Cardiovascular Health Among US and Argentine University Students - A Comparative Study of Behaviors and Risk Factors

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<th>ABSTRACT</th>
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<td><strong>Keyword:</strong></td>
<td>Purpose Cardiovascular disease is the leading cause of death in adults in both the United States and Argentina. The scientific literature has consistently shown the effects of behaviors and risk factors on cardiovascular health; however, most studies of modifiable behaviors and CVD risk factors examine older adults and elderly, and few have investigated behaviors and CVD risk factors in early adulthood. We assessed the associations between main cardiovascular behaviors and cardiovascular risk factors among 1,000 young adults in a cross-cultural analysis between the United States and Argentina.</td>
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<td>Cardiovascular Health</td>
<td>Methods A web-based survey assessed student development in the areas of demographic information, current medical information, personal health history, family health history, personal habits, and knowledge of cardiovascular health. We organized our survey and vital statistics measurements into eight variables: Body Mass Index (BMI), Mean Arterial Pressure (MAP), Resting Pulse, Country, Gender, Health History Score, Health Knowledge Score, Health Habit Score. We tested our data through principle component analysis, bivariate correlations, and independent sample T-tests.</td>
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<td>Argentina</td>
<td>Results Overall correlations showed that MAP is significantly negatively correlated with health history score and health knowledge score. In addition, MAP is significantly positively correlated with BMI. We also analyzed correlations by gender and country and found significant correlations there as well. By means of T-tests, we found significant differences between the means of MAP, health history score, health habit score, and knowledge score between both the female populations of Argentina and the US and the male populations of Argentina and the US.</td>
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<td>United States</td>
<td>Conclusions In conclusion, young adults with low prevalence of cardiovascular health behaviors have low prevalence of cardiovascular disease risk factors. After thorough analysis we saw that, cross culturally, correlations exist between CVD risk factors and CV behaviors that are consistent in both populations. Health habit, health knowledge, health history and BMI are all significantly correlated with mean arterial pressure. T-tests showed that population groups with higher CVD risk factor means also had lower behavior means, indicating that populations with poor CVD behavior correlate with an accumulation of CVD risk factors.</td>
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<td>University Health</td>
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1. INTRODUCTION

Throughout much of the world, cardiovascular disease (CVD) is a among the leading causes of adult death.\(^1\) In both the United States and Argentina, CVD annually accounts for over one third of adult mortality.\(^2,3\) Additionally, CVD is the primary cause of death among US Hispanic and Latino populations\(^4\) and this is often attributed to the low socioeconomic status held by a large proportion of these populations. Research shows that middle-age individuals with a low CVD risk profile, defined as the levels of established modifiable CVD risk factors,\(^5\) have dramatically lower mortality rates, greater longevity, and substantially lower rates and risks for CVD events in comparison to individuals without a low-risk profile.\(^5,6\) Furthermore, a low risk profile in middle age is associated with higher quality of life and lower Medicare charges in advanced age.\(^6,8-10\)

There is substantial epidemiological evidence shows that a person’s risk for cardiovascular disease will be dramatically lower if he or her can maintain optimal levels of risk factors until middle age. Additionally, his or her survival will be markedly longer than that of a person who has developed one or more risk factors.\(^11-13\) Primary prevention is viewed as the principal means to halt the onset of CVD, yet most studies of modifiable behaviors and CVD risk factors examine older adults and elderly,\(^14-17\) while few studies have investigated behaviors and CVD risk factors in early adulthood.\(^18\) There have been recent studies that examine in the young adult population the association between cardiovascular risk factors and behaviors with cardiovascular health, as measured by carotid intima thickness. Additionally, the prevalence of the ideal cardiovascular (CV) health metric has been studied in populations around the globe, however it has been mostly focused on country groups that are primarily of caucasian ethnicities, such as Finland, Australia, and the United States.\(^19\) We chose to examine a primarily caucasian population group against a primarily hispanic population group to assess whether there are differences in CV behaviors and risk factors between the two countries and whether the associated trends between behaviors and risk factors is a universal trend or not.

While studying in Argentina, we proposed and conducted a cross-cultural comparative study designed to evaluate ideal CVD health in young adults in both the United States and Argentina by assessing the association between cardiovascular health behaviors and risk factors as a means to prevent the onset of cardiovascular disease. Ideal cardiovascular health is defined as optimal levels for four behaviors - body mass index (BMI), smoking, physical activity, and diet, and three CV risk factors - blood pressure, fasting plasma glucose, and cholesterol.\(^19,20\) Research shows that the number of ideal CV health behaviors is directly significantly correlated with the number of ideal health factors.\(^19\) Additionally, ideal CV health has been associated with CV morbidity.\(^21\) Similarly, the number of ideal CV health metrics is associated with lower total and CVD mortality.\(^22,23\) Due to the limited funding and resources available in both locations, we chose to examine one easily assessable risk factor, blood pressure, against composites of the four listed behaviors. We focused on the relationship of the risk factor and behaviors in these two populations, keeping socioeconomic status, age, and nationality in each population constant. We hypothesized that the poor CV behaviors would be associated with poor CV risk factors. Additionally, we hypothesized that the relationship between risk factors and behaviors is homogeneous in both countries.

2. RESEARCH METHODS

In the fall of 2011, students at Pepperdine University, in Malibu, California, were invited to participate in an IRB sanctioned, voluntary web-based survey, as described below. Also in the fall of 2011, students at La Universidad Católica de Argentina (UCA), in Buenos Aires, Argentina, were invited by a team of cardiology residents and a Pepperdine research student to participate in the same research project. A data collection station was set up at the University’s School of Medicine while residents and the researcher invited Argentine students to voluntarily participate in the a hard copy of the web based survey given to Pepperdine students that had been translated into Spanish. After the students completed the survey, the residents and the student research, under the supervision of the attending cardiologists, collected the students’ data.

A web-based survey assessed student development in the areas of current medical information, personal health history, family health history, personal habits, and knowledge of cardiovascular health. The survey assessed demographic information as well. The survey included 35 items, exclusive of the demographic questions, to be answered by the participant, as well as 11 items to be measured by the study administrator to assess their current cardiovascular health. Participants responded to 27 yes or no questions, and 8 fill in the blanks.

A Spanish paper copy of the web based survey was created for the research group in Buenos Aires, Argentina. The survey was created by an Argentine cardiologist with the assistance of the student researcher in Argentina. The context of the consent form and all survey questions remained the same between the English web survey and the Spanish paper survey.

Demographic Form. Demographic information was collected by means of a self-report document in
which participants were asked their age, sex, class standing, major, ethnicity, and campus mailbox and email address (for Pepperdine students only, as a means of receiving the gift card).

**Personal Health History.** Information was self reported and consisted of 11 items categorized under blood pressure, dyslipidemia, and diabetes.

**Health History of Parents.** Participants were provided a list of 6 conditions contributing to cardiovascular health, and were asked to identify those that their parents have or have not suffered from, or if the student does not know.

**Personal Habits.** Participants self reported their weekly habits. The section consisted of 17 items examining patterns in sleep, smoking, diet, and exercise.

**Knowledge.** Participants were asked 3 comprehensive questions to assess their knowledge of cardiovascular health and risk factors. In each question participants will be presented with a list and asked to identify various parts. A sample question: Given the following 11 risk factors, identify the 4 that are most directly correlated with cardiovascular disease.

**Current Medical Information.** After completing the survey, Pepperdine students were invited to join researchers outside of the Pepperdine Waves Café between the hours of 12:00-16:00. There the students’ heart rate and blood pressure were taken by a trained survey administrator, and recorded alongside their survey results. Students who had not taken the survey were invited to complete the survey on paper and have their vitals taken upon immediate completion.

BP was measured using an automated sphygmomanometer device (Omron, model HEM-705CP, Omron Healthcare Inc., USA). The blood pressure cuff was placed around the right upper arm. Three baseline BP readings were taken at 2-min intervals by one of the investigators, while another investigator chatted amicably with the subject to dispel nervousness. An average of the 3 measurements was used for analysis.

Height and weight values were self reported by the participants as they were not comfortable having these measurements in public. The values were reported in inches and pounds, respectively, and both were later converted to centimeters and kilograms, respectively, during data scrubbing and analysis and were used to calculate the individuals BMI, using the formula: weight (kg) / [height (m)]^2

After taking the survey, UCA student had their height, weight, blood pressure and heart rate measured. A portable stadiometer was used to measure height in centimeters, and a portable digital weigh scale was used to measure weight in kilograms. An Omron HEM 629 wrist blood pressure monitor was use to collect the participants resting blood pressure and resting heart rate. Three measurements were taken of both the participants blood pressure and heart rate. An average of the three measurements for both blood pressure and heart was used for analysis.

3. RESULTS AND ANALYSIS

Participants were surveyed once, and data was analyzed using SPSS. Over 800 students were invited to participate in this research study. After a process of data scrubbing, 594 participants were eligible for analysis. The data scrubbing process included deleting data of participants not born in either USA or Argentina, purging subjects with incomplete surveys, and eliminating survey responses from students who did not have their vital statistics (heart rate and blood pressure) measured. As a result, we were able to record results as follows:  
Argentine Sample Size = 399, Female Subsample Size = 241, Male Subsample Size = 158; USA Sample Size = 195, Female Subsample Size = 101, Male Subsample Size = 94. We organized our survey and vital statistics measurements into eight variables. Although heart rate in literature is not considered a cardiovascular behavior or risk factor, it was included in our study to investigate the possibility of heart rate being a factor of cardiovascular health, since it is so closely related with the functioning of the cardiovascular system.

1) **Body Mass Index (BMI):** Target BMI range is 18.50 - 24.99 kg/m^2
2) **Mean Arterial Pressure (MAP):** Target value is 90 mmHg
3) **Resting Pulse:** Target value is 80 bpm
4) **Country:** Argentina = 1, US = 2
5) **Gender:** Female = 1, Male = 2
6) **Health History Score:** a composite score equal to the sum of the following binary scores (No = 1, Yes = 2) based on family health history: high cholesterol, diabetes, coronary artery disease, heart failure, stroke and lower limb artery disease.
7) **Health Knowledge Score:** a composite score equal to the sum of the following binary scores (Incorrect Knowledge = 1, Correct Knowledge = 2) based on individual’s knowledge that: diabetes causes CVD, high cholesterol causes CVD, smoking causes hypertension, smoking causes MI, smoking causes stroke, and smoking causes CVD.
8) **Health Habit Score:** a composite score equal to the sum of binary scores (No = 1, Yes = 2) based on the
following personal health habits: fast food consumer, participant regular exercise, daily consumer of two fruits & vegetable items, daily consumer of diet soda, daily consumer of soda, former smoker, and current smoker.

3.1 Principal Component Analysis

Figure 1: Principal Component Analysis

Given the number of indicators in our data set, we began our analysis by conducting Principle Component Analysis (PCA) to determine how variation in this ensemble of variables may best be explained. Our PCA reveals that three variables from our sample explain over 58% of sample variation. These are BMI, MAP, and pulse. In addition, 21% of variation is due to contributions made by the country in which a subject was studying and gender. The remaining variation is attributable to self-reported personal health information. The principal components themselves and personal health history belong to the list of 7 indicators of CV health as identified by the American Heart Association. These 7 indicators are comprised of 3 risk factors: blood pressure, fasting plasma glucose, and cholesterol, and 4 behaviors: BMI, smoking, physical activity, and diet. Moreover, because we gathered data in two countries and across both sexes and because we wish to help subjects increase their understanding of CVD risk - prompting our desire to capture CVD knowledge, we included several questions about general CVD knowledge. As a result of the principal component analysis, we measured the bivariate correlation of these 28 pairs of variables, giving us the correlation matrix depicted in Figure 1. In addition, we captured the PCA variance analysis as shown in Figure 2. From these we can see that the most critical variables that contribute to Cardiovascular Health are, in decreasing order of importance, BMI, MAP, and pulse. Therefore, in our modeling of data, we have focused on determining the ways that variables 4-8 drive the first three variables.

Our underlying hypothesis is that each of the CVD factors: BMI, MAP, and pulse are negatively correlated with health history, knowledge, and health habit; BMI, MAP, and pulse are pairwise positively correlated. The correlations in Figure 1 largely confirm our hypotheses, with the exception of BMI vs. Pulse and Pulse vs. Health History, both of which require further investigation. Further analysis of the correlation by gender and country revealed that the ONLY significant value is female Argentine students, for whom BMI vs. pulse correlates as -.115 with p-value 0.095. This result requires further research. As for Pulse vs. Health History, we carried out gender and country controlled analysis and we discovered that the only significant correlation belongs to those students who are male Argentines. The correlation was .137 with significance .086. This too requires further research, as planned for our next study.

3.2 Overall Correlations

Figure 2.1: Overall Correlations among Survey Variables

MAP and BMI are significantly positively correlated by a factor of 0.290. This implies that as a person’s BMI increases, so does their mean arterial pressure. Pulse and BMI are significantly negatively correlated by a factor of -0.115. This implies that as a person’s BMI increases, their heart rate decreases. BMI and the Health Habit Composite Score are significantly negatively correlated by a factor of -0.137. This implies that as the Health Habit Composite Score
decreases, their BMI increases. To understand this correlation, it is important to note that a low Health Habit Score indicates poor habits such as smoking, not eating daily fruits and vegetables and not adequately exercising. Thus performing unhealthy habits is correlated to an increase in a person’s BMI. BMI is negatively correlated with Health History Composite Score and Health Knowledge Score. This implies that as Health History Score decreases (the person has history of cardiovascular disease or risk factors in their family), BMI increases. Additionally as Health Knowledge Score Decreases (the person knows less about cardiovascular health), BMI increases. Although these are logical correlations, they are not at the 95% significance level.

MAP and Health History Composite Score are significantly negatively correlated by a factor of -0.113. This implies that as the Health History Composite Score decreases, their Mean Arterial Pressure increases. To understand this correlation, it is important to note that a low Health History Score indicates poor family cardiovascular health such as parents who have heart failure, diabetes, high cholesterol etc. Thus having poor family health history is correlated to an increase in a person’s MAP. This is a trend that expands across both US and Argentine populations. MAP and Health Knowledge Composite Score are significantly negatively correlated by a factor of -0.148. This implies that as the Health Knowledge Composite Score decreases, Mean Arterial Pressure increases. To understand this correlation, it is important to note that a low Health Knowledge Score indicates the individual knows less about cardiovascular health (such as not knowing that smoking is linked to cardiovascular disease, high cholesterol is linked to cvd, etc). Thus having poor health knowledge is correlated to an increase in a person’s MAP. This is a trend that expands across both US and Argentine populations. MAP is also correlated with heart rate and health habit score, positively by a factor of 0.053 and negatively by a factor of -0.088 respectively.

### 3.3 Correlation US Males

**Figure 2.2: US Male Correlations among Survey Variables**

MAP and BMI are significantly positively correlated by a factor of 0.224. This implies that as a person’s BMI increases, so does their mean arterial pressure. This correlation is significant at the 0.05 level. Though not significant MAP is negatively correlated with health habit score, health history score, and knowledge score while BMI is positively correlated with health habit score, health history score, and knowledge score. Detailed results in Figure 2.2.

### 3.4 Correlation Argentine Males

**Figure 2.3: Argentine Male Correlations among Survey Variables**

MAP and BMI are significantly positively correlated by a factor of 0.227. While not significant, MAP showed positive correlation with health habit score, health history score, and knowledge score. BMI showed negative correlation with health habit score, and positive correlations with health history and knowledge scores. Detailed results in Figure 2.4
3.5 Correlation US Females

Figure 2.4: US Female Correlations among Survey Variables

MAP and BMI are significantly positively correlated by a factor of 0.227. While not significant, MAP showed positive correlation with health habit score, health history score, and knowledge score. BMI showed negative correlation with health habit score, and positive correlations with health history and knowledge scores. Detailed results in Figure 2.4.

3.6 Correlation Argentine Females

Figure 2.5: Argentine Female Correlations among Survey Variables

MAP and BMI are significantly positively correlated by a factor of 0.198. MAP and pulse are significantly positively correlated by a factor of 0.146. BMI is significantly negatively correlated with health habits by a factor of -0.162, implying that as healthy habits increase, BMI decreases. While not significant, MAP showed positive correlation with health habit score and knowledge score, and a negative correlation with health history score. Detailed results in Figure 2.5.

3.7 Independent T-Tests

To dig deeper into the relationship between the main CVD risk factor and the four behaviors, we begin by considering a comparison of the means of the five factors as a function of the two countries, controlling for gender. We present these results in figures 4.1 and 4.2 below. Figure 4.1 shows the results for female subjects, whereas Figures 4.2 details the results for female subjects.

Argentina vs. USA Females

Figure 3.1: Female Group Statistics

Figure 4.1: Female T-Tests

It is evident that there is a significant difference in the between the means of the mean arterial pressure of the Argentine and US female populations. As T1 was argentine females and T2 was US females, it can be
noted that Argentine female population has a significantly larger mean, mean arterial pressure. Additionally, there are significant differences in the mean habit, health and knowledge scores between the Argentine and US female populations. Once again, the Argentine female population has significantly lower means in habit, health and knowledge scores. These low mean scores correspond to poorer health habits, history and less health knowledge. From these two pieces of evidence, it can be inferred that populations with significantly poorer health habits, history and knowledge will have significantly higher mean arterial pressure. Thus prevalence of poor cardiovascular health behaviors corresponds to poor cardiovascular disease risk factors.

**Argentina vs. USA Males**

Figure 3.2: Male Group Statistics

<table>
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<th>Country</th>
<th>N</th>
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<th>Std. Deviation</th>
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<tr>
<td>MAP</td>
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<td>156</td>
<td>95.400</td>
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<tr>
<td></td>
<td>2</td>
<td>93</td>
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<td></td>
<td>2</td>
<td>168</td>
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<tr>
<td></td>
<td>2</td>
<td>93</td>
<td>23.150</td>
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<tr>
<td>Pulse</td>
<td>1</td>
<td>156</td>
<td>72.600</td>
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<tr>
<td></td>
<td>2</td>
<td>92</td>
<td>70.920</td>
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<tr>
<td>Health Habit Score</td>
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<td>93</td>
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<td>Health History Score</td>
<td>1</td>
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<td>2</td>
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<td>11.410</td>
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<td>Knowledge Score</td>
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<td></td>
<td>2</td>
<td>93</td>
<td>11.490</td>
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Figure 4.2: Male T-Tests

<table>
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<tr>
<th></th>
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<th>Std. Error Difference</th>
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<td>6.06</td>
<td>248</td>
<td>0.000</td>
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<tr>
<td>BMI</td>
<td>3.343</td>
<td>248</td>
<td>0.001</td>
<td>1.722</td>
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<td>Pulse</td>
<td>1.028</td>
<td>248</td>
<td>0.306</td>
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<td>-8.681</td>
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<td>0.005</td>
<td>-2.184</td>
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</table>

It is evident that there is a significant difference in the between the means of the mean arterial pressure and the mean BMI of the Argentine and US male populations. As T1 was argentine males and T2 was US males, it can be noted that mean mean arterial pressure and mean BMI of the Argentine male population is greater than those of the US male population. Additionally, there are significant differences in the mean Habit, Health and Knowledge scores between the Argentine and US male populations. Once again, the Argentine male population has significantly lower means in habit, health and knowledge scores. These low means scores correspond to poorer health habits, health history and health knowledge. From these two pieces of evidence, it can be inferred that populations with significantly poorer health habits, history and knowledge will have significantly higher mean arterial pressure and BMI. Thus prevalence of poor cardiovascular health behaviors corresponds to poor cardiovascular disease risk factors. Additionally, prevalence of certain poor cardiovascular health behaviors (habit, history, and knowledge) corresponds to poor BMI, another cardiovascular health behavior. These statistical analyses reveal a number of conclusions - more than confirming our initial hypotheses about CVD in relation to country for young adults.

4. DISCUSSION AND CONCLUSION

The purpose of this study was to examine young adult cardiovascular health. In doing so, we hypothesized that young adults with low prevalence of cardiovascular health behaviors would have low prevalence of cardiovascular disease risk factors. After thorough analysis we saw that, cross culturally, correlations exist between CVD risk factors and CV behaviors that are consistent in both populations. Health habit, health knowledge, health history and BMI are all significantly correlated with mean arterial pressure. The AHA study found that ideal CV health is uncommon in young adult populations in the US, Finland, and Australia. This study however compared the ideal CV health metrics against carotid intima thickness while our study examined the relationship between CV health risk factors and CV health behaviors. The AHA study showed that there was an inverse association between ideal CV health metrics and the cIMT, thus risk factors and behaviors are associated with vascular health in the greater population. By analyzing American and Argentine populations we showed that poor cardiovascular behaviors are associated with poor CV risk factors. T-tests showed that population groups with a higher CVD risk factor, MAP, mean also had lower behavior means, indicating that populations with poor CVD behaviors correlate with accumulation of CVD risk factors. We can infer and speculate that a way to improve young adult CV health is to improve health habits and health knowledge, as improving health history is out of our control. A previous study in Brazil showed that young adults who consume a better, common Brazilian diet display healthier trends in regards to CVD risk factors while those who have a poor, processed diet display more harmful trends. It is interesting to note that the study stated that the processed diet is similar to the Western type of diet among the American population. This included a variety of foods such as hamburgers, hot dogs, french fries, etc. In this study, diet was assessed by the consumption of fruits and vegetables, fast food, and soda. In this study responses to diet were scored, in addition to other health habits, and was used to create a composite score. In the t-tests analysis it was found that the American students had higher composite scores than did the Argentine students, thus the American
students had healthier habits than did the Argentine. This trend contradicts the results of the Brazilian nutrition study, however dietary components were not assessed in this study as it was in the other. It would be advisable to pursue this matter further and investigate the true differences in Argentine and American health habits. Consequently that type of investigation would be able to pinpoint which specific habit component affects, and to what extent, cardiovascular health.

Although we found consistency in data, there were a few anomalies that presented themselves. One major flaw: the CVD component of heart rate. Correlation testing produced interesting results that we are unable to accurately explain. We hypothesize that these anomalies stem from slight errors in data collection methods. The public spaces prevented students from relaxing properly, and thus their reported heart rates were often higher due to anxiety. Although heart rate in literature is not considered a cardiovascular behavior or risk factor, it was included in our study anyways because heart rate is so closely tied to function of the cardiovascular system. Due to erroneous results, we now know that we must correct methods in order to obtain more accurate data in order to investigate heart rate as a cardiovascular health indicator.

Due to misunderstandings we would like to more accurately pinpoint the most important behaviors that influence cardiovascular health. We recommend an amended study that focuses on the behavior that most influences cardiovascular health. This future study must be able to quantify young adult habit and knowledge through more in depth questioning, rather than binary questions. We realized that even though we were asking the same questions in both countries, these questions were not necessarily standardized. For example, an Argentine’s perception of rigorous workout might be different than that of an American student. To better quantify our results we will need to ask more specific questions such as “How many times per week do you engage in exercise in which your heart rate is within the target range for your age? (Age 20 = 120-170)”\textsuperscript{25}. By using surveys with more specific questions we would be able to quantify health behaviors more precisely and thus have a range of data with which to perform in-depth statistical analysis, instead of utilizing binary data compiled into composite scores. This more in-depth analysis would allow us to pinpoint the major contributing behaviors to poor CV health risk factors in each country, which would allow us to analyze how different aspects of culture and society contribute to cardiovascular health.

In conclusion, young adults with low prevalence of cardiovascular health behaviors have low prevalence of cardiovascular disease risk factors. After thorough analysis we saw that, cross culturally, correlations exist between CVD risk factors and CV behaviors that are consistent in both populations. Health habit, health knowledge, health history and BMI are all significantly correlated with mean arterial pressure. T-tests showed that population groups with higher CVD risk factor means also had lower behavior means, indicating that populations with poor CVD behavior correlate with an accumulation of CVD risk factors. Further investigation into these behaviors with improved methodology has been proposed to pinpoint the exact differences in cardiovascular health between the young adult populations of Argentina and the United States.
ACKNOWLEDGEMENTS
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REFERENCES


**BIOGRAPHY OF AUTHORS**

*Note: Authorship is listed in alphabetical order. All authors contributed equally to this paper and thus all receive the title of first author.*

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<th>Education/Professional Experience</th>
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<td>Is Professor of Great Books &amp; Mathematics at Pepperdine University. He has served as a faculty member there since 1979, having earned his Ph.D. in mathematics from the University of Arizona that same year. His research interests include his ongoing work at the Hughes Research Lab in Malibu, CA on artificial neural networks and Bayesian networks, as well as working with undergraduate research students in biology, psychology, mathematics, and the great books. He may be reached at <a href="mailto:thompson@pepperdine.edu">thompson@pepperdine.edu</a>. See <a href="http://dt.pepperdine.edu">http://dt.pepperdine.edu</a> for more information.</td>
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