressure (mmHG) of 117.167 and group B had an average of 138.5. There is a 1.3 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.

iii) **Stage 2 - Temperature treatments (4 ^{o}C, 22 ^{o}C, 40 ^{o}C) and systolic blood pressure**

Figure 5 compares systolic blood pressures between groups A and B after a 22 ^{o}C temperature treatment.

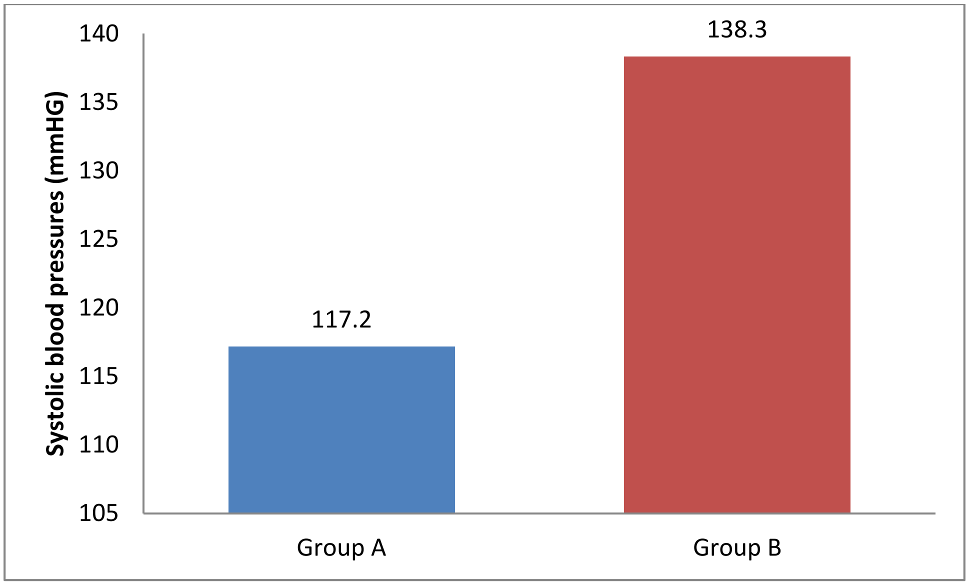

Figure 5. Comparison of average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 22 ^{o}C

After the 10 minutes 22 ^{o}C temperature treatment the results demonstrate that there are no significant changes in systolic blood pressures between the groups. Group A had a lower average systolic blood pressure after the 22 ^{o}C temperature treatment at 117.17, and group B had an average of 138.3. There is a 0.87 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.

Figure 6 below shows a comparison of systolic blood pressure readings after a cold temperature treatment (4 ^{o}C) between the two groups.

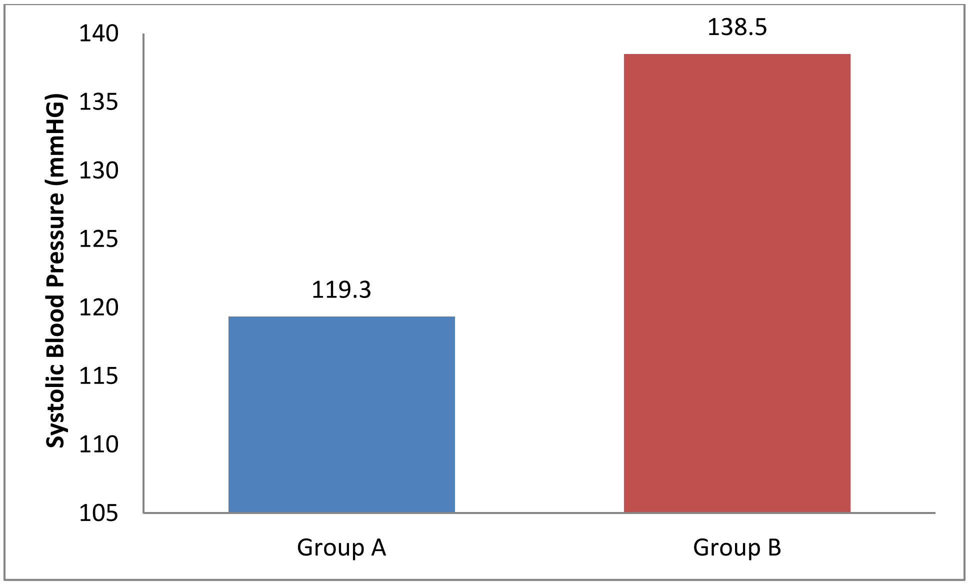

Figure 6. Comparison of average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 4.0 ^{o}C.

The results from this figure show a slight increase in systolic blood pressure compared to the control figure (+ 1-3 mmHG). Group A had a lower average systolic blood pressure after the 4.0 ^{o}C temperature treatment at 119.33 and group B had an average of 138.5. There is a 1.07 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.

The final temperature treatment at 40 ^{o}C shown in figure 7 below did not show any significant differences in systolic blood pressure readings compared to the control figure.

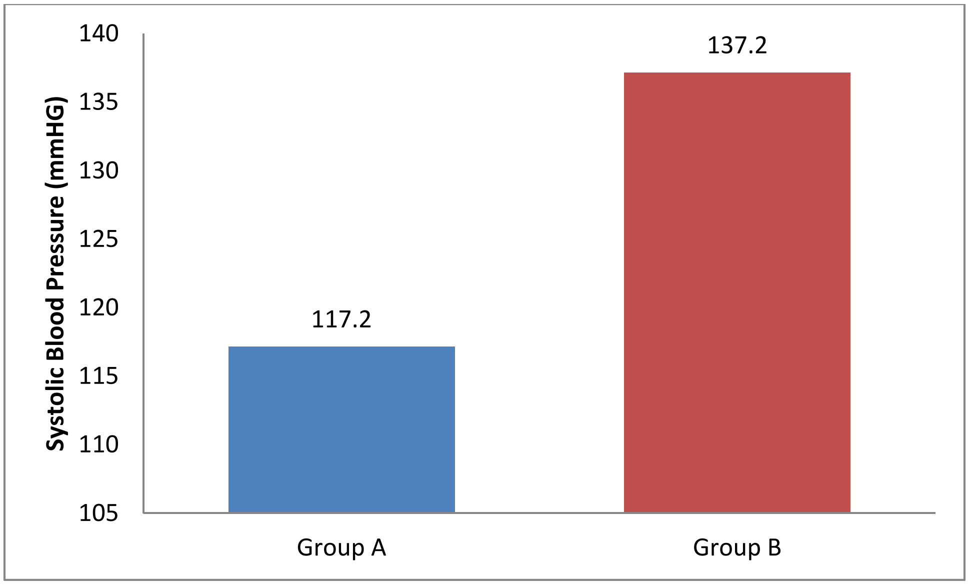

Figure 7. Comparison of average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 40 ^{o}C.

All of the systolic blood pressures for individuals in group A were lower than those from group B, but no significant changes in mmHg readings were noted. The average systolic blood pressure for group A was 117.17, and group B had an average of 137.17. There is a 0.85 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.

iv) **Stage 3 – Natural diuretics and ACE inhibitor treatment vs. systolic blood pressures**

The figure below compares systolic blood pressure readings between groups A and B after the 3 day pomegranate juice and parsley tea test.

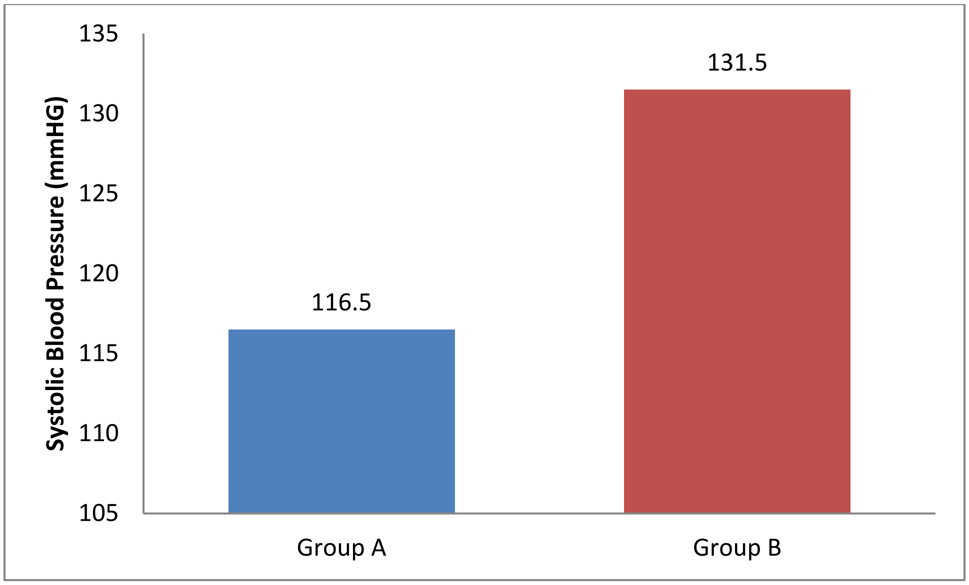

Figure 8. Comparison of systolic blood pressures between groups A and B after consuming a natural ACE inhibitor (Pomegranate Juice) and natural diuretic (Parsley tea with Lemon) for 3 days.

Group A did not show significant changes to their systolic blood pressure as compared to the control figure. Group B individuals showed a decrease in systolic blood pressures in 5/6 cases. There is a 0.57 probability that the difference between the groups was due to chance, indicating there is a significant difference between the variances of the two samples since it's greater than 0.10 critical value.The average decrease in systolic blood pressure in group B was between 5-8 mmHG, with most of the readings around 130 mmHG (compared to >137+ from the control figure). Group A had an average systolic blood pressure reading of 116.5, and group B had an average of 131.5. The average systolic blood pressure for group B for the natural ACE inhibitor and diuretic treatment was lower than any other previous treatment.

DISCUSSION

Figures 3 and 4 demonstrate that there is a difference between normotensive and hypertensive subjects after a fitness test. This test demonstrates how quickly blood pressure plays a role in returning pulse rates back to a normal state. Fit individuals (group A) had a lower pulse rate and systolic blood pressure after the fitness test based on the two figures. Their heart rate also returned more quickly to the resting condition after exercise than in a less fit individuals (group B). The fitness test showed distinctive pulse rate differences between groups A and B, but the systolic blood pressures from figure 4 did not change as much as expected. The aerobic exercise was intended to stimulate an increase in blood pressure in hypertensive individuals and that their corresponding pulse rates would return to a normal state at a slower rate than normotensive individuals. While the pulse rates returned more slowly in hypertensive subjects, their corresponding systolic blood pressures did not increase significantly. Solely from these results, an increase in heart rate did not correlate with blood pressure, most likely since blood vessels dilate to allow blood to flow more easily. However there is still previous research (Solti and others 1980; Palatini and others 1997) that indicates that increasing pulse rate can increase blood pressure. Therefore a change in experimental design could theoretically give different results for future studies. An increase in the length of a fitness treatment from 10 minutes to 45 minutes could produce more drastic changes in systolic blood pressures in hypertensive individuals. The intensity of the fitness treatment was decreased from 70 rpm to 50 rpm based on peer advice for this experiment. If the intensity was increased back to 70 rpm or even up to 80 rpm, this could demonstrate an increase in blood pressure in hypertensive subjects for future studies. Also future research could be performed on a long term basis of fitness to decrease systolic blood pressure, where a fitness treatment is performed every day, instead of a one-time 45 minute exercise. Other factors also need to be taken into account for the no noticeable increase in systolic blood pressure in the two study groups. Factors such as dehydration and fatigue can play a role in affecting the fitness treatment results because they can decrease oxygen supply to the arteries, giving different pulse rates and blood pressures. Solely based on the results, it would be difficult to determine if aerobic exercise is responsible for increasing blood pressure in hypertensive subjects. Based on previous research we can determine that aerobic exercise was significantly responsible for returning heart rates back to a normal resting state quicker in normotensive subjects than in hypertensive subjects.

Figures 5, 6 and 7 test the effect of various temperature treatments on systolic blood pressures. Figure 5 was used as a control temperature at 22^{o}C (room temperature) to be compared to the cold (4^{o}C) and warmer (40^{o}C) treatments. An increased surrounding temperature should decrease blood pressure and a lower surrounding temperature should increase blood pressure based on previous studies (Minami and others 1996; Verdon and others 1997). Figure 6 demonstrates a slight increase in systolic blood pressure compared to the control figure (+ 1-3 mmHG). The temperature treatment at 40 ^{o}C did not show any significant differences in systolic blood pressure readings compared to the control figure. Solely based on these results, a lower temperature (4 ^{o}C) stimulated an increased blood pressure (+ 1-3 mmHG) more significantly than an increased temperature (40 ^{o}C) had on lowering blood pressure. In previous studies, this temperature treatment test has shown more drastic results, indicating a change in experimental design could affect the results (Kristal-Boneh and others 1996). The temperatures for the warm and cold water baths are adequate, but an increase in duration of exposure to them could affect our results more drastically. Also, if the whole body had been exposed to a temperature change instead of just one hand the results are expected to differ. Overall this part of the experiment shows that avoiding colder temperatures could play a minor role in lowering systolic blood pressures, but more future research with more extreme temperature ranges are needed to be done.

Figure 8 shows the resulting systolic blood pressures after a 3 day consumption of a natural ACE inhibitor (pomegranate juice) and a natural diuretic (parsley tea with lemon). There were some significant changes to systolic blood pressures in hypertensive individuals. The average decrease in systolic blood pressure in group B was between 5-8 mmHG. These treatments are expected to regulate blood pressures, but since there were no hypotensive subjects our results only show a decrease in blood pressures in hypertensive subjects. Our results demonstrated individuals from group A had an average systolic blood pressure reading of 116.5, and group B had an average of 131.5. Group B had a significant decrease in their systolic blood pressures after taking the natural ACE inhibitor and diuretic treatment over three days. The ACE inhibitor decreased angiotensin II production leading to lowering of blood pressure by widening the blood vessels (Rao 2010). The natural diuretic treatment decreased the amount of fluid flowing through the blood vessels, and reducing pressure on the walls of the arteries. Based on the 3 day study a combination of parsley tea with lemon and pomegranate juice is an effective, natural, non-pharmaceutical treatment on lowering systolic blood pressure in hypertensive individuals. Future research for this area of the experiment would be to determine if these treatments can increase blood pressure in hypotensive subjects. Also it is difficult to determine whether the natural diuretic or ACE inhibitor had a greater effect on lowering blood pressure in hypertensive individuals. Future experiments could be performed comparing and contrasting the effectiveness of the two. Compliance issues are a concern if the individuals are not completely consuming the drinks over the 3 day period, which could have affected the results. Based on previous research natural ACE inhibitors and diuretics are a short term (even daily) treatment to regulate blood pressure temporarily. A long term effect over several months or years in hyper- and hypotensive individuals would give a deeper understanding into their field.

CONCLUSION

Noticeable changes to the experiment were changes to the fitness treatment. The intensity of the treatment was reduced to 50 rpm from 70 rpm based on peer advice from a professor (Dr. Janowicz). This reduction in intensity is more feasible and makes the fitness test easier to complete for the subjects. Also based on her changes, the treadmill was replaced with a spin bike. This experiment determined that systolic blood pressure plays a role in returning heart rates back to a normal state quicker in normotensive subjects than in hypertensive. Colder temperatures stimulated an increase in systolic blood pressure in normotensive subjects. Natural ACE inhibitors and diuretics were shown to be an effective, natural, non pharmaceutical treatment on lowering systolic blood pressures in hypertensive subjects. Hypertensive individuals can lower their blood pressures by long term aerobic exercise, avoiding colder temperatures (<4 ^{o}C) and consume natural diuretics and ACE inhibitors, such as pomegranate juice in combination with parsley tea with lemon.

REFERENCES

Alpérovitch A, Lacombe JM, Hanon O, Dartigues JF, Ritchie K, Ducimetière P, Tzourio C. *Relationship between blood pressure and outdoor temperature in a large sample of elderly individuals: the Three-City study.* 2009. Archives of Internal Medicine. 1: 75-80.

Antikainen R, Jousilahti P, Tuomilehto J. *Systolic blood pressure, isolated systolic hypertension and risk of coronary heart disease, strokes, cardiovascular disease and all-cause mortality in the middle-aged population*. 1998. Journal of Hyptertension. 5: 577-83.

Aronow WS, Starling L, Etienne F, D'Alba P, Edwards M, Lee NH, Parungao RF, Sales FF. *Risk factors for atherothrombotic brain infarction in persons over 62 years of age in a long-term health care facility*. 1987. Journal of the American Geriatrics Society. 35: 1-3.

Astrup P, Kjeldsen K. *Carbon monoxide, smoking, and atherosclerosis*. 1974. The Medical Clinics of North America. 2: 323-50.

Atlas SA. *The renin-angiotensin aldosterone system: pathophysiological role and pharmacologic inhibition*. 2007. Journal of Managed Care Pharmacy. 8: 9-20.

Barbee JH. *The effect of temperature on the relative viscosity of human blood*. 1973. Bioheology. 1: 1-5.

Black HR. *Isolated systolic hypertension in the elderly: lessons from clinical trials and future directions*. 1999. Journal of Hypertension. 5: 49-54.

Cho YI, Back LH, Crawford DW. *Experimental investigation of branch flow ratio, angle, and Reynolds number effects on the pressure and flow fields in arterial branch models*. 1985. Journal of biomechanical engineering. 3: 257-267.

Dzau VJ. *Mechanism of action of angiotensin-converting enzyme (ACE) inhibitors in hypertension and heart failure. Role of plasma versus tissue ACE*. 1990. Drugs. 2: 11-16.

Eckmann DM, Bowers S, Stecker M, Cheung AT. *Hematocrit, volume expander, temperature, and shear rate effects on blood viscosity*. 2000. Anesthesia and Analgesia. 3: 539-545.

Fan JL, Burgess KR, Thomas KN, Lucas SJ, Cotter JD, Kayser B, Peebles KC, Ainslie PN. *Effects of acetazolamide on cerebrovascular function and breathing stability at 5050 m.* 2012. The Journal of Physiology. 5: 1213-1215.

Fotherby MD, Williams JC, Forster LA, Craner P, Ferns GA. *Effect of vitamin C on ambulatory blood pressure and plasma lipids in older persons.* 2000. Journal of Hypertension. 4: 411-415.

Fowkes FGR, Lowe GDO, Rumley A, Lennie SE, Smith FB, Donnan PT. *The relationship between blood viscosity and blood pressure in a random sample of the population aged 55 to 74 years.* 1992. European Heart Journal. 5: 597- 601.

Gensini GF, Corradi F. [*Hypertension as a function of age*]. 2000. Italian Heart Journal: Offical Journal of the Italian Federation of Cardiology.

Giannuzzi P, Eleuteri E. *[Systolic-diastolic arterial hypertension versus isolated systolic hypertension].* 2000. Italian Heart Journal. 2: 93-99.

Hall WD. *Risk reduction associated with lowering systolic blood pressure: review of clinical trial data.* 1999. American Heart Journal. 3: 225-30.

Jafar TH,Schmid CH,Landa M,Giatras I,Toto R,Remuzzi G,Maschio G,Brenner BM,Kamper A,Zucchelli P,Becker G,Himmelmann A,Bannister K,Landais P,Shahinfar S,de Jong PE,de Zeeuw D,Lau J,Levey AS. *Angiotensin-converting enzyme inhibitors and progression of nondiabetic renal disease. A meta-analysis of patient-level data*. 2001. Annals of Internal Medicine. 2: 73-87.

Kannel WB. *Role of blood pressure in cardiovascular morbidity and mortality*. 1974. Progress in Cardiovascular Diseases. 17: 5-24.

Kannel WB. Incidence and epidemiology of heart failure. 2000. Heart Failure Reviews. 2: 167-73.

Kannel WB. *Hypertension as a risk factor for cardiac events--epidemiologic results of long-term studies.* 1993. Journal of Cardiovascular Pharmacology. 2: 27-37.

Kawut SM, Bagiella E, Lederer DJ, Shimbo D, Horn EM, Roberts KE, Hill NS, Barr RG, Rosenzweig EB, Post W, Tracy RP, Palevsky HI, Hassoun PM, Girgis RE; ASA-STAT Study Group. *Randomized clinical trial of aspirin and simvastatin for pulmonary arterial hypertension: ASA-STAT. 2011*. Circulation. 25: 2985-2893.

Kocemba J, Kawecka-Jaszcz K, Gryglewska B, Grodzicki T. *Isolated systolic hypertension: pathophysiology, consequences and therapeutic benefits*. 1998. Journal of Human Hypertension. 9: 621-6.

Kristal-Boneh E, Harari G, Green MS, Ribak J. *Summer-winter variation in 24 h ambulatory blood pressure.* 1996. Blood Pressure Monitoring. 1: 87-94.

Kuller LH. *Epidemiology of cardiovascular diseases: current perspectives*. 1976. American Journal of Epidemiology. 4: 425-96.

Letcher RL, Chien S, Pickering TG, Sealey JE, Laragh JH. *Direct relationship between blood pressure and blood viscosity in normal and hypertensive subjects. Role of fibrinogen and concentration*. 1981. The American Journal of Medicine. 6: 1195-1202.

Li Y, Alshaer H, Fernie G. *Blood pressure and thermal responses to repeated whole body cold exposure: effect of winter clothing.* 2009. European Journal of Applied Physiology. 6: 673-685.

Lowe GD, Lee AJ, Rumley A, Price JF, Fowkes FG. *Blood viscosity and risk of cardiovascular events: the Edinburgh Artery Study.* 1997. British Journal of Haematology. 1: 168-173.

Luna MB, Orsatti M, Poletto L. *Lerner's homeostasis and blood pressure.* 1998. Medical Hypotheses. 2: 89-93.

Martini J, Carpentier B, Negrete AC, Frangos JA, Intaglietta M. *Paradoxical hypotension following increased hematocrit and blood viscosity.* 2005. American Journal of Physiology. 5: H2136- H2143.

Martini J, Cabrales P, Tsai AG, Intaglietta M. *Mechanotransduction and the homeostatic significance of maintaining blood viscosity in hypotension, hypertension and haemorrhage.* 2006. Journal of Internal Medicine. 4: 364-372.

Minami J, Kawano Y, Ishimitsu T, Yoshimi H, Takishita S. *Seasonal variations in office, home and 24 h ambulatory blood pressure in patients with essential hypertension.* 1996. Journal of Hypertension. 14: 1421- 1450.

Mogensen CE. *New treatment guidelines for a patient with diabetes and hypertension*. 2003. Journal of Hypertension. 1: 25-30.

Morgan TO, Anderson AI, MacInnis RJ. *ACE inhibitors, beta-blockers, calcium blockers, and diuretics for the control of systolic hypertension.* 2001. American Journal of Hypertension. 3: 241-247.

Musini VM, Rezapour P, Wright JM, Bassett K, Jauca CD. *Blood pressure lowering efficacy of loop diuretics for primary hypertension.* 2012. Cochrane Database of Systematic Reviews. Issue 8. Art. No.: CD003825. DOI: 10.1002/14651858.CD003825.pub3.

Nielsen SE, Young JF, Daneshvar B, Lauridsen ST, Knuthsen P, Sandström B, Dragsted LO. *Effect of parsley (Petroselinum crispum) intake on urinary apigenin excretion, blood antioxidant* *enzymes and biomarkers for oxidative stress in human subjects.* 1999. The British Journal of Nutrition. 6: 447-455.

Palatini P, Casiglia E, Pauletto P, Staessen J, Kaciroti N, Julius S. *Relationship of tachycardia with high blood pressure and metabolic abnormalities: a study with mixture analysis in three populations.* 1997. Hypertension. 5: 1267- 1273.

Powers BJ, Coeytaux RR, Dolor RJ, Hasselblad V, Patel UD, Yancy WS Jr, Gray RN, Irvine RJ, Kendrick AS, Sanders GD. *Updated report on comparative effectiveness of ACE inhibitors, ARBs, and direct renin inhibitors for patients with essential hypertension: much more data, little new information.* 2012. Journal of General Internal Medicine. 6: 716-729.

Rao MS. *Inhibition of the renin angiotensin aldosterone system: focus on aliskiren*. 2010. The Journal of the Association of Physicians in India. 58: 102-108.

Salazar Vázquez BY, Martini J, Chávez Negrete A, Cabrales P, Tsai AG, Intaglietta M. *Microvascular benefits of increasing plasma viscosity and maintaining blood viscosity: counterintuitive experimental findings.* 2009. Bioheology. 3: 167-179.

Salazar Vázquez BY, Martini J, Chávez Negrete A, Tsai AG, Forconi S, Cabrales P, Johnson PC, Intaglietta M. *Cardiovascular benefits in moderate increases of blood and plasma viscosity surpass those associated with lowering viscosity: Experimental and clinical evidence.* 2010. Clinical Hemorheology and Microcirculation. 2: 75-85.

Salazar Vázquez BY. *Blood pressure and blood viscosity are not correlated in normal healthy subjects.* 2011. Vascular Health and Risk Management. 8: 1-6.

Solti F, Sebestyén M, Szabó Z, Czakó E, Rényi-Vámos F Jr. *Hypertension secondary to bradycardia: blood pressure regulation under the effect of impaired cerebral blood flow and bradycardia*. 1980. Acta Medica Academiae Scientiarum Hungaricae. 37: 167-175.

Verdon F, Jacot E, Boudry JF, Chuat M, Truong CB, Studer JP. *[Seasonal variations of blood pressure in normal subjects and patients with chronic disease].* 1997. Archives des Maladies du Coeur et des Vaisseaux. 9: 1239-1246.

Werner C, Pöss J, Böhm M. *Optimal antagonism of the Renin-Angiotensin-aldosterone system: do we need dual or triple therapy?* 2010. Drugs. 10: 1215-1230.

Widimský J. [*Target values in hypertension treatment. Will they apply in older patients with hypertension, diabetics and in patients with IHD*?]. 2009. Vnitrni Lekarstvi. 9: 833-40.

Table 1.0 Classification of Blood Pressure for Adults (18+ years of age)
According to the American Heart Association can be viewed at:
http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/AboutHighBloodPressure/Understanding-Blood-Pressure-Readings_UCM_301764_Article.jsp

Table 2.0 Classification of Normal Pulse Rates (beats per minute) for According to

The American Heart Association (Citation in references) can be viewed at:

http://www.heart.org/HEARTORG/GettingHealthy/PhysicalActivity/Target-Heart-Rates_UCM_434341_Article.jsp

APPENDIX A

Table 1 – Raw data comparing the systolic blood pressures between groups A and B.

Group A Systolic Blood Pressure (mmHG)	Group B Systolic Blood Pressure (mmHG)
114	135
119	139
112	132
120	142
115	140
118	138

Group A standard deviation - 3.14113

Group B standard deviation - 3.61478

The F-ratio is used to compare variances.
Group A sample size: 6, degrees of freedom (6-1) = 5
Group B sample size: 6 degrees of freedom (6-1) = 5

Probability = 0.10 DFn=5 DFd=5

F-ratio= 3.4530
10.00% of a F distribution has values greater than 3.453.

Probability that the difference was due to chance = 0.87, significant difference between the variances of the two samples since it's greater than 0.10 critical value.

Table 2 – Raw data comparing the diastolic blood pressures between groups A and B.

Group A Diastolic Blood Pressure (mmHG)	Group B Diastolic Blood Pressure (mmHG)
78	82
79	84
71	80
76	85
72	85
75	82

Group A standard deviation - 3.18852

Group B standard deviation - 2

Table 3 - Raw data comparing the pulse rates between groups A and B after a 10 minute fitness test at 50 rpm.

Group A Pulse Rate (BPM)	Group B Pulse Rate (BPM)
165	162
145	168
153	171
157	166
148	160
151	164

Group A standard deviation - 7.11102

Group B standard deviation – 4.02078

Table 4 – Raw data comparing the average systolic blood pressures between groups A and B after a 10 minute Fitness Test at 50 rpm.

Group A Systolic Blood Pressure (mmHG)	Group BSystolic Blood Pressure (mmHG)
123	139
112	141
115	135
114	134
121	140
118	142

Group A standard deviation - 4.26224

Group B standard deviation – 3.27109

Probability that the difference was due to chance = 1.30, significant difference between the variances of the two samples since it’s greater than 0.10 critical value

Table 5 - Raw data comparing the average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 22 ^{o}C.

Group A Systolic Blood Pressure (mmHG)	Group B Systolic Blood Pressure (mmHG)
119	141
117	139
115	138
118	134
114	141
120	137

Group A standard deviation - 2.31661

Group B standard deviation – 2.65832

Probability that the difference was due to chance = 0.87, significant difference between the variances of the two samples since it's greater than 0.10 critical value

Table 6 - Raw data comparing the average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 4 ^{o}C.

Group A Systolic Blood Pressure (mmHG)	Group B Systolic Blood Pressure (mmHG)
124	137
116	142
118	140
122	135
117	141
119	136

Group A standard deviation - 3.07679

Group B standard deviation – 2.88097

Probability that the difference was due to chance = 1.07, significant difference between the variances of the two samples since it's greater than 0.10 critical value

Table 7 - Raw data comparing the average systolic blood pressures between groups A and B after a 10 minute temperature treatment at 40 ^{o}C.

Group A Systolic Blood Pressure (mmHG)	Group B Systolic Blood Pressure (mmHG)
115	136
119	138
120	141
117	136
117	138
115	134

Group A standard deviation - 2.04124

Group B standard deviation – 2.40139

Probability that the difference was due to chance = 0.85, significant difference between the variances of the two samples since it's greater than 0.10 critical value

Table 8 – Raw data comparing the systolic blood pressures between groups A and B after consuming a natural ACE inhibitor (Pomegranate Juice) and natural diuretic (Parsley tea with Lemon) for 3 days

Group A Systolic Blood Pressure (mmHG)	Group B Systolic Blood Pressure (mmHG)
117	132
114	133
119	130
115	137
116	128
118	129

Group A standard deviation - 1.87083

Group B standard deviation – 3.27109

Probability that the difference was due to chance = 0.57, significant difference between the variances of the two samples since it's greater than 0.10 critical value.

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