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The Effects of Habitual Protein Consumption on Vasodilation in Young Adults

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Abstract

Introduction: Blood pressure is a critical indicator for a number of health risks and conditions, such as hypertension (high blood pressure), heart failure, and stroke. Decreasing blood pressure occurs by vasodilation (relaxation) of blood vessels. The consumption of high amounts of protein is hypothesized to have a correlation with the vasodilation of vessels, thus creating a decrease in blood pressure. **Purpose:** The purpose of this study was to relate blood vessel diameter to habitual protein consumption. Our findings have the power to make individuals more aware of the effect their habitual protein intake can have on cardiovascular health. **Methods:** This study was comprised of 20 individuals between the ages of 18-23 years (15 females, 5 males), divided into distinct categories based on self-reported 24-hour dietary recall values. Categories were classified as the following in grams of protein for kilogram of body weight: <1.2 and >1.2. While continuing their normal dietary habits, blood vessel diameter was evaluated with an ultrasound machine before and after a 5-minute occlusion to determine vessel response to flow mediated dilation (FMD). Diameter measures were taken during a relaxed state with the participant lying in the supine position for a total of 9 minutes. Twelve measurements on the participant's brachial artery of the right arm were obtained pre-occlusion and 12 post-occlusion. The average of the 12 measurements was used in all analyses to determine a pre-occlusion average value and post-occlusion average value. **Results:** The Repeated Measures ANOVA statistical analysis of vessel diameter change between participant groups of varying habitual protein intake was found to have no statistical significance ($p > .05$). When analyzed for sex-related differences, pre- and post-diameter values presented a trend for statistical significance with a value of ($p = .06$) between men and women. **Conclusion:** When analyzing the association between blood vessel diameter and habitual protein consumption with the use of FMD and ultrasound, our findings indicate

there was no significant effect. As evidenced by the trend for statistical significance, there is potential for sex-related differences. This trend suggests a possible relationship between sex-related responses to vasodilation, pre- and post-occlusion; thus, further investigation is warranted.

Introduction

Blood pressure can be a critical indicator when discussing a number of health risks and conditions. Having high blood pressure, or hypertension, increases the risk for heart attack, heart failure, stroke, kidney disease, and cardiovascular disease (CVD), which is the greatest cause of death globally (Chobanian, Bakris, & Black, 2003; Fekete, 2016). High blood pressure slowly weakens the heart and arteries it flows through, heightening one's susceptibility to stroke, arterial clots, heart disease, organ damage, and many other life-threatening conditions (Fekete, 2016). By increasing vessel diameter through vasodilation, resistance to blood flow decreases, consequently decreasing blood pressure (Mayo Clinic, 2016). Hypertension, or high blood pressure, is a medical condition as well as a public health issue that is becoming increasingly pressing as 33% of US adults are burdened by hypertension (Ballard, 2015). Blood pressure plays a key role in the diagnosis and treatment of hypertension (according to the American College of Cardiology is any SBP or DBP above 130/80 mmHg), cardiovascular disease, heart disease, and stroke. Heart disease is the leading cause of death for men and women – 1 in 4 deaths – and hypertension is a risk factor for heart disease (Whelton, Carey, 2018). Hypertension has further implications as metabolic disorders such as type 2 diabetes and metabolic syndromes are associated with increased CVD-related mortality (Ballard, 2015). Decreasing blood pressure is vital to the health of people across the country as it can help decrease the risk of stroke, cardiovascular disease, and other cardiovascular and circulatory diseases (Chobanian, Bakris, & Black, 2003). The relationship between high blood pressure and the mortality rate from strokes is strongly correlated (Prospective Studies Collaboration, 2002). Thus, mechanisms for decreasing and controlling high blood pressure are needed. This can be achieved through better strategies and habits aimed at improving endothelial health.

Reducing blood pressure can be accomplished primarily through vasodilation of blood vessels, resulting in a decrease of the resistance of the blood flow, as the vessel walls relax (Mayo Clinic, 2016). Vessel diameter is extremely important as it plays a vital role in determining blood pressure, which in turn can cause life-threatening cardiovascular conditions if not kept in check (Schuler, 2014). As the vessel diameter decreases, one's blood pressure increases because the same blood volume is in contact with the smaller vessel walls, increasing resistance. Inversely, as vessel diameter increases, one's blood pressure decreases. By decreasing blood pressure through vasodilation of vessels throughout the body, the risks and conditions associated with high blood pressure can decrease, increasing the health of many people in America.

Vasodilation can be the result of many factors and stimulants, including hormones, neurotransmitters, excitatory or inhibitory stimuli, and can take place locally or systemically throughout the body. It can occur through a cascade of signals in response to physiological signals that are detected by the body from the nervous system (Holowatz, Thompson-Torgerson, 2007). In addition, certain sympathetic reflexes can initiate this vasodilation stimulus for the body as a whole, or in a localized area (Kellogg, 2006). Protein, a macromolecule consisting of amino acids as building blocks, has a variety of functions including membrane and vessel composition. Proteins in the structure of these vessels can respond to stimuli, resulting in vasodilation of blood vessels, and therefore decreasing blood pressure. The consumption of protein is hypothesized to have an effect on the vasodilation of vessels, which can be measured using flow-mediated vasodilation paired with an ultrasound machine (GE Logiq, 2017). Ultrasound has been proven to be a dependable method in determining flow-mediated dilation as blood vessel diameter is a reliable indicator of endothelial function (Serizawa, 2015). Blood vessel diameter can then be compared to normative values for that vessel to determine if one's vessels are more constricted or dilated than they should be for proper cardiovascular health. Diameters deviating from the expected normal may give signs of malfunctioning endothelium surrounding the blood vessels (Serizawa, 2015; Sorenson, 1994). Healthy endothelium serves to prevent atherosclerosis through protective actions as well as excreting vasodilators into the bloodstream (Lind, 2015). As a result, endothelial dysfunction is often times an early marker of atherosclerosis, or narrowing of the arteries, and indicates vascular dysfunction (Naka, 2012; Fekete, 2016). Moreover, endothelial dysfunction frequently accompanies CVD risk factors such as diabetes, aging, and hypercholesterolemia (Ras, 2011).

Although there have been a number of studies conducted on flow-mediated dilation as a whole and its possible implications of future cardiovascular problems, almost none have investigated the effect of habitual protein consumption on vasodilation. Many previous studies have been conducted on both animals and human subjects and look at factors such as age, menopause, diabetes, endogenous molecules, and exercise. In addition, other studies have evaluated the role of protein consumption in cardiovascular health, particularly hypertension, but compared habitual consumption protein consumption with supplemented whey protein consumption (Fekete, 2016). However, with so many factors contributing to one's endothelial function and cardiovascular health, there are still many elements yet to be investigated. By conducting this study to explore the potential relationship between varying levels of habitual protein consumption and flow-mediated dilation, the knowledge base surrounding vasodilation of our blood vessels can be expanded.

The purpose of this study was to obtain a measurement of blood vessel diameter and a corresponding protein consumption value to establish a relationship between protein consumption and vasodilation of vessels. This relationship will determine if high protein consumption is beneficial in reducing blood pressure and ultimately lowering cardiovascular disease. It is hypothesized that a decrease in blood pressure will occur with high habitual consumption of protein through vasodilation. The second purpose of this study is to determine if the hypothesized correlation between habitual protein consumption and vasodilation are further affected by sex.

Methods

This was a cross-sectional study comparing participants between the ages of 18-39 years, male and female, of low and high habitual protein consumption for differences in vessel diameter of the brachial artery. According to the Dietary Reference Intake (DRI) by the Institutes of Medicine, >1.2 grams of protein per kilogram of body weight is classified as high protein consumption and <0.8 grams of protein for kilogram of body weight is classified as low protein consumption. For the purpose of this study, high protein consumption was defined as >1.2 grams of protein per kilogram of body weight and average protein consumption will be defined as <1.2 grams of protein per kilogram of body weight.

The study was comprised of 20 individuals (18-22 years of age), 15 females and 5 males, recruited from the University of Arkansas and the surrounding community. Each participant met the stated inclusion criteria and upon arrival to the University of Arkansas Exercise Science Research Center were categorized as having average or high protein consumption based on a 24-hour dietary recall. Males and females were placed into separate high protein consumption groups and average protein consumption groups, for a total of four distinct groups. These participants were healthy individuals with no known cardiovascular disease or history of heart conditions or diseases. The inclusion criteria were as follows:

- Males and females, ages 18-39 years
- Non-smokers
- No history of cardiovascular disease or condition

Participants were excluded if:

- Currently taking protein supplementation
- Currently taking prescription medication for cognitive or emotional disorders
- On medication for ADD or ADHD (Adderall, Vyvanse, Ritalin, etc.)
- History of high or low blood pressure, or other cardiovascular conditions.

Twenty-four hours prior to testing, participants were instructed to abstain from the consumption of any caffeine, stimulants, or blood thinners (such as ibuprofen, Advil, or aspirin) until data collection was completed. On the day of testing, participants reported to the Exercise Science Research Center on the University of Arkansas campus. Once there, participants were asked to complete an informed consent, 24-hour dietary recall log, and physical activity questionnaire. After the participant's weight and height were recorded, vessel diameter was evaluated using the Logiq e ultrasound and data were recorded. The Logiq e ultrasound is a sophisticated and accurate machine used for viewing a variety of anatomical structures in the body and is highly valid in viewing blood vessels. Flow-mediated dilation (FMD) was utilized in conjunction with ultrasound imaging of the brachial artery as this introduces a stressor to the vessel and produces a response from the artery. To do this, the participant was instructed to lie supine with the medial aspect of their right, upper arm easily accessible as the brachial artery is most superficial as it nears the axilla. Imaging the vessel at its most superficial location allowed for more accurate and complete evaluation of its diameter. Additionally, the CF color mode was used on the Logiq e ultrasound machine to more easily see pulsation of the vessel. The stressor was then introduced at the most distal end of the forearm in the form of a pressure cuff. When unoccluded, the cuff was deflated. When occluded, the cuff was inflated to 270 mmHg. Measurements were obtained with the participant lying supine for 2 minutes with the brachial artery unoccluded, 5 minutes occluded, and 2 additional minutes unoccluded, for a total of 9 minutes. A total of 24 values (12 pre-occlusion and 12 post-occlusion) were taken per participant and the pre-occlusion average values and post-occlusion average values were used for all analyses.

Prior to data collection, each technician was trained and tested for competency and reliability in using the Logiq e ultrasound so as to provide the most accurate data collection and analysis.

Results

This study sample was comprised of 20 individuals (5 males, 15 females). The ages of the participants ranged from 18-23 years with an average of 20.5 years of age. The participants had an average height of 1.705 meters and an average weight of 70.33 kilograms.

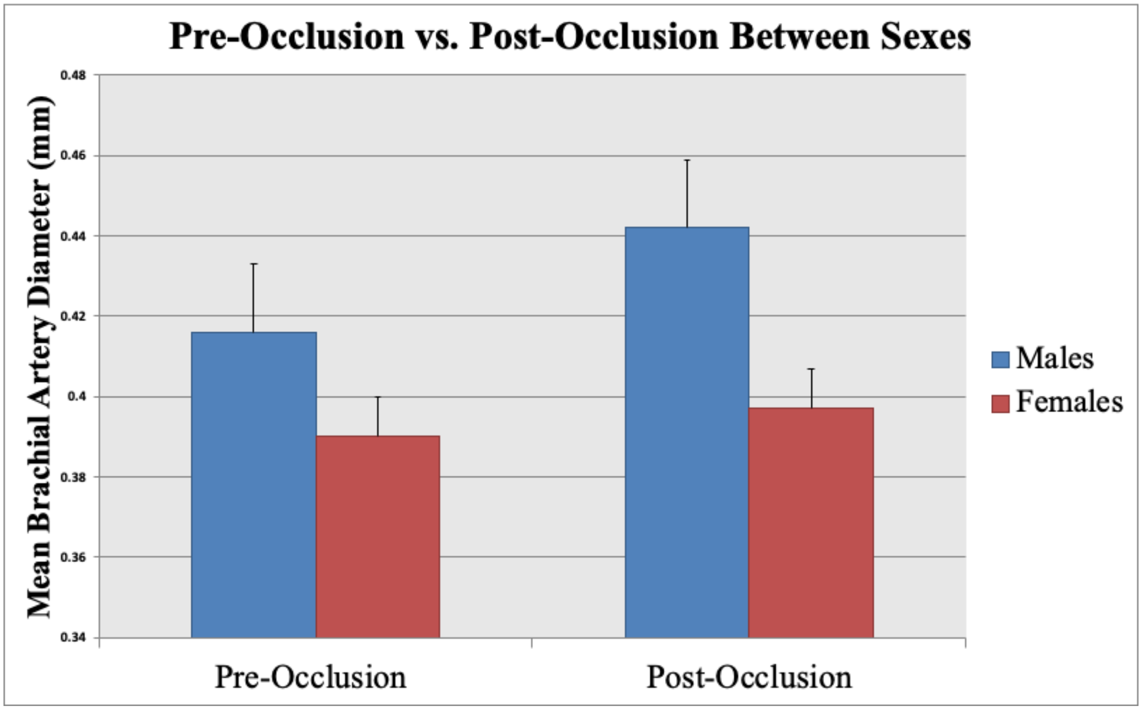
There were no significant differences between the high and average habitual protein groups when comparing their pre- and post-occlusion values. The Repeated Measures ANOVA statistical analysis of vessel diameter change between participant groups of varying habitual protein intake was found to have no statistical significance ($p > .05$). The average habitual protein consumption group (<1.2 g/kg) had a pre-occlusion vessel diameter average of 0.3850mm and a post-occlusion vessel diameter average of 0.3996mm. The average vessel diameter change for this group was 0.0146mm. The high habitual protein consumption group (>1.2 g/kg) had a pre-occlusion vessel diameter average of 0.4017mm and a post-occlusion vessel diameter average of 0.4046mm. The average vessel diameter change for the high protein consumption group was 0.0029mm. Therefore, there was no statistical significance, rejecting our hypothesis (p = .65).

When analyzed for sex-related differences, pre- and post-diameter values presented a trend for statistical significance with a value of (p = .06) between men and women.

Table 1. Initial demographic between groups.

	High Protein Consumption Group (*n* = 14)	Average Protein Consumption Group (*n* = 6)
Age (years)	20.3	21
M/F	3/11	2/4
Height (m)	1.709	1.695
Weight (kg)	68.69	74.14
Protein Consumption (grams)	115.18	68.82
Pre-Occlusion (mm)	0.4017	0.3850
Post-Occlusion (mm)	0.4046	0.3996
Difference (mm)	0.0029	0.0146

Figure 1. Pre- and Post-Occlusion value comparisons between sexes.



Discussion

This study gave insight into the relationship between habitual protein consumption and the vasodilation of vessels that not many other studies have examined. There was no significant difference between protein consumption and vessel vasodilation. However, there was a trend when analyzing the sex-related differences for pre- and post-occlusion changes on vessel vasodilation that point toward a potential statistical significance.

This potential relationship requires more advanced measurement accuracy for further evaluation for statistical significance. There were possible sources for error that could have made an impact on the values, including ultrasound measurement and vessel diameter miscalculations, and possible inaccuracies with the protein consumption values from the self-reported dietary log.

The specific population that was tested for this research hypothesis was between the ages of 20-24, with a majority being 21. This sample size of participants, even though the study was open to people of 18-39 years of age, was very narrow. This group of 20-24 year olds were generally healthy individuals and were of good physical health status. This small sample of the population may have provided an unrepresentative image of the actual endothelial health of 18-39 years olds and could have reflected why a huge difference was not seen in vasodilation between the two groups. In addition, the extreme ends of habitual protein consumption were not measured. The participants were grouped as average and high groups based on the Dietary Reference Intake (DRI) by the Institutes of Medicine. Once separated, the gaps between the groups were not on extreme ends of each other, therefore, creating a possible discrepancy for no significant results. Studying a more extreme gap between protein consumption groups, such as <0.8 g/kg and >1.6 g/kg, could show a trend or significance.

Although there was no statistical significance in the relationship between habitual protein consumption and vasodilation, the trend of sex differences proves that with more data collection on the topic, there is potential for future significant findings. In another study (Tremblay, Stimpson, Pyke, 2018), sex differences in relation with oscillatory shear stress and endothelial function were analyzed. Statistically significant results were found between males and females, and their corresponding endothelial function (Tremblay, Stimpson, Pyke, 2018).

Habitual protein consumption had no statistical significance on vasodilation of vessels, but studies show that there is a relationship between protein supplementation and vasodilation of vessels (Hagiu, 2017). Here, the mechanism of the protein molecule results in a release of nitric oxide, which is a known vasodilator (Hagiu, 2017). Further research could show the mechanistic difference between why nitric oxide is released from protein supplements but not from protein consumption from a habitual dietary source.

While this healthy population did not show results to support the hypothesis, using a population that has more compromised endothelial function could potentially show statistically significant results. The changes that could result between the vasodilation of a healthy individual and a participant with endothelial dysfunction can be analyzed using flow mediated dilation and ultrasound (Matsui, Kajikawa, Maruhashi, 2018).

A possible source of error influencing the results of the study could have arisen when analyzing the images on the FMD ultrasound, since they were manually measured and recorded. A more accurate analysis system using the Quipi FMD Studio software would give more reliable, consistent measurements. Additionally, the subjective nature of the 24-hour dietary recall may lead to inaccuracies due to imprecise portion sizes, inexact food sources, or lapses in memory.

The findings from this study helped us better understand the effects of habitual protein consumption on vasodilation in young adults. While they did not support our hypothesis based on previous research, we believe there is potential for further research into this topic and related areas.

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