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Hypertension Prevalence in College Seniors

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HYPERTENSION PREVALENCE IN COLLEGE SENIORS

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Section I - Introduction

High blood pressure is a condition known as hypertension, and it has been growing in the United States and the world in large numbers. Approximately 75 million Americans have hypertension, and hypertension in early life has been shown to increase the risk of having hypertension later in life. For this reason, college students were studied. This research paper addressed the issue of hypertension prevalence in college-aged students. As a population, college students have not be studied in great detail as to the prevalence of hypertension. This paper also discussed correlations with high blood pressure and what risk factors may predispose college students to this disease. For this, we sought to answer the following research questions:

1. Do college seniors display prehypertensive or hypertensive blood pressures?
2. What factors predispose a college student to having prehypertensive or hypertensive blood pressures?
3. Is there any correlation between certain factors and the prevalence of prehypertensive and hypertensive blood pressures?

From these questions, investigators hypothesized that there would be some college students that present as having high blood pressure (systolic pressure greater than 120 mmHg and/or diastolic pressure greater than 90 mmHg), and of those students that do present with this disease, there will be factors that correlate to the prevalence of high blood pressure.

Section II - Literature Review

Hypertension is characterized as abnormally high blood pressure, especially arterial blood pressure (Merriam-Webster). Hypertension severely affects the normal operations of the

circulatory system of the body and, more specifically, the way in which blood pressure operates within the body. Blood pressure is the amount of pressure that blood exerts onto the walls of the blood vessels of the body. This is normally expressed (in regards to units) in millimeters of Mercury, written *mmHg*. Blood pressure (BP) ensures that the body functions properly. For the purposes of this study, the focus was on the presence of high blood pressure, also known as *Hypertension (HTN)*. The prevalence of pre-hypertensive blood pressures was studied.

Hypertension is a severe medical issue that is sweeping across our nation in alarmingly large numbers (ASH, 2017). Approximately 75 million Americans have hypertension defined as having a resting systolic blood pressure $\geq$ 140 mmHg and/or diastolic blood pressure $\geq$ 90 mmHg, taking antihypertensive medication, or being told by a physician or other health care professional on at least two occasions that an individual has high blood pressure (Lippincott 2013). A prehypertensive blood pressure may be categorized as 120/80 but lower than 140/90. Anything below this (120/90) is considered to be a "safe" blood pressure. However, blood pressure readings as low as 115/75 mmHg are associated with higher than desirable risk of ischemic heart disease and stroke (Lippincott 2013).

Hypertension has been a growing problem in the USA and the world over in recent years. In longitudinal studies conducted over several decades there has been shown to be a marked increase in the prevalence in hypertension over the past 20 years (Rao, 2012). From 1970 to 1990, there was actually a decrease in the prevalence of hypertension from 32% to 25%. From 1990-2005 there began a large increase in diagnosed cases with hypertension, jumping from 25% to 28.6% and rising ever since. Across the world, hypertension is also a problem. In this same study, it was noted that Italy had a hypertension prevalence of 38% (being the lowest of 6 European countries surveyed) with Germany having the highest prevalence of 55%.

Hypertension causes many issues across the body that are often unseen and are not felt. For this reason, HTN is called the "silent killer." Many of the complications and symptoms of HTN are often not able to be detected or felt by most people (Ong et al., 2006), and due to this, HTN can go undetected for long periods of time. Oftentimes, by the time hypertension is detected, there has been a considerable amount of damage done. HTN does several things to damage the body (Burt et al, 1995), including causing atherosclerosis, aneurysms, heart disease, heart failure, diabetes (Sowers et al., 2001), as well as many other fatal issues. This small, rarely-noticed disease can turn, very rapidly, into one if not several severe diseases that can cause damage and death.

Hypertension is a very widespread condition affecting people of all ages, ethnicities and both males and females alike. It is a condition that is financially costly to treat and prevent because of measures that must be taken such as medications, diet plans and exercise plans. In America alone, 75 million adults have hypertension, with less than half of these having their condition under control (CDC, 2016). Another 33% of the American population have pre-hypertensive blood pressures - bringing the total proportions of people with hypertension or prehypertension to nearly 60% of adults in America. Due to this, treatment related to this disease costs the USA $46 billion annually (CDC, 2016).

Hypertension can affect any person, regardless of age. In industrial societies, a noticeable and progressive increase in blood pressure is seen as age increases (Franklin et al, 1997). For those people that have reached the ages of 65-74, over 65% of people are classified as having hypertension, with this number rising to nearly 80% for ages greater than 75 (Buford, 2016). These changes are most often due to increased peripheral resistance (Franklin et al, 1997) as blood vessels undergo change and become less flexible as aging progresses. All of these

changes take place without the presence of hypertension earlier in life, indicating that humans are susceptible to later-life hypertension without any other factors playing a role.

Children and young adults (classified as being aged 3 to 18) are also at risk for developing and having hypertension. Hypertension in early life has been shown to increase the risk of having hypertension later in life (Al-Majed and Sadek, 2012), and the prevalence of childhood hypertension and prehypertension is nearly as high as the prevalence in adults - close to 30%, including obese and overweight children (Riley, 2012). There are several factors that would lead a child or young adult to develop hypertension or prehypertension. These include being overweight or obese, having a family history of hypertension or cardiovascular disease, being male, and having parents who smoked during pregnancy; race and ethnicity have currently not been tied to hypertension and prehypertension prevalence in children (Riley, 2012).

College students, as a group, are an important population to investigate in regards to hypertension. Due to the prevalence of pre-hypertensive or hypertensive blood pressures that starts early in life and only increases across the lifespan (Al-Majed and Sadek, 2012), college students provide an interesting group to study. College students are classified as being a part of the adult population, but this group rarely has high rates of hypertension if presenting at all. In fact, for ages 20 to 34, there is only a 7.4% prevalence of hypertension among the general population - less than 8 out of every 100 persons (Buford, 2016). It is not the prevalence of hypertension in this age group that needs to be studied - it is the effect that factors, common during this stage of life, will have on later stages of life, such as middle and late adulthood. If we are able to discover what factors predispose a college student (or any younger person) to have pre-HTN or HTN, we may be able to reduce the future prevalence of prehypertensive and hypertensive blood pressures. There are several possible reasons as to why young adults and

college-aged students would partake in activities that could predispose them to having prehypertension and hypertension later in life, such as drinking heavily and eating out consistently. One of these ideas, known as Teen Invincibility Syndrome or the Personal Fable, suggests that teens engage in risky behavior because consequences will "always affect someone else, not me." They believe themselves to be the exception to the rule and therefore act as though they are invincible (Wickman et al., 2008). This phenomenon could explain why college aged people engage in activities that could one day lead to hypertension. College aged students may partake in these activities and essentially sign themselves up for having hypertension later in their life, even though their body may not react accordingly now.

Furthermore, very few studies have been conducted on the college age-range, giving little to no information about what characteristics might predispose a college student to having higher than recommended blood pressure. Majed and Sadek (2012) have conducted research on HTN in college students in Kuwait, but other than this, little to no research exists on college students. This exact study even mentions the fact that in Kuwait, all blood pressure studies have been conducted on adults, and none have been conducted on college age students - making that study the first to look at prehypertension and hypertension in current college students.

Of the plethora of blood pressure studies that have been conducted for all age groups, most of these have consisted of testing for the same risk factors, many of which are now clearly linked with the presence of hypertension. These factors include alcohol consumption, poor eating habits, and sedentary lifestyles, to name a few. These factors have been shown time and time again to be linked to the prevalence of hypertension and prehypertension and are not contested in regards to this. However, there may also be factors that could lead to hypertension and prehypertension other than these well-known links. With 76 millions Americans having

been diagnosed with hypertension (CDC, 2016), and an additional 33% of adults having prehypertension, there could be more underlying risk factors that could predispose people to these higher than desirable blood pressures than simply diet and exercise.

Therefore, this study seeks to answer the following three research questions.

1. Do college seniors display prehypertensive or hypertensive blood pressures?
2. What factors predispose a college student to having prehypertensive or hypertensive blood pressures?
3. Is there any correlation between certain factors and the prevalence of prehypertensive and hypertensive blood pressures?

The hypothesis will be stated as a series of statements.

1. Very few subjects will present with prehypertension or hypertension.
2. Of those that do present with these blood pressures, certain factors will be present that will have predisposed them to these conditions (alcohol consumption, studying habits, etc).

Section III - Methods

For this research project, the goal was to explore what factors may be the cause of HTN in the college-age population - specifically, those who were currently attending a college or a university. Investigators used the sample population of college students who were enrolled as students at a large Midwestern university.

Data was collected in the Exercise Physiology lab of the college campus. All data was collected from students enrolled in the undergraduate senior level course Exercise Science Capstone course (course number 5550:485:002). All subjects recruited for the study were senior level students who were set to graduate in either May, August, or December of 2017, and each of the participating students were declared Exercise Science majors. Data was collected on March 22nd, 2017, between 9:55 and 11:35 am.

Resting blood pressure was collected using a standard aneroid sphygmomanometer, cuff, and stethoscope. The same equipment was used to gather all of the data to keep it as consistent as possible. To gather the qualitative variables, a self-reported survey was administered to each participant. Participants completed the survey, but were not asked to identify themselves. This ensured that the study remained anonymous.

Procedures

Data collection began by weighing each participant and measuring their height and weight. Following this, the participants were instructed to sit in a chair for approximately five minutes to allow their blood pressure to acclimate. After waiting, their blood pressures were taken, one sample per arm. An average of the two readings were taken.

Once blood pressures were taken, subjects were asked to complete the form. Each participant was asked to fill it out as honestly as possible. The subjects were informed that no

identifying information was being asked of them. This allowed the study to remain anonymous, and also encouraged honesty in responses. Once they filled out the forms to completion, the subjects were allowed to leave the lab (see Appendix A).

Research Design

Once the data was collected, a Linear Regression Analysis was used to analyze the data. Several factors were tested for: the prevalence of hypertension and prehypertension, commute time, living arrangements, dietary habits, and school life will be among the various risk factors surveyed. Two types of comparisons were made: a.) systolic blood pressures to a risk factor, or b.) risk factor to risk factor. This provided conclusions on whether or not there was any correlation between systolic hypertension and prehypertension as well as to see if there was any correlation between two individual risk factors. Comparisons were only used as significant if the P-Value from the test was less than or equal to 0.05. Anything above this number showed neither correlation nor significance.

Section IV - Results

After conducting evaluations , blood pressures and analyzing the data, several conclusions emerged. Of all the subjects that participated, zero participants tested positive for Hypertension. In addition to this, only five persons tested positive for Prehypertension - three students having only Systolic prehypertension, with the final two having prehypertension of both their Systolic and Diastolic values. For the purpose of the results, systolic pressure will be examined. Diastolic pressures were not examined due to the fact that only two subjects presented with prehypertension, making our N-size far too small.

	N Size	Average BMI	Average Systolic BP	Average Diastolic Bp
Male	8	26.2 ± 2.6	114.8 ± 5.9	70.7 ± 4.4
Female	22	26 ± 5.6	115 ± 3.6	68.5 ± 6.4

Table 1. *Table showing - for each gender - N size, Average BMI and Standard Deviation, and Average Systolic and Diastolic blood pressures and Standard Deviation for both.*

There were very few true correlations that connected Blood Pressure to risk factor, and there were even fewer correlations between risk factors. For the purposes of this study, "correlation" refers to having a P-Value of less than or equal to 0.05. This P-Value means that the data collected was significant when compared to another set of data, such as systolic blood pressure being compared to commute time. Any data comparisons with a P-Value greater than 0.05 constitutes little to no significance and therefore no correlation.

When compared to systolic blood pressure, there were several factors that correlated to having prehypertensive values. These were: commute time, having changed college major at some point during your college career, the number of alcoholic drinks that are consumed per week on average, how many hours were spent working per week, and current plans after

graduation.

Of all of the subjects surveyed, just over half of them reported that they had changed their college major (see Figure 1). Upon further investigation, those subjects with prehypertension all reported to have at one point, changed their major. This finding identifies the relationship between declared major and prehypertension, $R^2 = 1$, meaning that there is a direct correlation for those with prehypertension.

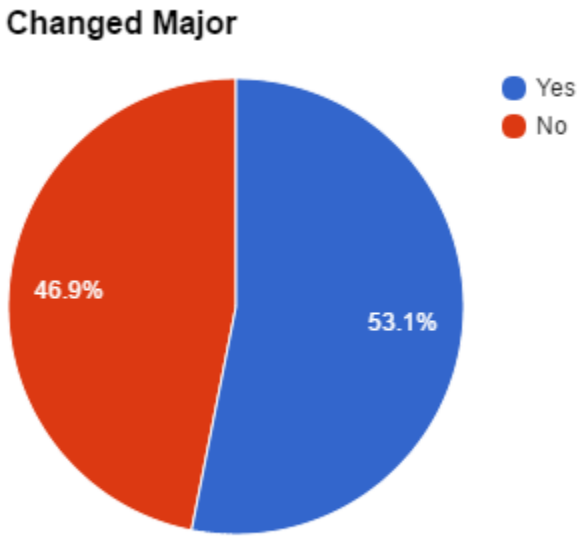

Figure 1. *A Pie chart showing the proportion of subjects who have previously changed their major, regardless of blood pressure.*

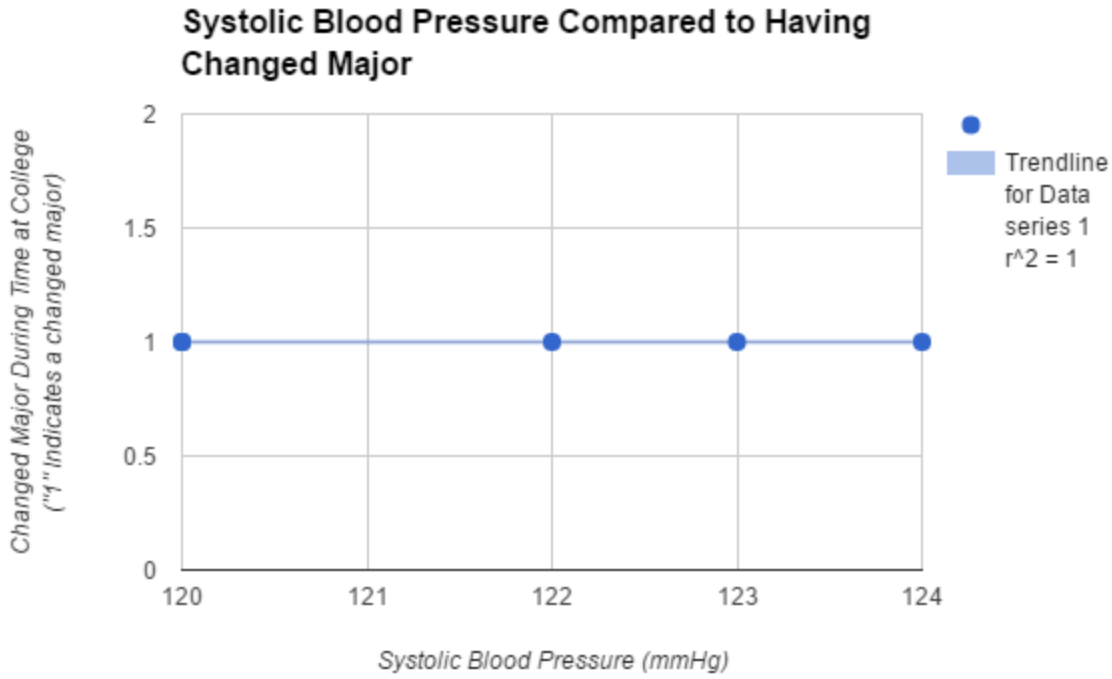

Figure 2. *A scatterplot showing systolic blood pressures compared to having changed major during college in subjects with prehypertension.*

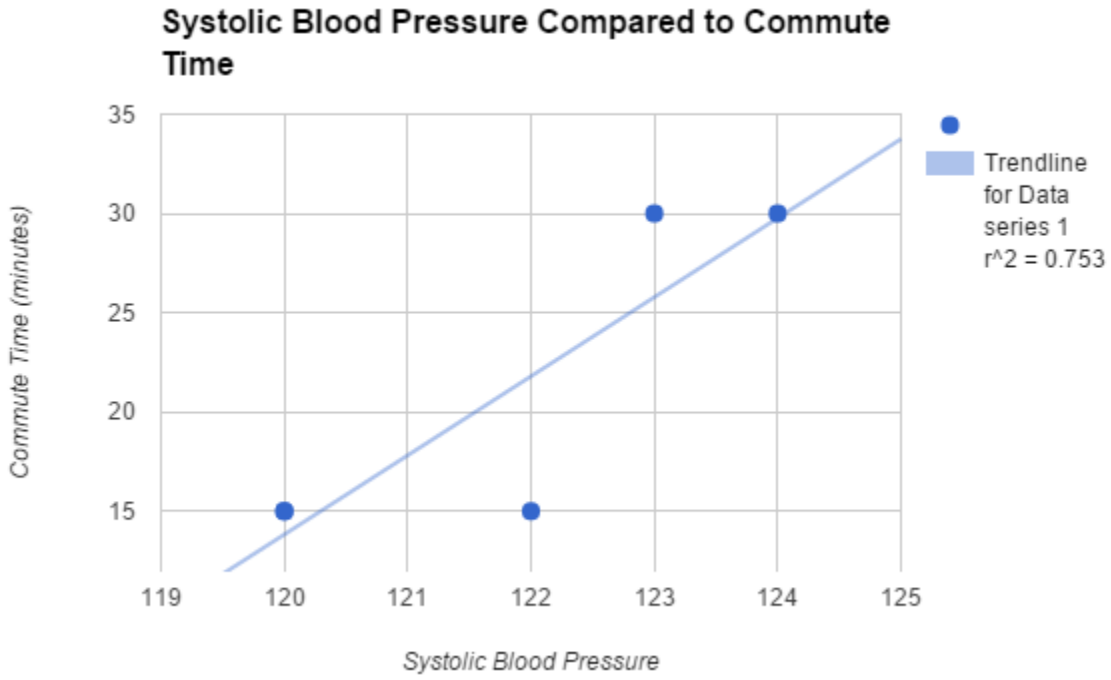

Figure 3. *A scatter plot showing the correlation between commute time and systolic blood pressure for those subjects with prehypertension. P = 0.05.*

The above scatterplot shows a fairly strong correlation between prehypertensive systolic blood pressure and commute time (expressed in minutes), with an R^2 value of 0.753. With a P-value = .05 this correlation is shown to be significant.

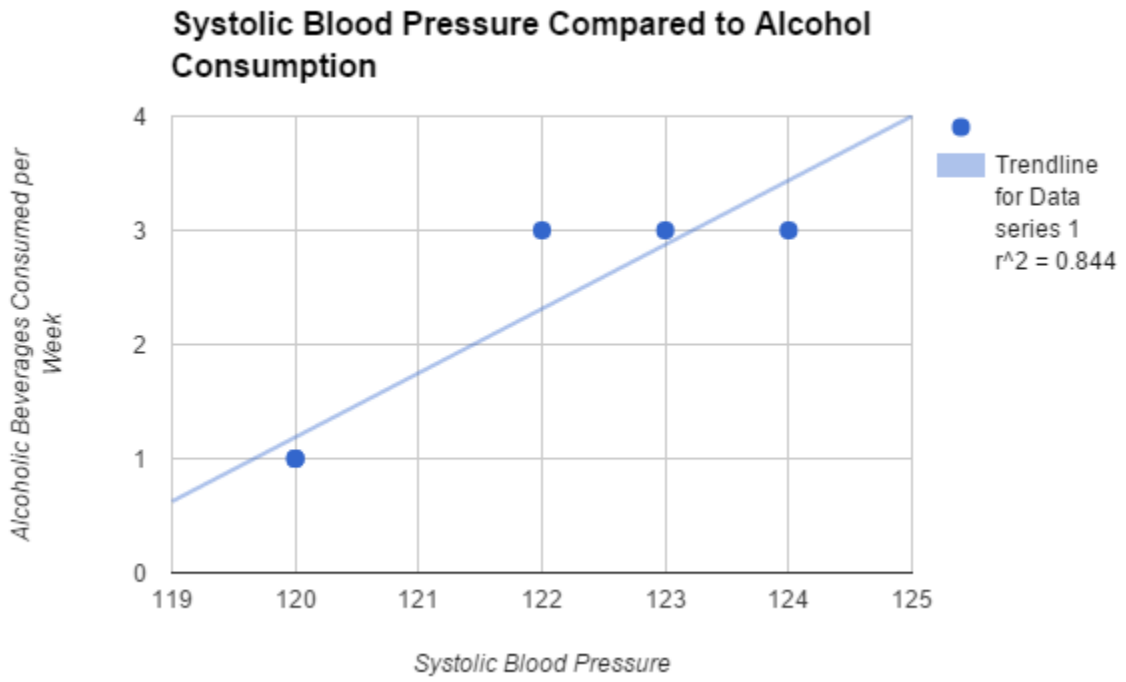

Figure 4. *A scatterplot showing the correlation to alcoholic drinks consumed per week to systolic blood pressure (expressed in mmHg) in those subjects with prehypertension. P = 0.02.*

With an R^2 value of 0.844, there is a very strong correlation between systolic prehypertension (in mmHg) and alcoholic drinks consumed per week in those subjects with hypertension. This correlation has a P-Value of 0.02, showing the significance between these two data sets.

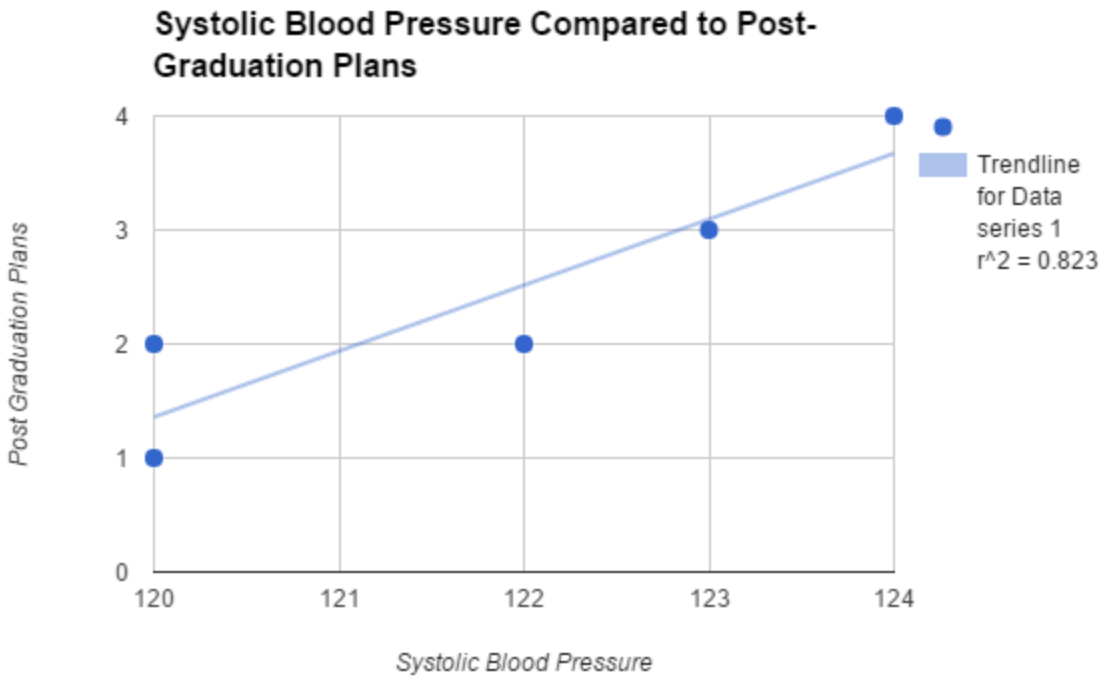

Figure 5. *A scatterplot showing the correlation of systolic blood pressure compared to post-graduation plans. P = 0.03.*

On the scatterplot shown above: "1" signifies that the subject has been accepted to a graduate school; "2" signifies that these subjects are waiting to be accepted to a graduate school; "3" signifies an "other" plan, such as taking a year off of school to travel or to work; and finally, "4" signifies that the subject is still searching for a job to work once they graduate. With a P-Value of 0.03, this data comparison is significant. An R^2 value of 0.823 shows that there is a strong correlation between post-graduation plans and systolic blood pressure in those subjects with prehypertension.

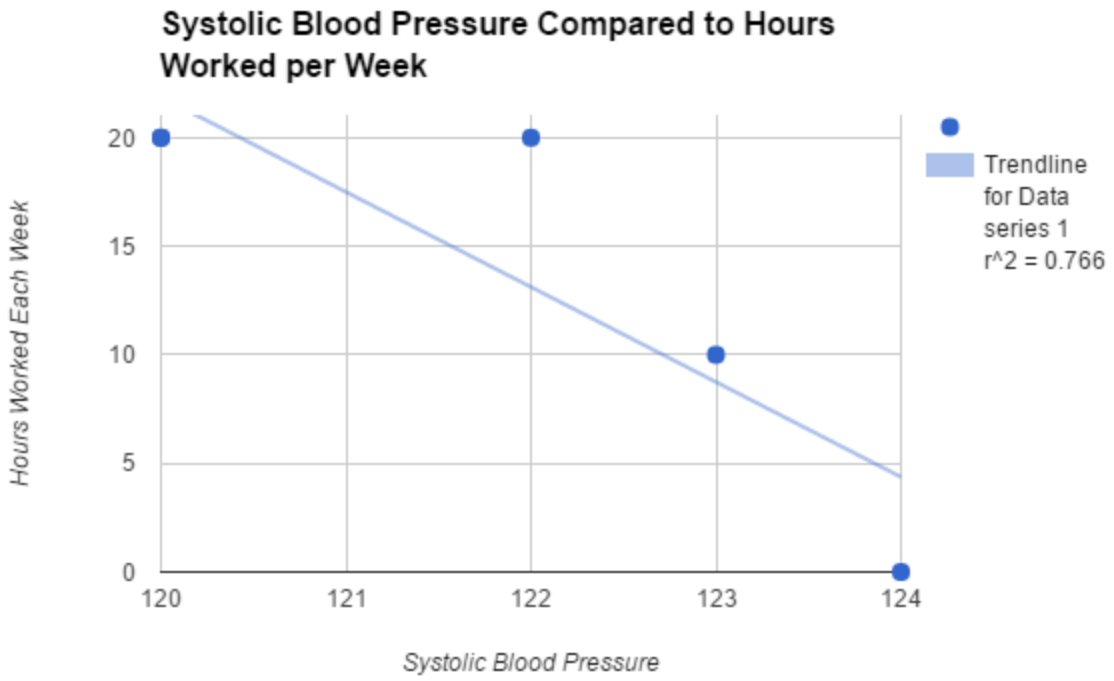

Figure 6. *A scatterplot showing the correlation of the number of hours worked per week and systolic blood pressure in subjects with prehypertension. P = 0.05.*

Having found a P-Value of 0.05, these data are shown to be statistically significant. An R^2 value of 0.766 shows that there is a strong correlation between hours worked per week and an increase in systolic blood pressure.

Following the comparison of systolic blood pressures to risk factors, those risk factors that tested positive for increasing systolic blood pressure were then compared against one another. During these analyses, we were able to find only a few statistically significant correlations: commute time compared to hours worked per week, commute time compared to post-graduation plans, and hours worked per week compared to post-graduation plans.

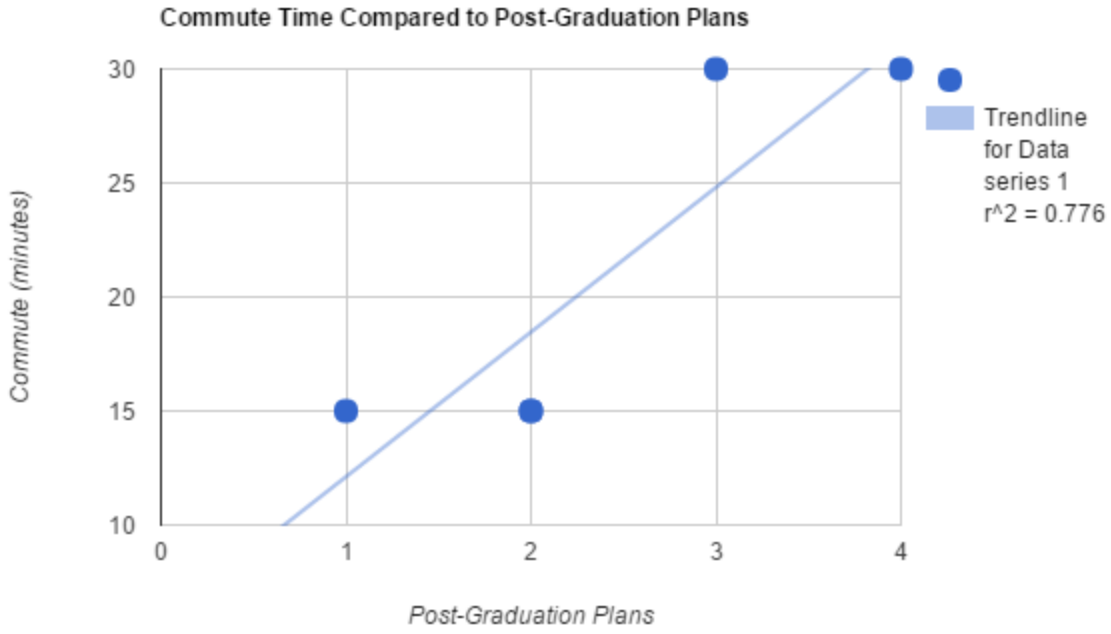

Figure 7. *A scatterplot showing the correlation between post-graduation plans and commute time in those subjects with prehypertension. P = 0.04.*

The scatterplot shown above shows the correlation between subject's post-graduation plans and commute time in minutes. With a P value of .04, this correlation has been shown to be statistically significant. An R^2 value of 0.776, there is a fairly strong correlation between these two data sets.

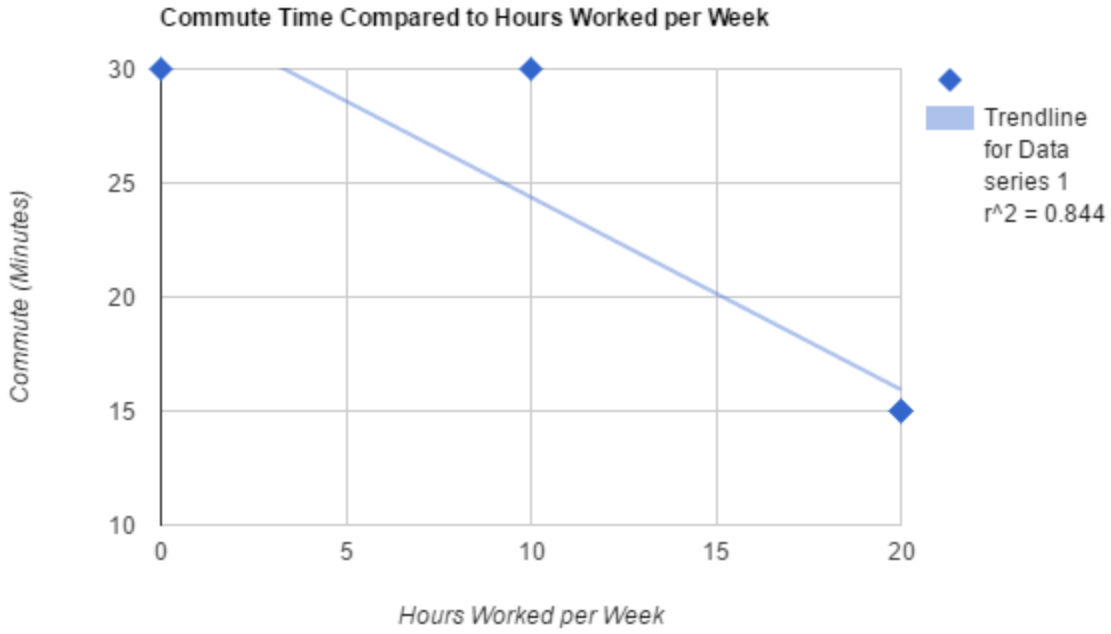

Figure 8. *A scatterplot showing the correlation between commute time and hours worked per week in those subjects with prehypertension. P = 0.02.*

The above scatterplot shows the correlation of Hours worked per week to commute time in minutes. With a P value of .02, this correlation is significant. An R^2 value of 0.844 indicates a strong correlation between these two risk factors.

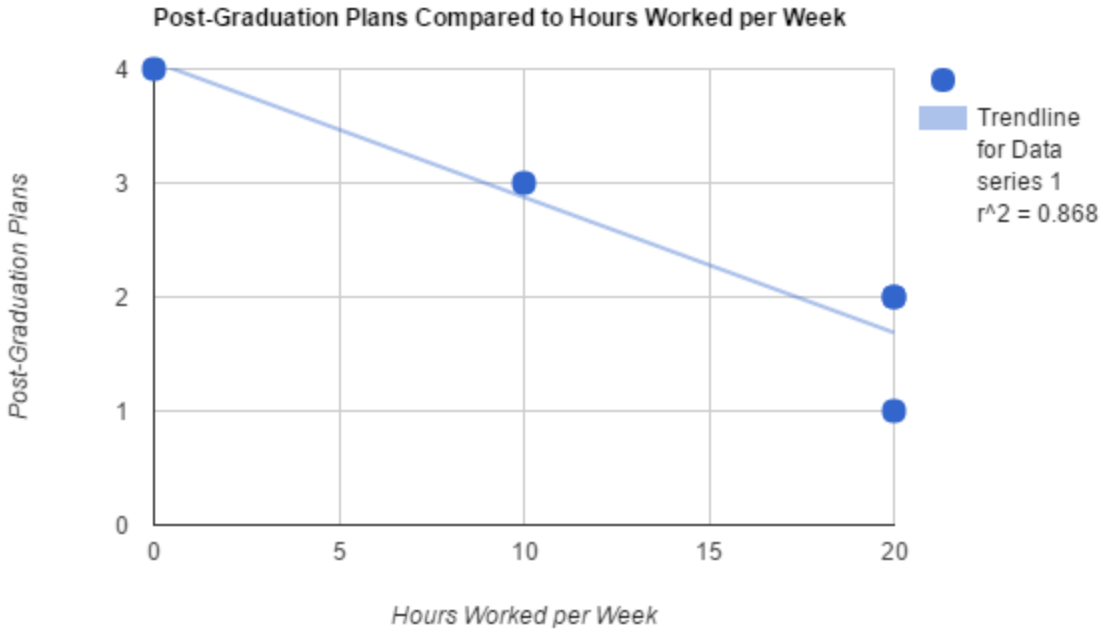

Figure 9. *A scatterplot showing the correlation between post-graduation plans and hours worked per week. P = 0.02.*

The above scatterplot shows the correlation between a subject's post-graduation plan and the hours per week they spend at work. With a P value of .02, this correlation is statistically significant. An R^2 value of 0.868 shows a very strong correlation between these two risk factors.

These are the conclusions that were able to be drawn from the data that was collected. Every other category that was surveyed did not have a P-value small enough to make the correlation tests significant.

Section V - Discussion

The purpose of this study was to discover variables that may predispose college students to have pre-hypertensive or hypertensive blood pressures. The investigators' hypothesis was that college students that lead a certain lifestyle (sedentary and/or lacking in exercise, among others) and are known to have certain risk factors (smoking, alcohol consumption, etc) will present with pre-hypertensive or hypertensive blood pressures, and in addition to this, students that have longer commute times, higher course loads, more work hours per week, and are graduating sooner will have high blood pressure.

After conducting the research, it was found that several correlations linking prehypertensive systolic blood pressure to risk factors. These risk factors were commute time, having changed majors at some time during their college career, alcohol consumption (measured as drinks per week), hours worked per week, and post-graduation plans. All of these factors had a P-value of less than or equal to 0.05, making them statistically significant. The correlations between risk factors, such as commute and hours worked per week, commute and post-graduation plans, and post-graduation plans and hours worked. Once more, all of these have P-values of less than or equal to 0.05, proving their significance.

Commute time was one of the factors that was strongly correlated with prehypertensive systolic blood pressures. This could be due to several things, such as the fact that students who commute are naturally more sedentary than other students, because of the time they spend sitting in their cars rather than walking to class. Due to this time of being even slightly more sedentary, systolic blood pressure may be increased. A study conducted from 1999-2006 has shown that sedentary behavior increases the risk of hypertension (Beunza et al, 2007). This study makes this conclusion logical. In addition, those who commute may have additional stress from running

late or encountering highway traffic on their way to class, which could increase their blood pressure.

The number of alcoholic drinks consumed per week was also shown to correlate with prehypertensive blood pressures. This is not surprising, as this has been shown in a plethora of previous studies (Beilin & Puddey, 2006).

At one time or another during their college career, every single subject that tested positive for prehypertension had changed their major, making this the only factor to affect those with prehypertension. There are several possible reasons for this. First and foremost, there could be a link between prehypertensive blood pressures and the stress of attempting to start a new major or take extra classes to make up time lost from switching majors. Over time, these stresses could lead to an increase in blood pressure. Stress has been shown to increase blood pressure (Kulkarni et al, 1998).

All but one of those subjects with prehypertension reported working while they are in school, most working between 10 and 20 hours per week. There was a strong correlation between the number of hours worked per week and higher blood pressure, and for several possible reasons. One explanation could be that the more hours that are worked per week, the less time there is to complete school work or study for tests. This could put additional stress onto the students, which could over time increase blood pressure. In addition to this, extra hours worked could lower the time students have available to engage in stress-relieving activities, such as hanging out with friends or exercising.

Finally, post-graduation plans were shown to be linked to an increase in systolic blood pressure. Most students who presented with prehypertension reported being unsure what they were doing after graduation - whether that be waiting for a graduate school to accept them, a

clinic to hire them, or potentially taking a year off of school before deciding what to do. The added stress of an undecided future could most certainly lead to an increase in blood pressure. In addition to this, there were several students who had already decided to either work at a job that had been hired for or to further their education via graduate school. For these students, the pressure to perform well and succeed could cause an increase in blood pressure. Stress has been shown to increase blood pressure (Kulkarni et al, 1998).

In addition to these factors that correlated with high systolic blood pressure, there were several factors that correlated with one another. One such pairing of factors was the correlation between hours worked per week and post-graduation plans. Those students who worked more hours per week were more likely to not have a job or graduate school lined up after graduation. These two factors play into each other, as the stress of an uncertain future combined with the stress of working 10-20 hours per week could lead to greater overall stress.

Hours worked per week was also found to correlate with commute time. This makes sense, as those students who work are unlikely to work on campus. Many students could work jobs that are closer to home than to school, which would correlate commute with hours worked.

Finally, there was a correlation between post-graduation plans and commute time. There appears to be no connection between the two data sets other than the fact that they both are shown to increase blood pressure on their own; there is no true reason as to why they would correlate with one another. While this is not helpful for the purposes of this study, it is interesting that these two would be linked.

Before collecting the data, the investigators' sought to answer three questions:

1. Do college seniors display prehypertensive or hypertensive blood pressures?
2. What factors predispose a college student to having prehypertensive or

hypertensive blood pressures?

3. Is there any correlation between certain factors and the prevalence of prehypertensive and hypertensive blood pressures?

After collecting and analyzing the data, these research questions can now be answered. First and foremost, the college students that were surveyed did present with prehypertensive blood pressures, but did not present with hypertensive blood pressures. This is not surprising, as the population surveyed was young, and blood pressure has been shown to increase as age increases (Franklin et al, 1997).

The second and third questions are heavily tied together, and they are both answered over the course of Section V - Discussion. Several factors have been identified as predisposing students to higher blood pressure, and there are several that have strong correlation to prehypertensive and hypertensive blood pressures.

Limitations

The number of participating subjects was relatively small. A larger sample size may have been a better representation of the population that was studied, limiting the influence of outliers or extremes. For better results, it would have been ideal to have a larger number of participants. Having data of blood pressures for hundreds of subjects did not fit into the scheduling of this current study. Due to the short duration of the study, additional variables such as VO_2max, specific diet recall, regular exercise intensity, and other factors that may be important in determining the relationship between university students predisposition to elevated blood pressure (both pre-hypertension and hypertension) were not studied. Secondly, due to limited time, the sample size relied on convenience rather than by true random sampling. This may

predispose the data to be skewed in a certain direction or may yield no problems at all – currently, investigators are not sure about this limitation. An additional limitation was that all of the subjects participating in the study were Exercise Science majors. The subjects were well educated in health and fitness, which may be the reason why many of our participants were not prehypertensive or hypertensive. In future studies, having a diverse amount of college participants from different majors may show a stronger correlation between stress levels and pre-hypertension or hypertension. Another factor was that the allotted time to conduct this study was limited. A longer period of time may have allowed our researchers to take their time while reading blood pressures. A longer period of time may have also gave our subjects additional time to focus on the survey and answer questions correctly. In future research additional time to conduct the study may be beneficial. Lastly, self-reporting on the survey that was used to collect data could also be a limiting factor in our data collection. Students may have lied or embellished certain aspects of the survey to make their answers seem more attractive or to make themselves appear to be in better shape.

Conclusion

This research has revealed many interesting characteristics of college-aged students, but most of them were not surprising. We had originally hypothesized that there would be at least a few subjects that presented with hypertension, but there were none - in fact, there were only a few with prehypertension. Our findings validate previous studies (Beilin & Puddey, 2006) that show that alcohol consumption increases blood pressure; other common stressors (work, post-graduation plans) were also shown to increase blood pressure in the subjects that we studied, also proving another study to be valid (Kulkarni et al, 1998). In addition to validating these previously conducted studies, we also found that longer commute times are correlated with

higher blood pressure. This was an interesting correlation to find which can hopefully be validated in future studies.

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