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McNair Scholars Program  
*Journal of Research Program*  
2013-2014 • Volume 19



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WICHITA STATE  
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# McNair Scholars Program

*Journal of Research Reports*

2013-2014 • Volume 19



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WICHITA STATE  
UNIVERSITY

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# Administration

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## From the Director

I am proud to present Volume 19 of the *Journal of Research Reports*, “Open Minds Open Doors.” The articles featured in this journal represent the work of the Program participants during the 2013 – 2014 grant year. As one reads through these multidisciplinary articles, it is clear that the breadth of research interests is as diverse as the students we serve. My staff and I are very pleased with the efforts that went into producing this body of scholarly work.

The Program only achieves such great accomplishments with the support of the University faculty, staff and administrators who have mentored students over the past 19 years. The mentors have guided the McNair Scholars in completing their research projects and have inspired them to unimaginable heights. The Program applauds each research mentor for his/her efforts in making undergraduate research a reality for the students in this Program.

In this journal, the works of fifteen undergraduate students will be showcased. Twelve students are McNair Scholars on the campus of Wichita State University and three are participants in the Kansas EPSCoR Summer Research Program, hosted on the campus of WSU in collaboration with Kansas State University and the University of Kansas with funding from the National Science Foundation.

A special word of thanks is directed to our Research Coordinator Mr. Matthew DeAngelis and Mr. Noah Trammell, writing tutor. Their dedication to the Program and keen ability to motivate the students to produce the best possible document is greatly appreciated. Appreciation is also given to our Senior Administrative Assistant Ms. Maria Lucas and Program Counselor Ms. Ashley Cervantes; without whose support and persistence in making sure that things get done correctly and in a timely manner, none of this would be possible.

Finally, I would like to congratulate the students for going beyond the classroom and putting their research interests into practice. Their efforts will not go unnoticed. This is an opportunity to share their brilliance with the academic community, and I am most proud of their accomplishments. These students are our future educators, and I thank them for the opportunity to serve as their director.

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# Research Papers

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# Barriers to Healthy Eating and Physical Activity in African American Women at Risk for Peripheral Arterial Disease

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## Abstract

This study seeks to gain a better understanding of barriers and mediators to physical exercise and healthy eating habits for African American women who present risk factors for peripheral arterial disease (PAD). Female participants, specifically those aged 60 or older who had hypertension, diabetes, hyperlipidemia, and/or smoked, were recruited to participate in a qualitative study of their daily physical activity and healthy eating habits. Themes that emerged for barriers to healthful eating include the following: personal reasons, costs/access, and no barriers. Themes that emerged for barriers to physical activity include: physical pain/health, time, and no barriers. Information from this study helps us to understand barriers as perceived by African American women who possess risk factors for PAD and how to intervene on those barriers.



# Introduction

Among African American women, studies show that there are many barriers to physical activity and healthy eating. Some barriers that were common among both categories (healthy eating and physical activity) were competing demands, social support issues, lack of motivation, and cultural differences. The purpose of this study is to gain knowledge and an understanding of the common barriers to physical activity and healthful eating habits for African American women at risk for peripheral arterial disease (PAD).

## Literature Review

Peripheral arterial disease is a form of atherosclerosis. PAD occurs when there is plaque build-up in the wall of the arteries, often the arteries of the lower limbs. Risk factors for PAD are as follows: aging, smoking, diabetes mellitus, hyperlipidemia, and hypertension (Ghidei & Collins, 2012, p.1). Progression of PAD can accelerate when one or more of these risk factors are present. With cardiovascular ischemic event rates being higher in individuals with PAD, the fact that 80% of U.S. adults are hypertensive, or that 25.3% of U.S. adults have hyperlipidemia can be quite daunting (Steffen, Duprez, Boucher, Ershow, & Hirsch, 2008).

African Americans are 2.8 times more likely than Non-Hispanic Whites to have PAD (Ghidei & Collins, 2012). In fact, according to the National Health and Nutrition Examination Survey (NHANES), compared to Non-Hispanic Whites and Mexican Americans, African Americans have a higher prevalence rate of PAD (Ghidei & Collins, 2012, p.1). The occurrence of PAD is 41% in African American women as compared to 23% for Non-Hispanic White women (Ghidei & Collins, 2012). This could be due to the prevalence rates of the risk factors in the African American population. According to Nies, Vollman, and Cook (1999), African American women are two times more likely to have diabetes, hypertension, and stroke as

compared to other ethnicities. African Americans also have a hypertension prevalence rate of 45.2% compared to the 29.1% for Non-Hispanic Whites (Warren-Findlow & Seymour, 2011).

There are several different methods of treatment for patients with PAD. PAD can be managed through exercise or physical activity, smoking cessation, and a healthy diet. Research has shown that increased participation in physical activity can have positive effects on health. This includes lowering blood pressure, inflammation markers, and lipid levels (Steffen et al., 2008). Exercise is second only to avoiding tobacco as the most important lifestyle change for treating and preventing PAD (Ghidei & Collins, 2012, p. 10). Eating healthy was shown to have effects similar to participating in physical activity. Steffen, Duprez, Boucher, Ershow and Hirsch (2008) claimed that hypertension, diabetes, and hyperlipidemia could all be improved with changes in dietary intake.

Physical activity and healthy eating habits can have a positive effect on the above listed chronic diseases. It is imperative to gain an understanding of barriers to physical activity and a healthy diet for older African American women at risk for PAD. Gaining knowledge of the barriers that African American women at risk for PAD face could provide further insight on how to best help these women; whether it is by developing exercise programs that these women can abide by or by developing healthy eating menus that keep culture and income in mind. This study examines the most common barriers to participating in physical activity and maintaining a healthy diet for African American women at risk for peripheral arterial disease.

## Barriers to Healthy Eating in African American Women

Barriers to healthy dieting can be separated into three categories: personal, social, and environmental. Personal barriers to healthy dieting are a lack of knowledge and psychological factors (Baruth, Sharpe, Parra-Medina, & Wilcox,

2014). Implied in eating healthy is the knowledge of how to eat healthy. Psychological factors, according to Baruth, Sharpe, Parra-Medina and Wilcox (2014), include African American women reporting feeling defeated. African American women stated that when considering switching to a healthier diet, thoughts of past attempts at weight loss, their own or of someone they know, comes to the foreground of their thoughts. This thought process leaves these women with a negative mindset about healthy dieting, and before these women have begun, they have already determined that it is impossible and pointless. Other psychological factors include the following: “eating for reasons other than hunger (e.g. depression), having a food addiction, and finding comfort in food” (Baruth et al., 2014).

Social barriers to healthy dieting were as follows: “lack of time, planning and cooking healthy meals, exhaustion, role strain/ competing demands for time, unsupportive social environment, social food consumption, family customs for both food and eating, and food preferences and need for kids” (Baruth et al., 2014). As reported by Baruth et al. (2014), African American women elucidated that planning and cooking healthy meals for themselves and their families was only one part of not having enough. African American women also felt that the time it takes to calculate caloric intake, sodium consumption, and the many other factors that need to be tracked when dieting, has proven to be too time consuming when one is just trying to consume a quick lunch during lunch break.

Exhaustion, role strain, and competing demands on time stand conjointly as barriers. According to Acheampong and Haldeman (2013), 48.9% of African American women serve as the heads of their households. In essence, not only were at least half of the women in the study working a lot because of money being scarce, these women also tended to have other obligations such as taking care of the children and shopping (food, school clothes and supplies, etc.). Being a friend, a counselor, and a variety of other

roles—all of these play into consumption of time. An unsupportive social environment is actually multiple barriers combined as one. African American women reported being pressured to eat more by friends and family, not being supported by friends and family, and being told that losing weight is not necessary for them (Baruth et al., 2014). The last statement refers to friends and family trying to create a more positive outlook on the body image of their loved one. However, such statements, though supportive and made with good intentions, can be damaging to these women and may in fact be detrimental to their health if they fail to start and maintain a healthy diet. African American women disclosed succumbing to social pressure when eating (Baruth et al., 2014). For instance, women may have a healthy meal planned for lunch, but then co-workers suggest eating elsewhere; women revealed that in this situation they would concede to the desires of their coworkers (Baruth et al., 2014).

Among the listed social barriers to healthy dieting were family customs. Within this barrier are sub-barriers listed by the participants. These sub-barriers were as follows: “being taught to eat everything on their plates, to fix a heavy plate, [and] to eat junk food and soul food” (Baruth et al., 2014). In essence, women were not raised to eat healthy and therefore do not know how to diet healthy. As a result, women pass down the same dietary habits to their children, and the cycle of unhealthy eating in the African American culture continues. The last social barrier mentioned was the food preferences and needs of children. This barrier was further explored, and it was discovered that participants did not see fit to deprive their children of their dietary needs and preferences because their parent is overweight.

Environmental barriers to healthy dieting are cost, access, and availability. The Brigham and Women’s Hospital (BWH) compared the cost of a seven-day heart healthy menu to the monthly maximum benefits given by the Food Stamp Program and the Financial Economic Self-Sufficiency Standard (FESS). The BWH

found that for a single person living alone (65 years and older) and for a family of four, even with maximum benefits from either program, there was still a deficit in average monthly food cost (Johnson, Wilson, Fulp, Schuetz & Orton, n.d.). This study showed that the cost of healthy eating, even with government assistance, is still not affordable for the average African-American woman with a family, nor is it affordable for the average African American woman, 65 years and older, living on her own.

“National research indicates that supermarkets are less likely to be located in urban neighborhoods...Far fewer residents of urban neighborhoods have access to a car and are more likely to rely on convenience stores close to home or easily accessible by public transit” (Johnson et al., n.d.). Having easiest access to convenience stores and local grocery stores limits the kinds of healthy foods that can be obtained, how much healthy food can be procured, and when those healthy foods can be purchased. Local grocery stores and convenience stores, compared to supermarkets, have smaller selections, less variety, and limited ability to sell certain health food items like fruits and vegetables in and out of season. The presence of farmers markets from spring to autumn, in some cities, helps increase access to health foods that would not normally be available to African American women (Johnson et al., n.d.). Farmers markets are an excellent source because they offer healthier food choices at a lower cost. However, Johnson et al. notes that many farmers markets are currently incapable of accepting Electronic Benefits Transfer (EBT) cards in use by the food stamp programs (n.d.), which leads to the next barrier: availability. The BWH also found that not all places accept EBT cards (Johnson et al., n.d.). For African American women with this assistance, healthy options become severely limited not only because of accessibility, but also because the amount of variety decreases.

### **Barriers to Physical Activity in African American Women**

Barriers to physical activity, much like the barriers to healthy dieting, can be separated into five categories: personal, social, environmental, policy and cultural. Personal barriers to physical activity are as follows: age, no children, lack of childcare, lack of motivation, not seeing quick results, not having fun/finding enjoyment in participating in physical activity, issues related to body size, fear of injuries and health conditions, not feeling it necessary to engage in more activity, and ignorance of proper physical activity.

In the study conducted by Rohm, Young, and Voorhees, women with no children were statistically less than half as likely to be engaged in some type of physical activity (2003). Although Rohm et al. (2003) gives no explanation for this result, the response given by African American women in this study indicated that they disagreed with the notion that social roles, such as childcare, family, work, etc. would stop them from participating in physical activity. Contradicting this viewpoint is the fact that lack of childcare was listed as a barrier (Nies, Vollman, & Cook, 1999). In the study done by Nies, Vollman and Cook (1999), one participant stated “My biggest hassle is childcare,” while another declared “if there is no baby sitter you cannot exercise.” Other participants from Sanderson, Littleton, and Pulley (2002) took a different approach to lack of childcare as a barrier. Participants stated that the presence of children becomes so common that even when a baby sitter is available to take the children the women remain inactive because they are unaccustomed to not having their children around.

Lack of motivation, in the studies conducted by Baruth et al. (2014) and Nies et al. (1999), was commonly described as lacking the inner desire to exercise. On the other hand, participants in Sanderson et al. (2002) offered a different explanation for lack of motivation. They linked fatigue and competing responsibilities (a social barrier) to lack of motivation. Women in the study explained that by the time they finish working,

taking care of the kids, and doing house chores, they are too tired and unmotivated to work out. Also, coupled with a lack of motivation was not seeing results quickly. Some of the participants in the Baruth et al. study (2014) proclaimed that, because they did not see the results of their efforts fast enough, they could not continue to be committed to exercise.

Issues with body size included two subcategories: being overweight and feeling intimidated. Intimidation encompassed being made fun of by others, being the biggest person at the gym or feeling out of place because not many people at the gym look like them (not many people at the gym are African American), and being intimidated by exercise itself (Baruth et al., 2014). Some women confessed that being overweight was a barrier because it led to them feeling fatigued and unmotivated (Sanderson, Littleton, & Pulley, 2002). Women also described their participation in physical activity as torture or as unnecessary because they already spend enough time participating in physical activity (e.g. chasing children). Fear of injury and health conditions were also mentioned. As stated by Pekmezi et al. (2013), participants of the study feared doing more harm to themselves than good. Women worried about spraining an ankle or about health conditions, such as pain in the knees.

Social barriers to participating in physical activity included the following: lack of time/competing demands, lack of energy, lack of social support, not having a partner, and multiple social roles. Something that was common to most of these barriers was their similarity in reasoning when compared to their healthy eating barrier counterparts. For instance, lack of time/competing demands was identified as a barrier for healthy eating and for participating in physical activity. Women from several studies offered the same explanation for both, proclaiming that responsibilities from home and work life made being physically active impossible (Pekmezi et al., 2013). Lack of energy and fatigue were also offered as explanations for both HE and PA.

These barriers, in addition to responsibilities, led to them feeling exhausted and burned out (Baruth et al., 2014). Social support was largely similar to HE, but differed in that women described being motivated when seeing others in their neighborhoods, family, friends, etc. participating in physical activity (Sanderson et al., 2002). However, when they do not see these things and are surrounded by those who are overweight or unmotivated, they remain physically inactive themselves (Sanderson et al., 2002). The study done by Rohm et al. (2003) contradicts these statements. According to statistical analysis, women who belonged to social groups were more likely to be inactive. Not having a workout partner was related to lack of social support. Rohm et al. (2003) showed that, statistically speaking, women without a partner were less likely to be active. In the research conducted by Baruth et al. (2014) participants mentioned being dependent on their spouse or long-term partner; if this person quits, they would quit. Finally, multiple social roles were mentioned as a barrier. According to Rohm et al. (2003) women with fewer social roles were more than two times as likely to participate in some form of physical activity.

Environmental barriers included: unsafe neighborhoods, unsupervised children, lack of access to facilities, and cost. Unsafe neighborhoods encompassed four subcategories of safety issues, violence, dogs, and traffic. With crime and violence mostly occurring at night, women did not feel comfortable walking or exercising by themselves at night (Baruth et al., 2014). Complaints of loose dogs or just the knowledge that dogs were in the neighborhood were enough to deter some women from participating in physical activity. Additionally, women mentioned not being able to walk on the streets (should sidewalks, etc. be unkempt) because drivers do not adhere to the speed limits of residential areas. As if their neighborhood was not enough to deter them, unsupervised neighborhood children often shout destructive, mean, and negative comments, averting the efforts of some of these women (Baruth et al., 2014).



Another common barrier reported was a lack of access to facilities. This included the dissatisfaction with how far away facilities, such as a gym, were located. Sanderson et al. (2002) relate that “No community or recreational centers with exercise equipment were identified, and sidewalks, streetlights, and parks were scarce.” Therefore, participation in physical activity would risk their safety (staying near home) or their time and/or money (travelling to participate in physical activity). In addition the cost of gym memberships frequently appeared as a barrier. Women stated that they did not have the resources to pay for gym memberships or for programs that aid in participation in physical activity (Sanderson et al., 2002).

In addition to lack of facilities at home or in the neighborhood, women also noted a lack of access to facilities at the work place. Women reported a lack of encouragement at the workplace (Sanderson et al., 2002) and inability to use exercise facilities at work (Nies et al., 1999). Some women expounded on this statement by explaining that their place of occupation would only encourage them to work more. Lunch breaks were not long enough to allow for physical activity, and early closing times at child daycare centers prevented women from participating in physical activity (PA) after work. Nies et al.’s (1999) participants reported that the problem was not lack of facilities but their employers making the facilities inaccessible to employees. Women reported that their access to the building (i.e. badge) would be taken, leaving them no access to the facilities.

Cultural barriers may prevent some African American women from participating in PA. The following cultural barriers were identified: perceived negative outcomes of physical activity, views on body image, work ethic and types of jobs, and lack of role models. Urban participants in the study conducted by Pekmezi et al. (2013) described sweating as a negative outcome of physical activity. Participants were concerned about the effects perspiration would have on

their hair. They explained that a lot of time and money went into them getting their hair done and an excess of perspiration would undo their hair (Pekmezi et al., 2013).

Views on body image may also affect the likelihood of African American women to participate in PA. Participants in the study conducted by Sanderson, Littleton and Pulley (2002) believed that African American women like their larger hips and curves while Caucasian women prefer to be “thin.” According to Sanderson et al. (2002), “the heavier you are, it is more acceptable in the African American community.” Participants also felt that African American women tend to work in harder, more physically demanding jobs with less pay than Caucasian women. This led African American women to participate in different types of physical activity. One woman articulated this perception by stating “It appears to me that they [whites] are more physically active than we are...and I notice that the barriers might be that we don’t have the money to join the exercise place” (Sanderson, Littleton, & Pulley, 2002).

In summary, common categories or themes were found among the literature for both barriers to healthy eating and barriers to physical activity. The categories were personal, social, environmental, policy-related, and cultural. Among each category many barriers and sub-barriers were discovered. The majority of these studies focused on African American women who were obese or from disadvantaged backgrounds. This study will focus on older African American women who are at risk for PAD. Limited research has been conducted with this population. This study is seeking to determine whether or not this population of women perceives different barriers to healthy eating and physical activity.

## Methodology

### Participants

The study sample was comprised of 14 participants. The criteria for inclusion in the study

were as follows: (a) female, (b) African American, (c) 60 years or older, (d) has one or more risk factors for PAD (hypertension, diabetes mellitus, present or past smoker, high cholesterol), and (e) has an ABI greater than 0.995. Most participants reported an income at or below \$39,999, with three reporting incomes at or above \$50,000. All women had health insurance. Six women were divorced, five were married, and two were widowed. The purpose of selecting participants based on these criteria was to identify African American women at risk for PAD.

## Study Design

This was a phenomenological qualitative study whose purpose was to identify common barriers to participating in physical activity and maintaining a healthy diet for African American women at risk for Peripheral Arterial Disease (PAD). Participants who were not eligible for a previous walking intervention clinical trial, because they screened negative for Peripheral Arterial Disease, were recruited for this study.

## Procedures

Participants were informed of the study and the opportunity to participate. Then a convenient time and place were scheduled for each participant. At the beginning of each interview, written consent was obtained for participation and audio recording of the interview. Probing questions were included to encourage participants to expand their comments and to request clarification. The interviewer used a tape recorder and wrote notes to document responses. The audio recording was then transcribed by a study team member. At the completion of the interview, participants were asked for any additional comments and thanked for their time. This study was reviewed and approved by the Human Subjects Committee at the University Of Kansas School Of Medicine-Wichita.

## Data Analysis

Transcribed data were individually analyzed

by the two researchers (JF, MLR). The transcript of each interview was read and supplemented with written notes as needed. Emergent themes were noted from each participant interview. The analysis of the text was a process by which the researcher identified emerging themes across written summaries and identified salient themes supported by excerpts from the transcribed interviews. The findings and any differences between individual analyses were discussed to reach consensus on emergent themes. Specific themes provided primary lessons about barriers to physical activity and healthy eating among African American women.

Interview questions were developed to identify participants' daily physical activity and eating habits. Participants were asked to talk about specific barriers that prevented them from engaging in physical activity. They were also asked to talk about specific barriers that prevented them from maintaining a healthy diet, as well as barriers to fruit and vegetable consumption (See Appendix A).

## Results

Semi-structured interviews were conducted with a total of 14 participants. Analysis of the qualitative interviews revealed three emerging themes for barriers to healthy eating and three emerging theme for barriers to physical activity. The themes for barriers to healthy eating were personal, costs/access, and no barriers (see Appendix B) and the themes for physical activity were physical pain/health, time, and no barriers (see Appendix C).

### Personal Barriers to Healthy Eating

The first common barrier to healthy eating was cravings for foods such as: chocolate, sweets, and salty snacks. Initially, some women would begin by stating that they do not have any barriers to healthy eating, but would go on to explain how they loved a particular type of junk food, such as chocolate and salty snacks, and would frequently eat it. One participant explained that she loved

sweets. She said, “I will send someone for candy. I would like to eat it every day.” Another woman explained “I eat the wrong thing at the wrong time. I often crave a salty snack.”

Other personal barriers emerged around personal choice. Some participants made a conscious decision to not eat healthy foods. Several women mentioned their dislike of cooking or lack of motivation for eating a healthful diet.

### **Costs/Access as a Barrier to Healthy Eating**

Cost emerged as a barrier to healthy eating. While all participants believed fresh fruits and vegetables were in good supply and readily available from local grocery stores, cost was sometimes an issue. Participants stated maintaining a healthy diet was costly, especially when purchasing fresh fruits and vegetables. One woman said, “I try to eat healthy, but sometimes I can’t purchase quality food because of the cost of organic foods. I buy regular food instead.” Another woman stated that she changed her diet a few years ago because of health issues and tries to eat more fruit and vegetables, but this can “get expensive.”

### **No Barriers to Healthy Eating**

The majority of participants indicated that they had no specific barriers to eating a healthy diet. These women indicated that they had access to fresh fruits and vegetables and made sure to incorporate those foods into their diet at least twice a week if not daily. One participant stated “I usually eat breakfast, light lunch, and dinner.” Another participant stated, “I eat fruits and vegetables daily.” This participant went further to say how she loves eating fruits and vegetables, particularly during the summer when they are in season. In addition, one participant claimed that she did not have any barriers, noting that it was her personal choice to eat healthy foods.

### **Physical Pain/Health Barriers to Physical Activity**

Health and pain issues were a significant

barrier for many women who want to participate in physical activity. One participant stated that her knees make it uncomfortable to walk because she does not have any ligaments. Another participant listed “back surgery, stroke, and right side weakness,” along with a knee replacement as reasons for not participating in physical activity. For some participants, pain was not the only obstacle that kept them from participating in physical activity. Participants also mentioned asthma and not being able to get enough air to their lungs as barriers to physical activity.

### **Time Barriers to Physical Activity**

Time was mentioned as a barrier. One participant explained how her work can be very demanding (she works 3 times a week), and her job requires her to stand a lot, which leads to physical pain as well.

### **No Barriers to Physical Activity**

Similar to the barriers to healthy eating identified in this study, a lack of barriers to PA was frequently reported. When asked to further expand on the topic, the women explained that they felt that they did not face any barriers to physical activity.

## **Discussion**

Overall, participants reported minimal to no barriers to healthy eating and physical activity. There was a general consensus among the women that had access to healthy foods such as fresh fruits and vegetables was not a problem. Most women were already watching their consumption of fresh fruits and vegetables, as well as their intake of salt and other unhealthy foods.

### **Personal Barriers to Healthy Eating**

Personal barriers to healthy eating were as follows: cravings for other foods, the personal choice not to eat healthy foods, and not liking to cook. Among the common barriers to healthy eating listed in the literature were lack of

knowledge and psychological factors (Baruth, Sharpe, Parra-Medina, & Wilcox, 2014). Psychological factors were split into subcategories which included feeling defeated, eating for reasons other than hunger (e.g. depression), food addiction, and finding food comforting (Baruth et al., 2014). The personal barriers found in this study do not reflect the literature. Women from the study conducted by Baruth et al. (2014) did not report giving into cravings as a barrier, but rather giving into unhealthy eating habits as a social barrier. Women explained that food was a part of socializing. Participants of this study did not report eating unhealthy food items because of socializing, but rather because they enjoy those particular foods and choose to eat them.

### **Costs/Access as a Barrier to Healthy Eating**

Cost as a barrier to healthy eating was established among other studies and was also identified in this one. According to Acheampong and Haldeman (2013), African American women stated that one of their most common barriers to healthy eating was the cost of food. Some participants in this study agreed. Baruth et al. (2014) claim African American women believe that healthier foods are more expensive. This was corroborated by this study. One woman proclaimed that sometimes she cannot purchase organic food, so she just buys non-organic food. Another participant talked about how in the “off season” fresh fruits and vegetables become expensive, so as a substitute, she buys canned fruits and vegetables.

### **No Barriers to Healthy Eating**

A lack of barriers to healthy eating was not common in the literature. This discrepancy could be due to participants’ definition of a healthy and unhealthy diet or to participants not wanting to disclose such information. For example, one participant reported that she did not have any barriers to healthy eating, but later reported that she “loves chocolate.” Some participants said that

they did not have any barriers to healthy eating because it is their personal choice to eat healthy food items.

### **Physical Pain/Health Barriers to Physical Activity**

Participants of this study identified health and pain problems as a barrier to physical activity. Participants mentioned joint pain, knee pain, back problems, problems standing, and discomfort during walking. One participant explained that she does not have any ligaments in her knees so her bones rub together, making walking uncomfortable. Physical pain/health was also a common barrier mentioned among other women in other studies. Baruth, Sharpe, Parra-Medina, and Wilcox (2014) report one woman who broke three of her toes during exercise, which now prohibits her from PA. Another participant of the same study explained that her joints are no longer cooperating and her knees are beginning to pain her. Difficulty breathing or asthma were not mentioned in other studies.

### **Time Barriers to Physical Activity**

Time constraints were also mentioned as a barrier to physical activity due to work demands. This barrier is mentioned in several other studies. The low number of women who listed this as a barrier could be due to the fact that most women who participated in this study were unemployed and 60 years or older. Previous research conducted had a younger age range (25-50 years of age, etc.), and a lot of women identified themselves as the main caretakers in their household (Acheampong & Haldeman, 2013). No participants in our study identified as the main caretakers in their households. Therefore, participants of our study may not hold as many social roles or have to deal with as many work demands when compared to women in other studies.

### **No Barriers to Physical Activity**

Half of the participants in this study reported



that they did not experience any barriers to participating in physical activity. This could be because the participants already participate in physical activity or do not feel the need to participate in physical activity. One participant explained that she did not have any barriers to PA. She tries “to overcome any barriers limited by knees. I cannot walk often.” Although the participant acknowledged her health as a potential barrier, her perception was that she did not have any barriers.

### Limitations

There are limitations to this study. Our findings may not be generalizable to larger populations because of our small sample size. Increasing the sample size may allow for a broader spectrum of responses. Another limitation is the definition or perception of key concepts used in this study. Women in this study may have defined “healthy diet” and “barrier” differently than intended. A greater clarification of terms is recommended for future studies.

## Conclusion

In conclusion, pain and health were common barriers for engaging in physical activity. The cost of fresh fruits and vegetables, desire to eat other foods, and the lack of motivation to follow a healthy diet were common reasons for not eating healthy. In addition, a common theme that emerged among participants was a lack of barriers to physical activity and healthy eating. Future studies should investigate why women felt that they did not have any barriers to physical activity and healthy eating. Further studies should include a larger population size and a clear definition of healthy eating and physical activity. Information from this study helps us to understand barriers to African American women who possess risk factors for PAD and how to intervene on those barriers for future research.

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## Appendix A

Table 1 <i>Qualitative Questions About Barriers to Physical Activity and Healthy Eating</i>	
1) How often do you engage in physical activity?	
2) What types of activities do you like to do the most? Where do you normally go to engage in physical activity?	
3) Do you have any specific barriers that prevent you from engaging in physical activity?	
4) What is your biggest barrier to healthy eating?	

## Appendix B

Table 2 <i>Common Barriers to Healthy Eating</i>	
Emerging Themes	Barriers
Personal	Cravings for other foods Personal choice to not eat healthy foods Doesn't like to cook
Costs/Access	Organic foods are expensive Fresh fruits and vegetables are costly Off season makes some fruits & veggies harder to access
No barriers	Lack of barriers mentioned Personal choice to eat healthy foods

Appendix C

Table 2 <i>Common Barriers to Physical Activity</i>	
Emerging Themes	Barriers
Physical Pain/Health	Joint Pain Knee Pain Back Problems Problems with standing Uncomfortable to walk Asthma/Difficulty breathing
Time	Work Demands
No barriers	Lack of barriers mentioned



# College Students' Opinions on Gun Violence and Mental Health Issues

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## Abstract

**M**ass shootings have captured America's headlines in recent years. The perpetrator is often reported as being mentally ill. But is it their illness that caused them to commit the shootings or is it access to guns? The purpose of this study is to gather information about college students' attitudes and opinions on gun violence, mental health, and the relationship between the two. Four hundred nineteen Wichita State University students completed a 52-item survey. Results of the survey show that when asked about whether increasing mental health services would help to prevent gun violence, 25% of respondents stated that they strongly agreed and only 2% strongly disagreed with that statement. Furthermore, when asked if there should be laws prohibiting persons with mental illness to carry handguns, 34% strongly agreed and only 2% strongly disagreed with that statement. These results can

be helpful in implementing new laws because, by gathering various opinions, the best social policy can be developed.

## Introduction

Jared Loughner, a disturbed 22-year-old, killed six people, including former U.S. representative Gabrielle Giffords. He had signs of psychiatric illness and social psychopathology but was not referred to receive any psychological treatment (Faria, 2013); Twenty-six-year-old James Holmes was mentally unstable and killed twelve people at a movie theatre in Aurora, Colorado (Faria, 2013; Hall & Friedman, 2013). Adam Lanza was a 20-year-old diagnosed with a personality disorder. He carried out the second deadliest mass shooting ever recorded in the United States, killing six adults and 20 children at Sandy Hook Elementary School in Newtown, Connecticut (Faria, 2013). Each one of these criminals represents the failures of the mental health system and criminal justice system. Psychiatrist and Director of Student Health Services at the University of Colorado Dr. Lynne Fenton, had counseled Holmes multiple times. When Holmes began sending her threatening letters, she reported him to campus security. This report did not lead to incarceration. He later committed the shooting at a movie theatre in Aurora, Colorado (Rosenberg, 2014). Many lawsuits were filed against Dr. Fenton and the University of Colorado for not having Holmes properly committed. However, blaming mass shootings committed by mentally ill individuals on psychiatric professionals is not rational. Some perpetrators never seek medical attention, and when they do, it is not always effective (Sanger-Katz, 2013). Psychologists, psychiatrists, and physicians in the healthcare system can only do so much. It is a group effort in which law enforcement should participate (Hall & Friedman, 2013).

The effectiveness of federal and state laws on preventing firearms from falling into the wrong hands is questionable. Current federal

law prohibits “certain classes of people from purchasing firearms, including convicted felons, adjudicated persons with mental illness and drug abusers” (The Institute of Law, Psychiatry, & Public Policy, 2013). Seung-Hui Cho, perpetrator of the Virginia Tech massacre, had a mental health record that went all the way back to middle school (Rosenberg, 2014), but that did not stop him from committing one of the most brutal mass murders in U.S. history. Steven Kazmierczak, Elliot Rodgers, and Aaron Rey Ybarra are most recent examples of college campus mass shooters. As a teenager, Kazmierczak was hospitalized for psychiatric issues. He took interest in past mass shootings such as the one at Virginia Tech (Boudreau & Zamost). Rodgers posted many disturbing videos on YouTube. His mother saw the videos, grew concerned about his mental health, and contacted mental health officials who sent police officers to his apartment (Rucker & Costa, 2014). Ybarra had also stopped taking his mental health medication because he “wanted to feel the hate.” This hate led to the death of one Seattle Pacific University student (Clarridge & Sullivan, 2014). All four men were able to attain firearms, either legally or illegally, to carry out each attack. This leads to the question of what loopholes are in the system and what can be done to close them.

This study was conducted to gather the opinions of college students on gun violence, mental health, and the relationship between the two. The goal of this research was to gain a clearer determination of mental illness’s impact on both gun violence and policy. The responses given by college students can be used to create policies that will prevent these tragedies from occurring.

## Literature Review

In response to the recent increase of mass shootings, President Obama proposed new policies to prevent further tragedies. His plan includes “closing background check loopholes to keep guns out of dangerous hands, banning military-style assault weapons and high-capacity magazines while taking other common-sense

steps to reduce gun violence, make schools safer, and increase access to mental health services” (Now Is The Time, 2013). President Obama proposes increased coverage of mental health treatment so millions more can afford it. Future research should be conducted to evaluate these policies when more data are available. His plan also encourages gun owners to safely store their firearms (Now Is The Time, 2013). However, it fails to address that, even if a gun is stored safely, parents are typically not aware of how knowledgeable their children are about the location of their guns and ammunition (McNamara & Findling, 2008, p. 192). Families must work together to learn about guns and gun safety. It is essential that discussions take place as to why there is a gun in the household, what it should be used for, and the consequences of mishandling the weapon.

The Centers for Disease Control and Prevention (CDC) define mental illness as “disorders generally characterized by dysregulation of mood, thought, and/or behavior, as recognized by the Diagnostic and Statistical Manual, 4th edition, of the American Psychiatric Association” (Centers for Disease Control and Prevention, n.d.). It is important to have a clear understanding of what these terms mean. The CDC also reports that 25,423 firearm homicides and 34,235 firearm suicides occurred between 2006 and 2007 (Centers for Disease Control and Prevention, n.d.). Deinstitutionalization of mental patients could have contributed to homicides and suicides by firearm. Deinstitutionalization of mental patients began in the 1960s and put thousands of mental patients, dangerous or not, back on the streets. This was due to health care costs and the health strategy of overseeing health care via community outreach and outpatient treatment (Faria, 2013). President Obama acknowledges the potential relationship between mental illness and gun violence, proposing in his plans to increase access to mental health care and to ban high-capacity magazines. His proposals are responsive to the opinions of the public.

Princeton Survey Research Associates International surveyed 1,003 adults from September 19th to the 22nd via landline and cell phones, conducting the United Technologies/National Journal Congressional Connection Poll. This survey indicated major differences between whites’ and minorities’ opinions on gun control. Minorities favored banning assault weapons to reduce mass shootings (68% to 29%). Whites split fairly evenly, 53% to 45% (Brownstein, 2013). Sixty-seven percent of minorities thought limiting the size of ammunition clips would help, and 47% of whites also agreed (Brownstein, 2013). The majority of each group supported background checks; 84% of minorities agreed background checks would have an impact, and so did 72% of whites (Brownstein, 2013). The article briefly mentions that women are more likely to support gun-control measures than men. Gun violence is a time-independent issue. Support for gun control and more mental health policies tend to be higher immediately following a mass shooting or public tragedy. Therefore, public opinion poll results will fluctuate depending on when polls are given and taken.

A month after the Newtown shooting, according to the *New York Times/CBS News* polls, the majority of Americans (54%) believe that gun laws should be stricter (Cooper & Sussman, 2013). This is an increase from last April’s poll, which indicated 39% of Americans supported stricter laws (Cooper & Sussman, 2013). Background checks were also very popular after the Newton shooting, with nine to ten in favor. Nine in ten of those respondents had guns in their household, and 85% of households include National Rifle Association members (Cooper & Sussman, 2013). A ban on high-capacity magazines was supported by six in ten, and 53% of respondents supported a ban on some semiautomatic weapons (Cooper & Sussman, 2013). Eight in ten believed that mental health screening and treatment would help reduce gun violence (Cooper & Sussman, 2013). This poll was conducted via landlines and cell phones from January 11 to 15, surveying 1,110 adults



(Cooper & Sussman, 2013). Conducting surveys by phone excludes all those who do not own phones. Some individuals may not answer when they are called, and those who do answer may not be who they say they are.

McGinty, Webster, and Barry (2013) conducted a survey to evaluate how the public's attitude toward people with mental illness and support for gun control was affected by news media messages. A sample of 1,797 participants was randomly selected from an online panel. Four groups were created: one read a news story describing a mass shooting by a person with serious mental illness; the second group read a news story describing the same mass shooting and a proposal for gun restrictions for people with serious mental illness; the third group, again, read the same mass shooting story, but this one had a proposal to ban large-capacity magazines; the last group was the control group who did not read any stories. Results showed that "36% of participants were unwilling to work closely with someone with serious mental illness and 30% were unwilling to have such a person as a neighbor" (McGinty, Webster, and Barry, 2013, p. 496). Forty percent of participants believed that those with serious mental illness were more dangerous than those without (McGinty et al., 2013, p. 496). The vast majority (71%) of participants supported gun restrictions for people with mental illness, and 48% supported banning large-capacity magazines (McGinty et al., 2013, p. 496). When it came to gun control proposals, those in group one and three reported

the same amount of support for gun restrictions on individuals with serious mental illness even though group one just read the news story with no proposals (McGinty et al., 2013, p. 500). The support for a ban on high-capacity magazines was highest in the third group and lowest in group four (the control) (McGinty et al., 2013, p. 500). This indicates that exposure to certain news media does influence a person's perception of individuals with mental illness and his or her support, or lack thereof, for gun control policies.

### Methods

A 52-item online survey was created on Qualtrics to gather the opinions of college students about social media, mental health and gun control/violence. 1,400 randomly selected students were sent a link to participate in the survey, and 419 completed the survey. Most respondents were white (72%), female (57%), non-gun owners (70%) who did not identify with a political group (30%). Table 1 lists the statements used in this study. Participants were eligible to win a \$75 gift card to the University Bookstore. IRB approval was received for this project. Results were analyzed using SPSS.

## Results

### Demographics

Fifty-seven percent of the sample were female, 72% were white, 70% did not own a gun, and 30% did not identify with any political

**Table 1: Statements Used for Study**

I believe that increasing access to mental health services will help to prevent gun violence.
I believe that there should be laws prohibiting persons with mental illness to carry handguns.
I believe that the underlying cause of gun violence is lack of mental health services.
I believe that insurance companies should be required to offer benefits for mental health that are the same as benefits for other medical services.
I do not believe that the United States government should increase spending on mental health care in the United States to reduce gun violence.

party. The overall percentages for each statement are reported below. The results are grouped by gender, ethnicity, and political party affiliation. The responses were collapsed into agree and disagree. Agree includes strongly agree, agree and somewhat agree. Disagree includes strongly disagree, disagree and somewhat agree.

Statement 1: I believe that increasing access to mental health services will help to prevent gun violence.

Eighty-one percent of respondents agree with the statement. Overall, the majority of respondents agree with the idea that increasing access to mental health services would help prevent gun violence.

Statement 2: I believe that there should be laws prohibiting persons with mental illness to carry handguns.

Eighty-seven and five hundredths percent of respondents agree with the statement. Again, an overwhelming majority believe there should be laws prohibiting mentally ill individuals from carrying handguns.

Statement 3: I believe that the underlying cause of gun violence is lack of mental health services.

Forty-five percent of respondents agree with the statement. Responses were fairly evenly split

for this statement, but slightly more students believe there is a different reason for the gun violence, not lack of mental health services.

Statement 4: I believe that insurance companies should be required to offer benefits for mental health that are the same benefits for other medical services.

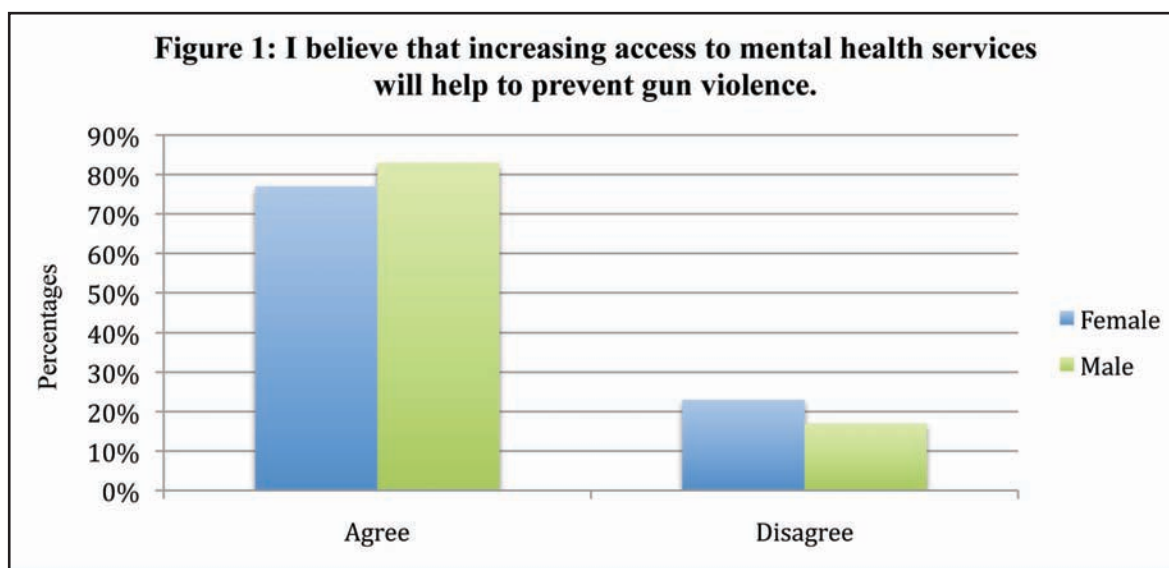
Ninety-one percent of respondents agree with the statement.

Statement 5: I do not believe that the United States government should increase spending on mental health care in the United States to reduce gun violence.

Thirty-eight percent of respondents agree with the statement; however, 61% disagree with this statement. A majority of the students disagree with this statement.

**Gender.** Figure 1 describes how each gender responded to the statement “increasing mental health services to help prevent gun violence.” Males were more likely to believe increasing access to mental health services would help prevent gun violence (83% to 77%).

Males are more likely to believe there should be laws prohibiting the mentally ill from carrying handguns (90% to 86%). Both genders were split on whether or not the cause of gun violence is lack of mental health services or other factors





(47% to 43%). Both genders believe insurance companies should be required to offer benefits for mental health that are the same benefits for other medical services (93% to 91%). Females are more likely to believe the United States government should increase spending on mental health care in the United States to reduce gun violence (65% to 59%).

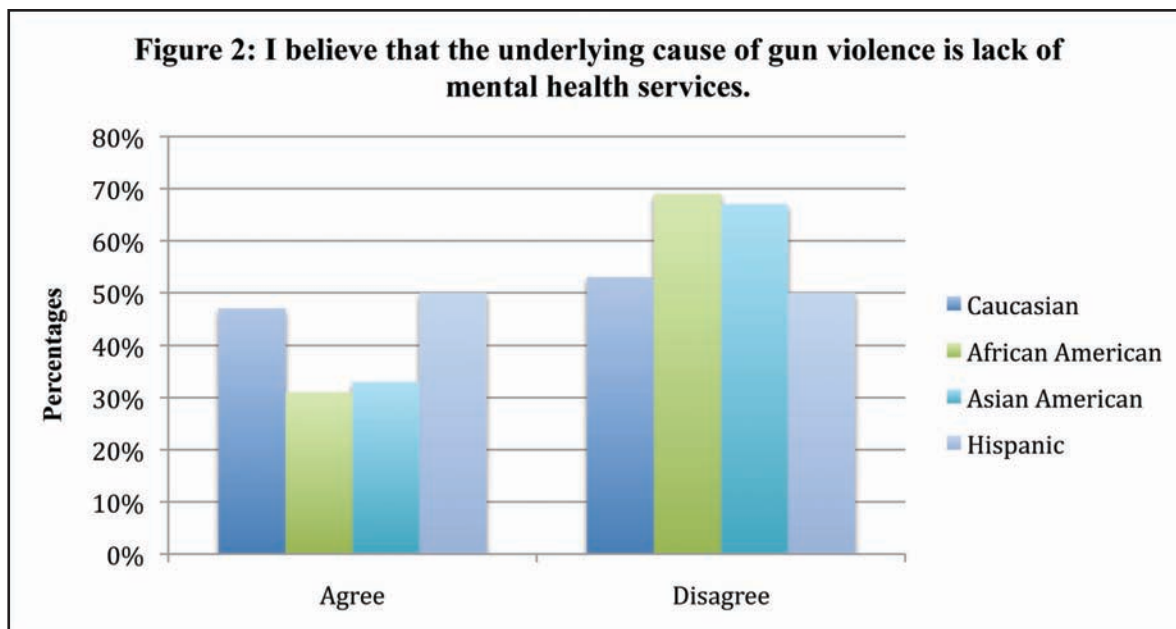
**Ethnicities.** Figure 2 illustrates the differences between ethnicities and their opinions on whether or not that lack of mental health care is the underlying cause of gun violence. Fewer than half of the Caucasian students believe the underlying cause of gun violence is lack of mental health services (47%). African Americans are more likely to disagree with the statement that the underlying cause of gun violence being lack of mental health (31%). Only 40% of Asian American students believe lack of mental health services was the underlying cause for gun violence. A little more than half of the Hispanic students surveyed believe lack of mental health services was the cause of gun violence (51%).

Regarding the statement “I believe that increasing access to mental health services will help to prevent gun violence,” 81% of Caucasian students, 82% of African American students, 60%

of Asian American students, and 89% of Hispanic students agree. Ninety percent of Caucasian students, 82% of African American students, 93% of Asian American students, and 100% of Hispanic students believe there should be laws prohibiting the mentally ill to carry handguns. Thirty-five percent of Caucasian students, 57% of African American students, 40% of Asian American students, and 51% of Hispanic students did not believe the United States government should increase spending on mental health care in the United States to reduce gun violence.

**Political Affiliation.** Figure 3 illustrates the opinions of students who affiliate with certain political parties in regards to the mentally ill and their right to carry handguns. More Republicans support having laws that ban mentally ill individuals from carrying handguns than Democrats and those who do not identify (90% to 83% to 86% respectively).

Seventy-eight percent of Republicans believe increasing access to mental health services would help to prevent gun violence. Eighty-four percent of Democrats and 79% of those who do not identify with any political party agree as well. For the statement, “I believe the underlying cause of gun violence is lack of mental health services,”



46% of Republicans, 52% of Democrats, and 47% of those who do not identify agree. Sixty percent of Republicans, 95% of Democrats, and 94% of those who do not identify believe insurance companies should be required to offer benefits for mental health that are the same benefits for other medical services. For the statement, “I do not believe that the United States government should increase spending on mental health care in the United States to reduce gun violence,” 43% of Republicans, 29% of Democrats, and 35% of those who do not identify with any political party agree.

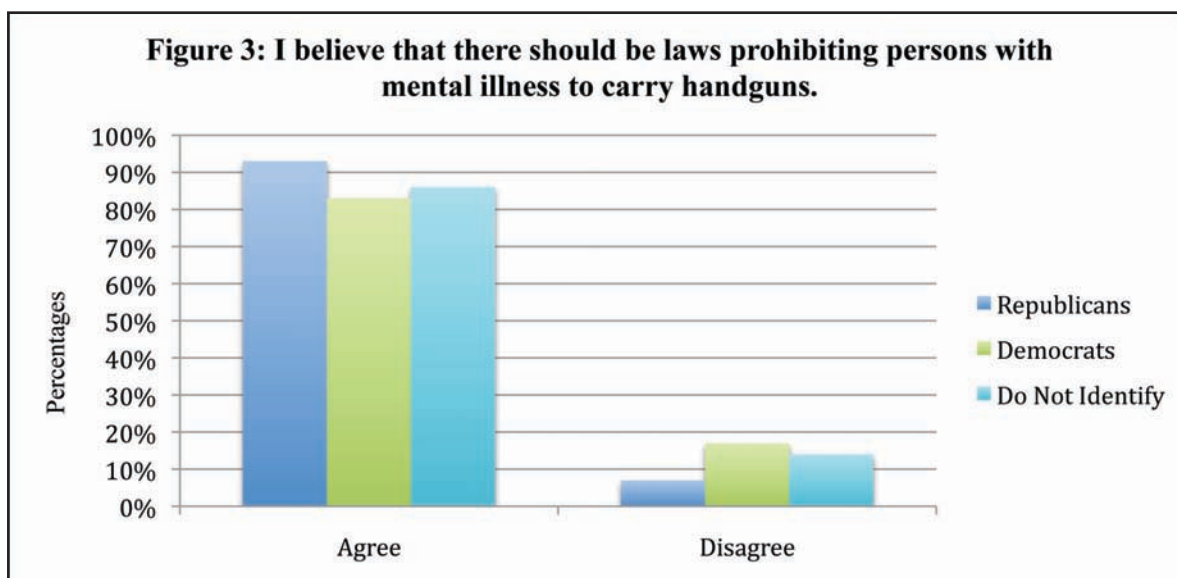
## Discussion

This study’s major findings include the following: only 30% of respondents owned guns; more males believe increasing access to mental health services would reduce gun violence; Caucasians and other ethnicities both support, fairly equally, an increase in mental health care; and more Republicans support gun control measures than Democrats or those who do not identify with a political party.

Overall, the majority of those surveyed believe that there should be restrictions on gun acquisition by the mentally ill. They also believe

insurance companies should provide mental health care and that the government should provide more mental health services to the mentally ill. However, they do not believe mental illness is the underlying cause for gun violence. Further research could explore what Americans consider the main cause of gun violence.

Kansas is a high gun carrying state; therefore, it was surprising to find that only 30% of the respondents owned guns. Ninety percent of gun owners support laws prohibiting persons with mental illness from carrying handguns. However, fewer than half (46%) believe it is lack of mental health care that causes gun violence. Brownstein (2013) found that females tend to support more gun-control measures, but in our study, more males believed increasing access to mental health services would reduce gun violence. This suggests that more males believe there is a correlation between mental illness and gun violence. Brownstein (2013) also found that minorities are more likely to support gun control laws than whites. However, this study found that between whites and other ethnicities (African American, Asian American, Hispanic), there was little difference in support for increasing mental health care. All of the Hispanic/Latino students surveyed agree with the statement, “I believe that



there should be laws prohibiting persons with mental illnesses the right to carry handguns.” All of the Asian American students surveyed believe insurance companies should be required to offer benefits for mental health similar to other medical services. If there were laws preventing the mentally ill from getting a gun and if insurance companies pay to help the mentally ill, the chances that they will attain a gun and commit a crime would be reduced. It is very interesting that the majority of Asian Americans and Hispanic/Latino students who took this survey agree, while some Caucasian and African American students disagree. More Republicans supported banning the mentally ill from gun ownership. Republicans tend to be pro-gun. Debates over gun control become a hot topic when tragedies like Newtown occur. Mental health is usually brought up as well. Therefore, it makes sense for Republicans to support such a law that would allow them to keep their guns but prevent their firearms from falling into unfit hands.

## Limitations

There are limitations to this study. First, this is an opinion study; therefore, survey respondents may have given socially desirable answers and may not have shared their true feelings. On the other hand, answers were kept completely confidential, and students may have expressed how they truly feel. Focus groups should be conducted with these groups to learn more about why they answered the way they did. Second, although this is a fairly representative sample of Wichita State, it may not be representative of all college students. Wichita State University is a commuter campus

located in the Midwest and may not represent more traditional campuses across the nation. Third, the survey statements may have been leading, and many of the statements could have been interpreted multiple ways. This may have impacted the data and led to research bias.

## Conclusion

To understand some of the responses, it may be helpful if researchers gather qualitative data from survey respondents. It is not clear why some respondents strongly agreed or strongly disagreed with a statement. It might be interesting to see how age differentiates these statements. College age students can possibly become policy makers. Those who vote are college-aged and older. It would be interesting to conduct a study comparing the opinions of a generation of college-aged students with those of an older generation (people in their 40s and 50s). More studies are needed to get a handle on increasing safety on college campuses, increasing access to mental health services, and promoting mental wellness. More social policies need to be proposed and implemented to prevent further tragedies involving gun violence and/or our mentally ill. These social policies can stem from the results of national polls or surveys like this. It is important to try to get the opinions of as many different people as possible, different ages, ethnicities, political affiliation, etc. By gathering various opinions, the best social policy can be developed. In the wake of numerous college shootings, it behooves policy makers to step in and address this issue before more lives are lost to gun violence.

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# Mathematical Modeling of Drug Elution from Polymeric Microspheres

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## Abstract

When developing drug delivery systems researchers are concerned with optimizing the initial quantity of drug to be loaded in the delivery system to obtain the desired drug concentration in the body. Current methods for optimizing drug delivery systems are based on experimental trials and can become time consuming and very expensive. In order to arrive at improved drug delivery systems that are faster and cheaper, mathematical modeling and computational simulation for optimization of drug delivery systems can be utilized. The focus of this research is to modify mathematical and computational models that were developed to model the diffusion of drugs through non-degradable polymeric microspheres to enable them to model biodegradable microspheres and eventually optimize this drug delivery system. Mathematical models were formulated, developed then

implemented using COMSOL Multiphysics software. Once a working model came to fruition in COMSOL, work was done to sustain parameterized variables such as: diameter, shell thickness, and initial concentration; properties such as diffusion coefficients, degradation rates of chosen polymer, etc. were calculated from literature. When finished, work to design optimization features within the model could begin to help obtain optimal drug/polymer combinations to achieve the best possible therapeutic dosage for a given condition. These models show promise in optimizing drug delivery systems for any given drug/polymer combination.

## Introduction

For centuries humans have been using and administering therapeutic drugs, and through the years, the creation and administration of drugs has grown into a multibillion dollar business.

With varying forms of sickness and disease plaguing humans every day, the need for novel, effective, and more efficient drug delivery mechanisms is always present. Unfortunately, the driving factor of producing novel medicines and their delivery systems comes down to the price that a company will have to pay to invent and develop this medicine/system combination. According to an analysis by Forbes examining the research and development history of major pharmaceutical companies, 95% of experimental medicines studied in humans fail to be both effective in the body and safe [3]. A company can expect to spend \$350 million or more attempting to bring a new pharmaceutical drug into the market. Some large pharmaceutical companies may be working on multiple pharmaceutical projects at one time and may spend up to \$5 billion per pharmaceutical project [3]. These numbers are staggering and create obstacles when research projects need consideration for funding: companies risk large amounts of capital and may see no return on this investment. Many potential

breakthrough medical drugs will never see the light of day. There is a need for cutting the cost of pharmaceutical innovation, and mathematics may hold the answer.

Many factors are considered in the research and development of new medicines and their drug delivery systems. When developing an effective drug/drug delivery system combination, researchers try to find a drug delivery system that provides a consistent and effective therapeutic drug dose within the body for a certain amount of time. The aim of this research is to explore the methods of optimizing drug delivery systems with the use of mathematical modeling and computer aided design. The approach to enhance the delivery of therapeutic pharmaceutical drugs, for many decades, has been done through the trial and error of experimental studies. This method is quickly being supplemented with the use of mathematical software to predict probable experimental outcomes. Large amounts of pharmaceutical research budgets are spent in the experimental stage of developing novel drugs and their delivery mechanisms. This cost can be reduced with the help of mathematical formulations and computer software. An accurate computational simulation can predict an experimental drug diffusing through a new delivery mechanism thousands of times over, in a multitude of environments, over many different periods of time.

Current mathematical and computer modeling techniques for microspheres were researched and discussed to show how computer modeling is used to understand and enhance drug delivery systems. First, a mathematical model was designed to simulate different drug diffusion profiles of non-degradable polymeric microspheres of various sizes with varying polymeric molecular shells and thicknesses. The mathematical model was first used to explain the physical phenomena occurring during the diffusion of drug through a non-degradable microsphere. Once the governing equations were established and the mathematical model was



rationalized, the model was implemented with the use of COMSOL Multiphysics software. There, a geometric layout of the microsphere was built, along with the boundary conditions and material diffusion coefficients that were acquired through review of literature. Once the model was complete, time-dependent simulations were run through COMSOL to determine how different polymers, shell thicknesses, and microsphere sizes affected the rate diffusion of certain drugs. The experience gained from creating this first model was used to help begin the process of developing a model for a biodegradable polymeric microsphere system, and eventually, for an optimization element to help formulate an optimized drug delivery system. By including a system that could mathematically consider required research parameters (i.e. drug duration in body, maximum and minimum drug concentration in body, etc.) and results from previous time-dependent simulations of drug diffusion, our model could then potentially predict a set of optimized variable parameters (i.e. microsphere size, drug concentration, etc.) to achieve the desired patient therapeutic dosage. Any effective drug delivery system must deliver the drug to the intended location both efficiently and effectively and remove itself once the job is done. Many polymeric microsphere systems do this by degrading in the body into biocompatible parts that can be easily removed from the body without harm to the patient. Much of the research was focused on formulating the physics and math behind such a task and learning how to apply the COMSOL Multiphysics software platform to perform this task. The model and studies presented here are intended to show the versatility of the model created.

## Methods

COMSOL Multiphysics software platform was the primary software used to apply the mathematical models and run simulations of drug diffusion. The COMSOL Multiphysics interface assumed all chemical species were

transported by diffusion. It was also assumed that all species present were dilute, meaning that their concentration is small compared to the solvent. Fick's second law for diffusion was used to generate the governing equations used in the model. Due to time constraints, many assumptions were made (see schematics), and constants and material properties (diffusion coefficients, degradation rates) were calculated.

## Model Development

### Design Objectives

The overall design objectives for the research were as follows:

- Design a computer model to evaluate diffusion of a drug from non-degradable microspheres.
- Demonstrate that the model can simulate different scenarios of varying polymers, polymeric shell thicknesses, microsphere sizes, and initial drug concentrations.
- Analyze drug concentrations within the environment with respect to microsphere size, polymeric shell thickness, initial drug concentrations, and drug uptake within the system over certain periods of time.
- Work to allow the model to support variable parameterization within simulation studies.
- Redesign the non-degradable model to allow for degradation while eluting drug from the surface.
- Develop an optimization system that can give possible variable combinations (microsphere size, initial drug concentrations, etc.) to fit desired patient parameters such as drug concentration and time duration of drug within the body.

### Schematics

For the drug diffusion part of the model, many assumptions were made to simplify the problem:

1. The microsphere is spherically uniform and will be modeled as a sphere.



2. Uniform properties throughout the system were assumed in this model.
3. The drug diffuses throughout the entire surface of the microsphere.
4. Drug diffusion happens uniformly throughout the microsphere, which results in a two-dimensional axi-symmetric problem.

When advancing to the biodegradable microsphere model some variations in the assumptions were made:

1. The microsphere is spherically uniform and will be modeled as a sphere.
2. Uniform properties throughout the system were assumed in this model.
3. Degradation of the microsphere happens at a constant rate throughout the entire surface of the microsphere.
4. The drug diffuses throughout the entire surface of the microsphere, while the polymeric microsphere is degrading.

### Geometric Layout

The microspheres were assumed to be spherically uniform and modeled as spheres, which allowed for construction of a simplified two-dimensional axi-symmetrical geometry. This allows for less computing time and storage of data when executing simulations. To create the geometric layout of the microsphere, whether

for non-degrading or degrading microspheres, a two-dimensional construct of half a microsphere was created in COMSOL. COMSOL then rotated the two-dimensional schematic around the  $r = 0$  axis when developing a three dimensional construct. A parameter sweep was performed during simulations. Within the model the microsphere diameter, shell thickness, or initial drug concentration can be treated as variables that can change within the simulation study. Therefore numerous microsphere variations can be modeled at the same time. An example of the variable table used in the simulations in COMSOL can be seen in Figure 1. Due to computational time constraints, each simulation studied only one changing variable at a time. Figure 2 shows a simple schematic of the two dimensional construct of the non-biodegradable microsphere. The purple semi-circle represents the initial drug loading zone which is essentially the inner sphere where the drug is encapsulated by the polymeric shell. The grey domain shows the polymeric shell, and the red square represents the solution in which the microsphere is introduced. The drug will diffuse out toward. To help simplify the problem size of the system as a whole, a mesh of triangles was created (Figure 3). The mesh determines the resolution of the finite element used to discretize the model [4]. A structured mesh can generally help to reduce the problem size and uses a set of polynomial functions to approximated variables

Sweep type: Specified combinations

Parameter names	Parameter value list
R (Radius of Microsphere)	range(2.5[mm],2.5[mm],10[mm])
T (Thickness of Shell)	range(2[um],2[um],16[um])
C (Concentration of Drug)	range(25[mol/m <sup>3</sup> ],25[mol/m <sup>3</sup> ],250[mol/m <sup>3</sup> ])

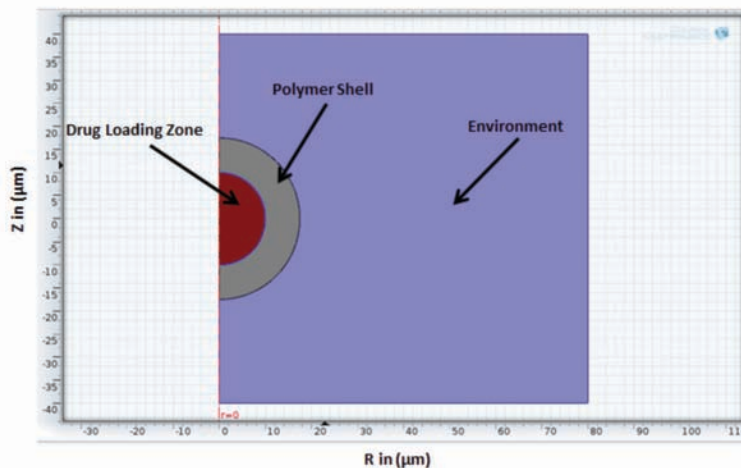
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**Figure 1.** Table for the parametric sweep performed in different simulations. Each variable was simulated independently from each other to save on computation time.

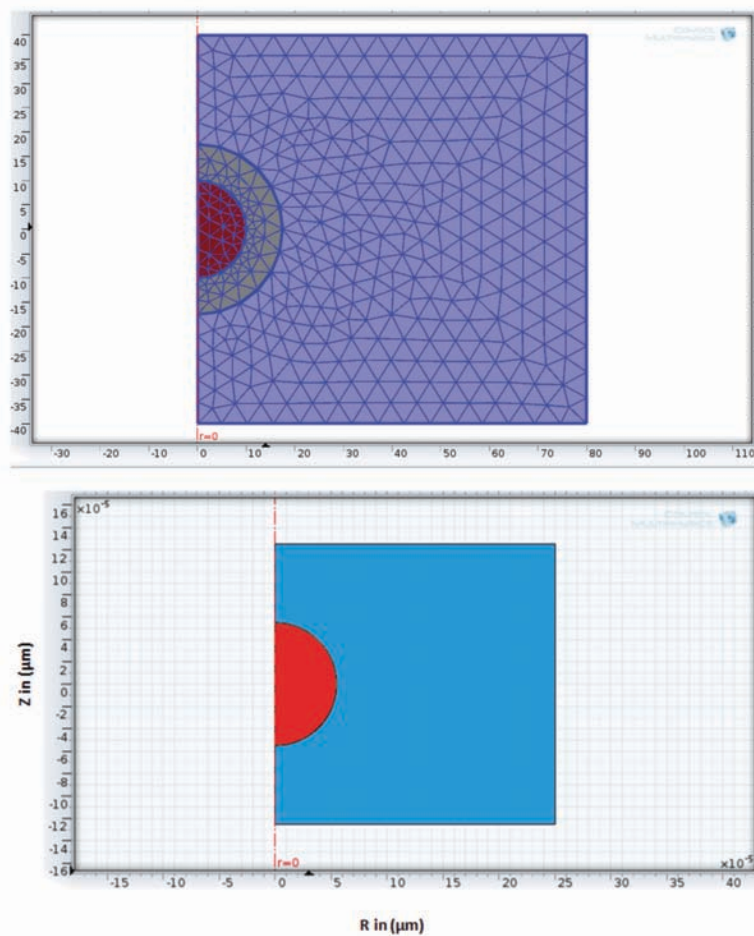
# Mathematical Modeling of Drug Elution from Polymeric Microspheres

that are being measured in the simulation [4]. The same basic steps were taken to move the model from non-degradable microspheres to biodegradable microspheres and can be seen in

Figure 4. For the biodegradable microsphere, two main domains exist, the microsphere, which consists of a polymer/drug matrix (red), and the environment in which it will degrade (blue).



**Figure 2:** Two-dimensional schematic layout of a non-biodegradable microsphere geometry created within COMSOL. The axis is at  $r = 0$ , and the 2-dimensional schematic seen here is rotated about that axis 360 degrees to create a 3-dimensional construct of the drug loaded microsphere.



## Mathematical Model

Fick's second law of diffusion was used to predict the diffusion of the drug out of the microsphere system. Fick's second law helps determine how the diffusion causes concentrations of species to change with respect to time [5, 6]. Fick's law governs the diffusion of solutes, dilute mixtures, or solutions. The final governing equation that was derived and implemented is the mass balance equation see below:

$$\frac{\partial c}{\partial t} = +u \times \nabla c = \nabla \times (D \nabla c) + R$$

- C is the concentration of the species ( $\text{mol} \cdot \text{m}^{-3}$ )
- D denotes the diffusion coefficient ( $\text{m}^2 \cdot \text{s}^{-1}$ )
- R is a reaction rate expression for the drug ( $\text{mol} \cdot \text{m}^{-3} \cdot \text{s}^{-1}$ )
- u is the velocity vector ( $\text{m} \cdot \text{s}^{-1}$ )

The first term on the left side of the equation,  $\frac{\partial c}{\partial t}$  corresponds to the accumulation of the species with respect to time, while the second term accounts for the convective transport due to velocity field *u*. On the right side of the mass balance equation,  $\nabla \times (D \nabla c)$  describes the diffusion transport, which accounts for the interaction between the dilute species and the solvent. The second term, *R*, on the right side of equation, represents a source term or sink term, typically due to a chemical reaction. Drug was considered only moving through diffusion; therefore, the convection term was eliminated. The equation then becomes the following:

$$\frac{\partial c}{\partial t} = \nabla \times (D \nabla c) + R$$

To account for the degradation of the microsphere, the microsphere was represented as a deformed geometry within COMSOL. The radius of the domain for the microsphere was treated as a moving boundary which receded at a constant rate towards the center of the microsphere. This degradation rate would be calculated using results from previous research for a given polymer system in water.

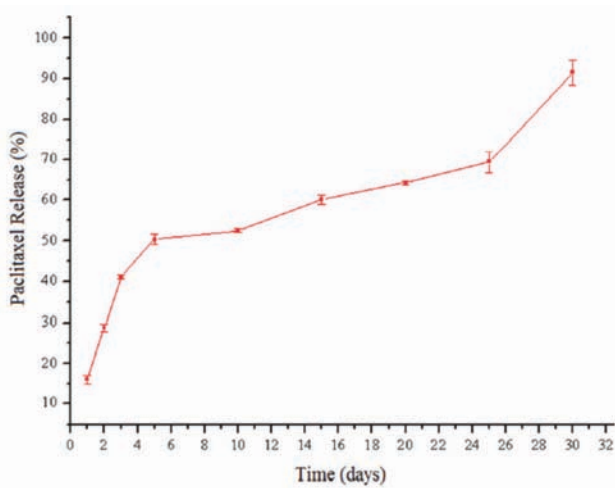
## Boundary Conditions

For the boundary conditions of the non-degradable model, it was assumed that drug diffused in a uniform manner throughout the entire surface of the microsphere. On the right boundary ( $r = 0$ ), which can be seen in Figure 2, the species flux was zero because that was the axis of rotation used to create the three-dimensional construct. The initial drug concentration in the polymeric shell, as well as in the medium (water) that the drug would diffuse out towards, was set as  $0 \frac{\text{mol}}{\text{m}^3}$ . The surrounding boundaries at the bottom top and left that define the blue square in Figure 2 were considered closed, also making the species flux zero. When advancing to the biodegradable model, the same boundary conditions were applied.

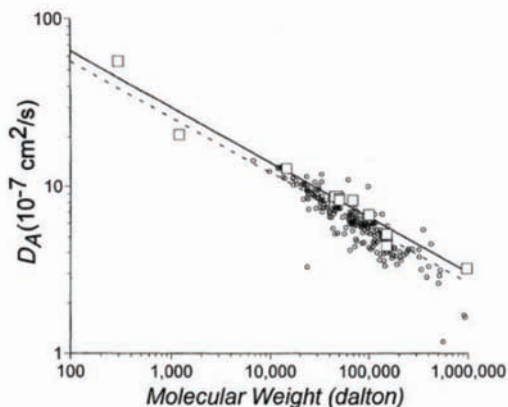
## Materials

Paclitaxel and Poly-L-co-D,L-lactic acid (PLDLA) was the drug / polymer drug delivery system chosen to test the model. Paclitaxel is a well-known versatile anti-cancer drug that can fight many types of cancer, but has a low solubility in water and other pharmaceutical solvents. The current chemicals used to deliver the drug cause severe side effects for patients [2, 7]. Therefore, there is a need for a more effective drug delivery system, and polymeric microspheres could help. When the drug delivery system was finalized, the material properties had to be calculated. The copolymer used to simulate degradation was PLDLA 70:30. The diffusion from PLDLA was calculated using the formula  $\frac{\eta^t}{\eta_\infty} = 4 \left( \frac{Dt}{\pi L^2} \right)^{1/2}$  which can be used to calculate Fickian diffusion release from a thin polymer sample [1]. Where  $\frac{\eta^t}{\eta_\infty}$  is equal to the percentage of drug release, *t* is the time to achieve that percentage of drug release, *L* is the length which in this case can be treated as the microsphere radius, and *D* is the diffusion coefficient. Figure 5 shows the time dependent release of Paclitaxel in solvent which was used to determine the percentage of Paclitaxel release with respect to time. For example, the diffusion coefficient for a 5 $\mu\text{m}$  radius was calculated at

$2.06 \times 10^{-18} \text{ m}^2/\text{s}$ . The diffusion coefficient for Paclitaxel in water was estimated using the graph from Figure 6. Knowing the molecular weight of Paclitaxel is about 853 Daltons, the diffusion coefficient was estimated to be  $3.1 \times 10^{-10} \text{ m}^2/\text{s}$ . The diffusion coefficient of water was used because the environment in the simulations would be modeled as water. Even though in the experimental study phosphate buffer solution was used (PBS), in the study that produced the data in Figure 5, water was the main source that caused the degradation of the polymeric microsphere. For this reason, the diffusion coefficient was estimated for water and Paclitaxol, not PBS and Paclitaxol.



**Figure 5:** Time dependent drug release of Paclitaxel in solvent for 30 days [2]



**Figure 6:** Diffusion coefficients for globular proteins in water [1].

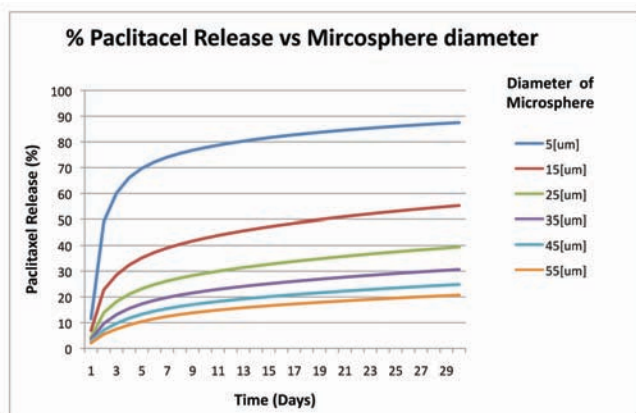
The degradation rate of the PLDLA microspheres was calculated using experimental data from a study observing the *in vitro* degradation of PLDLA membranes [8]. The degradation was calculated using the average Molecular Weight (Mw) data from 0 to 2 weeks, which is 28 days, close to the 30 days that were modeled in the simulations. The beginning Mw at 0 weeks was 282.7 g/mol, and the Mw after 2 weeks was 184.256 g/mol. First, the volume of the average microsphere ( $12.7 \mu\text{m}$ ) was calculated, which came to  $\sim 1.0725 \times 10^{-15} \text{ m}^3$ . This volume, multiplied by the estimated density of PLDLA ( $1.32 \text{ g/cm}^3$ ), gave a close approximation to the grams of PLDLA in the microsphere, which was calculated to be  $\sim 1.4157 \times 10^{-9}$  grams. The degradation rate was calculated by subtracting the Mw at 2 weeks (184.256 g/mol) from the starting Mw (282.7 g/mol), dividing it by the starting Mw (282.7 g/mol), then dividing again by 28 days to get the percentage degradation per day. This percentage degradation per day was calculated to be 1.2436%. This percentage degradation was multiplied by the total starting PLDLA grams ( $1.4157 \times 10^{-9}$  grams) which gave the amount of grams that would be “degraded” away after 1 day, which was  $\sim 1.7697 \times 10^{-11}$  grams. This subtracted from the total starting mass gives the theoretical mass of the PLDLA microsphere after 1 day. Working backwards by dividing  $1.7697 \times 10^{-11}$  grams by the density would give a microsphere volume which could then be used to solve for the new radius of the microsphere after one day, which was  $\sim 6.3235 \mu\text{m}$ . This radius subtracted from the beginning radius ( $6.35 \mu\text{m}$ ) gives the estimated degradation rate after 1 day ( $\sim 2.6434 \times 10^{-8} \text{ m/day}$ ). This was used as the velocity at which the mesh within the microsphere would degrade.

## Results and Discussion

Before the biodegradable model was implemented in COMSOL, the use of parameter variability was tested. When the first model was built, simulations were only computed one at



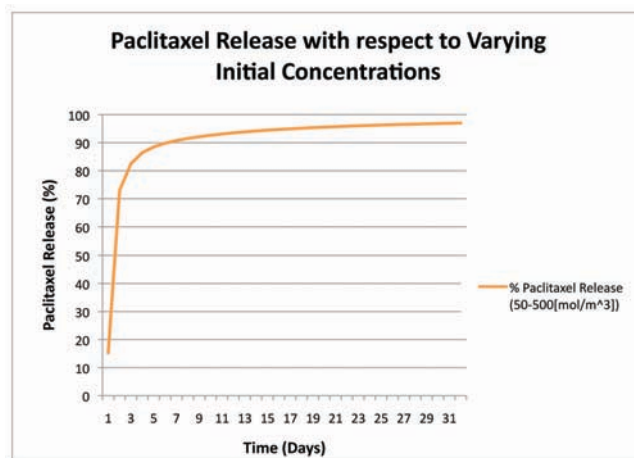
a time. Every time a variable, like microsphere diameter, was analyzed, the diameter had to be changed manually for every simulation. The first objective of this research was to move from independent manual analysis of variables to parameterize variables within the model that would change automatically while computational simulations were taking place. The non-biodegradable model was tested first, and with time, this process was perfected. The three variables tested were microsphere radius, polymeric shell thickness, and initial drug concentration. Figure 7 shows the percentage of Paclitaxel release with respect to various microsphere diameters for 30 days. The initial concentration for all the microspheres in this study was  $500 \frac{\text{mol}}{\text{m}^3}$ , and the polymeric shell thickness for all microspheres was  $2\mu\text{m}$ . The simulations show that as the microsphere's radius increases, the release of Paclitaxel decreases with respect to time. It took about 13 days for the microsphere with a radius of  $5\mu\text{m}$  to release 80% of its initial Paclitaxel concentration, while within the same time period the microspheres with radius's of 15-, 25-, 35-, 45-, and  $55\mu\text{m}$  released 45-, 31-, 24-, 19-, and 15%, respectively, of their Paclitaxel initial drug concentration.



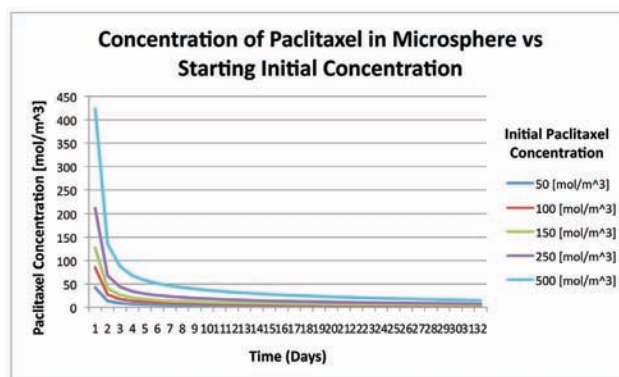
**Figure 7:** Time dependent release of Paclitaxel with different sizes of PLDLA microspheres.

Figure 8 shows the percentage of Paclitaxel release with respect to various initial concentrations. The microsphere diameter for

all of the microspheres in this study was  $5\mu\text{m}$ , and the polymeric shell thickness was  $2\mu\text{m}$ . Initial concentrations of 50, 100, 150, 200, 250, 300, 350, 400, 450, and  $500 \frac{\text{mol}}{\text{m}^3}$  were simulated. Only one line is shown to represent all of the various initial Paclitaxel concentrations because the percentage of release for every concentration was the same. Figure 9 shows some of the microsphere Paclitaxel concentrations within the microsphere with respect to time. Although the plots seem different, when the percentage of Paclitaxel release is calculated the rate of release for each microsphere is exactly the same.



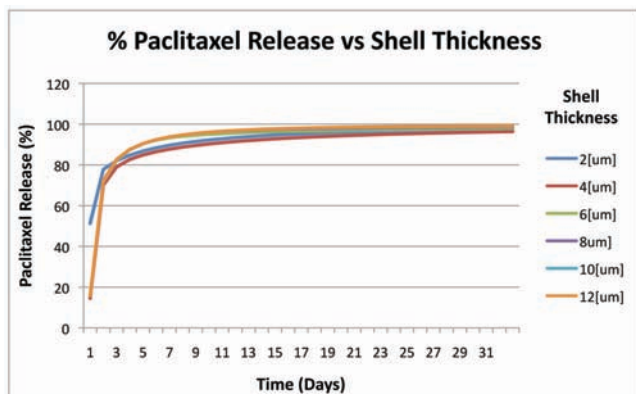
**Figure 8:** Time dependent release of Paclitaxel with respect to different initial drug concentrations.



**Figure 9:** Time dependent release of Paclitaxel with respect to different initial concentrations of Paclitaxel in PLDLA microspheres.

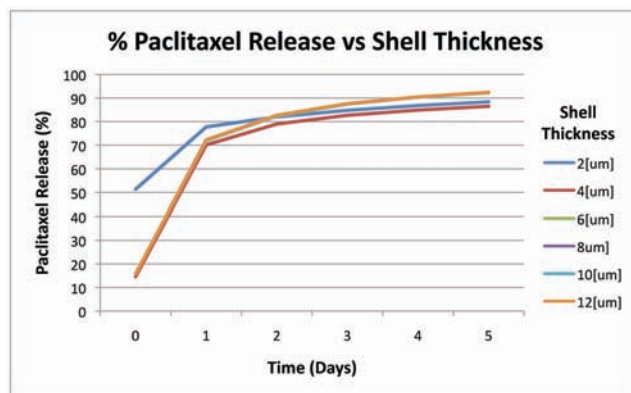
Figure 10 shows the percentage of Paclitaxel release with respect to shell thickness. The initial

Paclitaxel concentration for all the microspheres was  $500 \frac{\text{mol}}{\text{m}^3}$ , and the microsphere diameter was set to  $5\mu\text{m}$ . The percentage release rates are very similar and only differ significantly within the first 5 days (Figure 10). The microsphere with the  $2\mu\text{m}$  shell thickness released Paclitaxel the fastest, taking only one day to release 50% of its initial Paclitaxel Concentration, while all other microspheres released less than 17% of their Paclitaxel concentration within the first day.

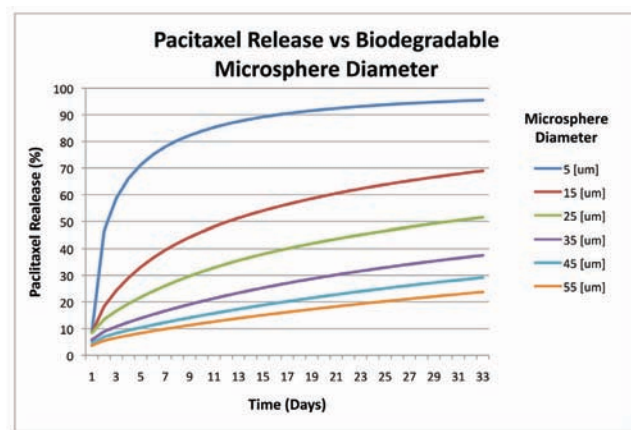


**Figure 10:** Time dependent release of Paclitaxel with respect to different PLDLA shell thicknesses.

Once the non-degradable microsphere model was able to perform parameter simulations with ease, the biodegradable model was ready for implementation (Figure 4). With the diffusion coefficients and degradation rates finalized, the model was set to run simulations comparing release rates of different sized microspheres. Figure 11 shows the results for Paclitaxel release for microspheres of 5-, 15-, 25-, 35-, 45-, and 55 $\mu\text{m}$  diameters. Again, the microsphere to release Paclitaxel the fastest was the  $5\mu\text{m}$  diameter microsphere, releasing 50% of its initial Paclitaxel in a little over 2 days while releasing 90% of its initial Paclitaxel concentration in about 16 days. It took 12 and 30 days for the  $15\mu\text{m}$  and  $25\mu\text{m}$  diameter microspheres, respectively, to release 50% of their drug concentrations, while the microspheres with diameters above  $25\mu\text{m}$  did not release 50% or more of their Paclitaxel in the 30 days' time.



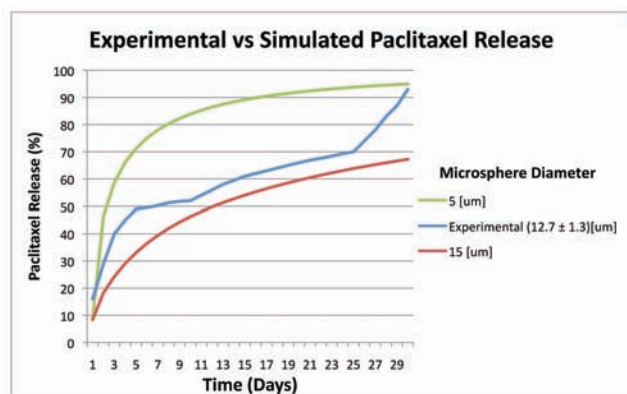
**Figure 11:** Time dependent release of Paclitaxel with respect to different PLDLA shell thicknesses for the first 6 days.



**Figure 11:** Time dependent release of Paclitaxel for biodegradable PLDLA microspheres with varying microsphere diameters.

For the non-degradable PLDLA microspheres, each of the simulations produces data that would be expected in experimental studies. As microspheres increase in diameter, the rate of release of drug decreases because the smaller a microsphere gets the shorter the distance water has to travel to penetrate the microsphere and reach the center, diffusing the drug out of the microsphere. Also the rate of release for differing initial concentration should remain the same because the microsphere diameter and shell thickness remained the same. Given that the material properties are the same, the rate of diffusion of drug will diffuse at a constant rate. Given the results, there was

confidence that further development to account for biodegradation would produce results similar to experimental data. Taking a rough estimate of the Paclitaxel release given in Figure 5 and comparing it to simulated data, the simulated results did fall within range. The average Paclitaxel percentage release for thirty days is shown for microspheres of  $12.7\mu\text{m} \pm 1.3\mu\text{m}$  in Figure 12. The simulated percentage release of Paclitaxel microspheres of  $5\mu\text{m}$  and  $15\mu\text{m}$  are also shown.



**Figure 12:** *Experimental time dependent release of Paclitaxel compared to simulated Paclitaxel release.*

The optimization portion of this model is still being designed so that more robust comparisons between experimental and simulated data can be made. Simulated results are being tailored for use in conjunction with specific parameters from published experimental studies, so that analysis between experimental and simulated data can be more thorough. The optimization portion of this model is also under development to create the next phase of this research. Once validation of the model is complete with actual experimental data, the optimization capability of the model will be able to estimate optimal microsphere dimensions and drug concentrations for desired therapeutic dosage given patient parameters.

## Conclusions

A model was designed to first simulate the diffusion of a drug through a polymer encapsulation and into a medium, and then to progress to modeling the drug diffusion through degradation of a polymer. This model was able to show versatility, in that it could investigate different variables that deal with a certain drug delivery system and provide insight to examine how the drug delivery system reacts to certain variable changes. Governing equations were selected with initial and boundary conditions were specified. Different polymers, shell thicknesses, microsphere sizes, and drug concentration were evaluated with ease by using the parameterized variables. Simulations were conducted to determine how these different variables affected the overall system and diffusion of Paclitaxel in PLDLA microspheres. The model was used as a foundation to allow for the modeling of biodegradable polymeric microspheres. This model was able to simulate various microspheres and return data similar to experimental outcomes.

## Design Recommendations

For future initiatives, the model could be expanded to evaluate different microsphere drug delivery systems, such as swelling and erosion systems, which can add even greater versatility to this model. Also, mesh construction should be carefully thought out. A more defined mesh could be created to allow for more accurate drug diffusion profiles. The type of polygonal shape and number of elements could be further studied to investigate how the mesh of the system affects the concentration values that are being acquired and to determine whether or not there are noticeable variations in data that are being collected. As for variable constants like diffusion coefficients, they should be experimentally acquired to validate them in the model. Specific diffusion coefficients for drugs and their diffusion in respective polymers and mediums can be

experimentally acquired and then applied to their respective models. This model was also limited to a one-species transport of diffusion, but the model could be expanded to model multiple species of drugs, proteins, polymer degradation, etc. happening at the same time.

## Future Work

Future work for this research is currently underway in validating experimental data with simulated results. This requires changing simulated parameters to match those used in experimental studies, comparing results to experimental data. The development of the optimization component is almost complete,

and with validation through experimental data underway, this model is close to becoming a standalone tool for the optimization of polymeric drug delivering microspheres.

## Acknowledgments

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# Purification and Analysis of Ig4 Patu2: A Mutation in the Cytoskeletal Protein Palladin Overexpressed in Metastasizing Pancreatic Cancer

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## Abstract

**P**alladin is a human protein that has been shown to be involved in both normal and abnormal cell motility. A single amino acid change in palladin was recently identified in the highly migratory pancreatic cancer cell line, referred to as Patu2. This mutation increases the migration rate of cultured cells, and we hypothesize that this mutation could alter the structure and function of palladin. My goal is to conduct research on the Ig4 mutation and investigate its structure and function in comparison with the wild type domain. However, there are a few hurdles that must be crossed prior to the investigation. The first hurdle is isolating the mutated domain as a soluble protein. The purpose of the project is to optimize the expression and purification of the Patu2 Ig4 domain of palladin. Our approach involves utilizing an effective auto-induction media to promote

protein expression and then adding a solubility tag to enable purification for subsequent *in vitro* observations of this mutant protein's activity. Auto-induction media are formulated to increase the glucose concentrations and mitigate lactose present within the media and include trace metals to optimize cell growth potential. This formula promotes maximum cell density prior to induction, increasing the amount of bacterial cells capable of expressing the targeted protein. Our results indicate that palladin protein expression is significantly increased using the auto-induction media when compared to using LB. Furthermore, we have established a purification protocol, such as the implementation of Roche Ni-NTA Resin and amylose resin that will enable us to obtain adequate quantities of the Patu2 mutant form of palladin. This provides the first step required for understanding the cause of pancreatic cancer.

## Introduction

Palladin, a recently discovered protein, has been associated with cell to cell junctions and cytoskeletal structure and motility (Parast & Otey, 2000). Upon its discovery, the protein was shown to be expressed in various cancerous cells during metastatic invasion, and recently a mutation within palladin was associated with pancreatic cancer (Henderson-Jackson et al., 2011; Arneman, 2007). This mutation is located in the Ig4 domain of palladin, an immunoglobulin-domain containing protein, which replaces the amino acid tryptophan with the amino acid cysteine. Such a mutation could alter the structure and function of the protein; however, current research has not uncovered the role of this mutated domain. Palladin associates with actin, an important cytoskeletal protein, and the Beck lab has previously shown that this interaction is critical for actin polymerization and organization. The goal of this study is to conduct research on the Ig4 mutation, known as Patu2 or pancreatic tumor, and investigate its

structure and function in comparison with the wild type domain.

### 1.1 Palladin Discovery

The protein palladin was discovered approximately 14 years ago. Since that time it has been associated with the actin cytoskeleton, cell-to-cell junctions, and also its capacity to be overexpressed throughout various cancerous cells (Parast et al., 2000; Henderson-Jackson et al., 2011; Goicoechea et al., 2013). Palladin was first misidentified as  $\alpha$ -actinin, which cross-links to actin and binds to other cytoskeletal proteins. Further analysis a decade later demonstrated a molecular weight difference, and palladin was properly identified and named after Palladio, a Renaissance architect (Parast et al., 2000). Palladin's original discovery was due to mAb labeled C10 (an antibody) which was discovered to have bound to the 105 kDa monomer  $\alpha$ -actinin, an actin binding protein, and to have played regulatory and structural roles in muscle and nonmuscle cells (Parast & Otey, 2000; Sjöblom, Salmazo, & Djinović-Carugo, 2008). A decade had passed and the C10 antibody was identified as binding to a protein nearly 15 kDa less than  $\alpha$ -actinin.

Controversy began over the novel protein when Pogue-Geile et al. (2006) suggested that a point mutation had been associated with familial pancreatic cancer. However, Klein et al. (2009) and others did not observe these deleterious mutations, nor did they consider palladin significantly involved in the deadly cancer. Both studies identified polymorphisms, one at P239S and the other at S236G, which led to inquiries into mutated Ig domains of the palladin isoforms (Pogue-Geile et al., 2006; Klein et al., 2009; Meyer et al., 2012). This novel protein's interactions have been unraveled in research labs and medical clinics (Goicoechea, Arneman, & Otey, 2008; Tay et al., 2010).

Since its discovery, palladin has been shown to play regulatory roles in embryonic development along neural crest cells, cytoskeletal

muscle cell structure, and skeletal muscle cell structure (Parast & Otey, 2000; Goicoechea et al., 2008; Jin, 2011). Palladin's role in cell motility led researchers to investigate the upregulation of palladin found throughout various cancerous cells (Goicoechea et al., 2008; Goicoechea et al., 2013; Tay et al., 2010; Henderson-Jackson et al. 2011).

## 1.2 Palladin: Structure and Function

Palladin began with an elusive discovery and has since been shown to play ubiquitous roles throughout muscle and nonmuscle cells. Immunofluorescent labeling and yeast two-hybrid assays demonstrate palladin's cytoskeletal interactions along with other associated proteins (Parast & Otey, 2000). Alternative splicing reveal multiple isoforms, which are differences of weight and domains of the protein. Some isoforms contain proline-rich regions (see Figure 1), and the most common isoforms weigh 90 and 140 kDa.

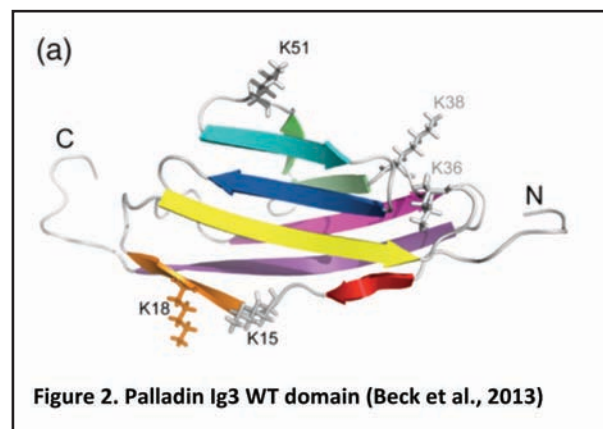
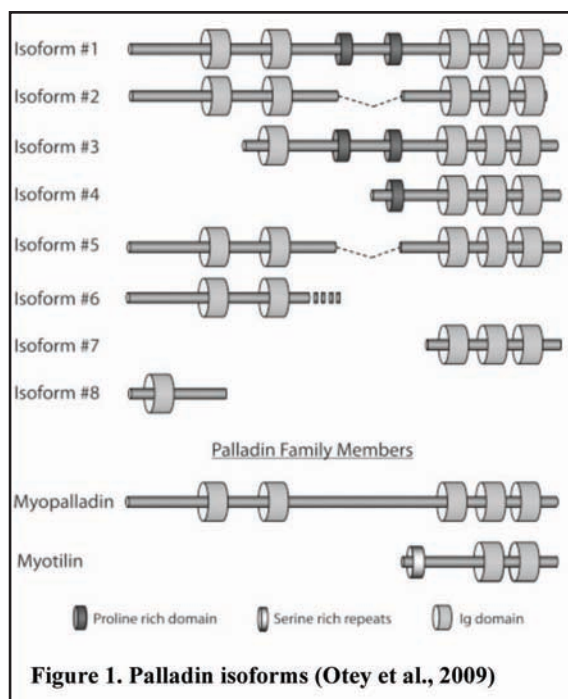
All of these isoforms contain multiple immunoglobulin-like (Ig) domains. Myopalladin and myotilin, palladin family members, have a similar domain organization and are both

associated with disease states. Myopalladin, the 200 kDa protein expressed only in the muscles of the heart, has also received attention for its role in heart disease. Myotilin mutations have been linked to muscular dystrophy. Although there may be slight variations within such sequences, the overall structure appears to be conserved and such domains are used as models in the study of their role in human disease (Parast & Otey, 2000; Otey, Rachlin, Moza, Arneman, & Olli, 2005; Otey et al., 2009).

## 1.3 Palladin: Immunoglobulin (Ig) Domains

Upon the discovery of palladin, researchers identified the highly conserved immunoglobulin (Ig) domains and investigated their binding affinity to actin, another protein crucial to muscle and nonmuscle cells (Parast & Otey, 2000; Sjöblom et al., 2008; Beck et al., 2013). The Ig3 domain of palladin was shown to be the minimal domain required to bind directly to actin. By using NMR, it is possible to observe the structure of the Ig3 domain in order to aid in understanding the actin binding sites (see Figure 2) (Dixon et al., 2008; Beck et al., 2013). The folds of the immunoglobulin proteins are crucial to their function, and their stability has been attributed to their hydrophobic core (Banach et al., 2013).

Recently, *in vitro* research has also been conducted on the role of the Ig4 domain, which does not appear to bind to actin unless Ig3 is also present (Dixon et al., 2008; Beck et al., 2013). Once it was confirmed that Ig3 was the limiting



factor, researchers began varying concentrations of the single and tandem domains. The discovery that the linker region has no binding affinity enables independent analysis. However, increased actin binding does occur once the tandem domains (Ig34) are linked (Dixon, et al., 2008; Beck, et al., 2013). Palladin has been identified as an actin binding protein (ABP), although proteins such as ezrin and vinculin bind to palladin to assist in cell motility and other protein functions (Otey et al., 2005; Beck et al., 2013). The investigation of palladin's domains and binding proteins continues, as the over-expression of palladin has been linked to cancer metastasis and other cancerous cell interactions (Henderson-Jackson et al., 2011).

### 1.4 Palladin: Mutations and Disease

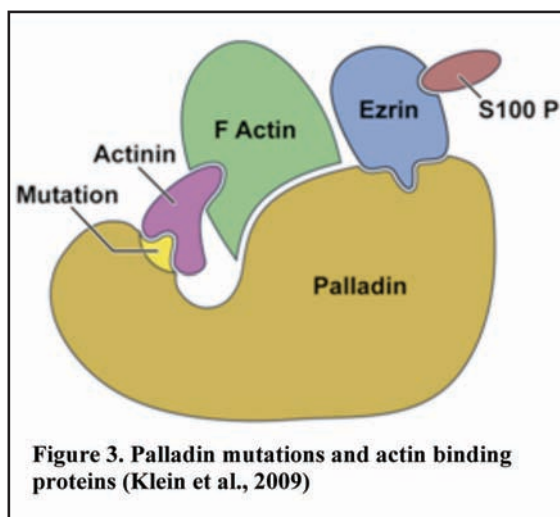
A mutation in palladin was identified in a family with a highly penetrant form of pancreatic cancer. However, upon further analysis, the mutation was not discovered in 48 unrelated individuals who also had pancreatic cancer (Kay et al., 2006; Klein et al., 2009). Palladin over-expression has also been discovered in some patients who suffer from metastatic hepatic cancer. The over-expression has also been associated with breast cancer metastasis, indicating potential contributions to tumorigenesis (Henderson-Jackson et al., 2011). The over-expression of palladin in pancreatic

cancer suggests a potential pathway to activate cancer associated fibroblasts (CAFs). It was observed that CAFs promote tumor invasion due to palladin over-expression (Goicoechea et al., 2013). Another pathway, involving the protein kinases Akt1 and 2, may have regulatory roles associated with palladin. Such regulatory roles alter the expression of palladin, playing a role in cytoskeletal structure, thus affecting the nuclear envelope. This suggests implications in chromatin remodeling (Chin & Toker, 2010; Jin, 2011). Palladin binding proteins continue to remain elusive, and such proteins have demonstrated interactive roles with other proteins and pathway signaling (Figure 3) (Otey et al., 2005).

Mutations within the hydrophobic core of the Ig4 domain of palladin have also been identified, specifically a tryptophan to cysteine mutation. The Ig4 mutation has been associated with pancreatic tumor cell lines. The mutation was labeled Patu2 and was shown to have smaller aggregates of stress fibers and less actin binding. (Arneman, 2007). Other than the correlation with pancreatic cancer and actin cytoskeleton, little is known about how this mutation in Ig4 affects palladin's structure and function.

### 2.1 Traditional Protein Expression in Bacteria

In general, biochemical research involves investigating many aspects of a protein, including structure, function, modifications, localization, or interactions with other molecules. To investigate how particular proteins regulate biological functions, researchers usually require a means of producing large quantities of functional proteins. Due to the size and complexity of proteins, chemical synthesis is not practical. Instead, biochemists use living cells and their cellular machinery as factories to build and construct proteins based on supplied genetic templates. Unlike proteins, DNA is simple to construct synthetically or *in vitro* using well-established molecular biology techniques. Therefore, DNA containing specific genes, with or without add-



on affinity tag sequences, can be constructed as templates for protein expression. Proteins produced from such DNA templates are called recombinant proteins, and most recombinant proteins can be cloned and expressed at high levels in the bacteria *Escherichia Coli* (*E. coli*). Optimal conditions for the growth and expression of the protein of interest should first be established in order to produce the protein in large quantities that are both functional and purified, or isolated away from all other proteins in the bacterial cell. The standard media of choice for the growth of most bacterial cells is LB media. Overexpression of the protein of interest is achieved by increasing the binding strength of the promoter region, assisting transcription. This is most commonly achieved by placing the DNA sequence for a protein of interest into a high copy-number plasmid containing the *lac* promoter. The addition of IPTG (a lactose analog) activates the *lac* promoter and causes the bacteria to express the protein of interest.

### 2.2 Auto-induction Protein Expression

Implementing auto-induction has aided in the purification steps of Ig4 Patu2. Auto-induction media eliminate the use of IPTG to induce protein expression at a specified optical density (OD). To induce the expression of the desired protein, competent *E. coli* cells were grown at a given temperature. The cells are grown until an optical density is obtained under the conditions specified by the protocol. Once the desired OD was obtained the *lac* operon in the plasmid will express the desired protein (among others) when induced with isopropylthiogalactoside (IPTG) (Griffiths, Wessler, Carroll & Doebley, 2012). At that point most protocols require that temperatures be reduced so cell growth will slow down but protein expression will continue. Auto-inducing media allows researchers to “skip” the induction step when adding IPTG, but the OD may continue to be monitored prior to any change in temperature. This could potentially eliminate any errors of

induction that occur before or after saturation, errors that could cause fewer cells to be available for protein expression. The yield of protein expression could potentially increase due to the induction of competent cells at a saturation point of high cell density. Thus the media optimizes cell activity and increases protein yield.

### 2.3 Auto-induction Media Preparation

The auto-induction media has been formulated to optimize the carbon source, glucose, and, prior to lactose conversion, to release the *lac* repressor binding to the operon. As the cells grow, they will utilize the glucose in the media first. Once this carbon source is exhausted, the cells will begin to use lactose. Induction will occur as this transition occurs. Auto-induction media decreases the amount of lactose in the medium, which could cause the unintended induction of IPTG-induced competent cells. When incorporating tryptone or N-Z amine into media such as LB, casein, which contains lactose residues, is present. Even with high concentrations of amino acids, which can suppress induction, less than 0.001% lactose is needed to induce cells as they approach saturation (Studier, 2007). Such enhancements optimized within the media could offer an alternative to protein expression and potentially optimize protein yield of IPTG-induced competent cells compliant within the media. Auto-inducing media thus allows the researcher to “skip” the induction step when adding IPTG, but the cell density can continue to be monitored prior to any change in temperature. This could eliminate any errors of induction occurring before or after saturation, errors that could cause fewer cells to be available for protein expression. The yield of protein expression could increase due to the induction of competent cells at a saturation point of high cell density. Thus the media optimized cell activity and increased protein yield.



### 3. Purpose

The immunoglobulin (Ig) domain of Ig4 Patu2 contains a mutation within the protein palladin, an actin-binding protein necessary for cytoskeletal structure. Palladin has been shown to be overexpressed in metastasizing pancreatic cancer cells (Goicoechea et al., 2013), and this Patu2 mutation is also observed in a pancreatic cancer cell line (Arneman, 2007). The Patu2 mutation results in a single point mutation of a conserved tryptophan residue to a cysteine. The goal of this study is to conduct research on the Ig4 mutation, known as Patu2 (pancreatic tumor), and investigate its structure and function in comparison with the wild type domain. The first step will be to isolate the mutated domain as a soluble protein. This will be accomplished by attaching a maltose-binding protein (MBP tag) onto the sequence. The protein appears to degrade quickly which ensures protein assays are performed in a timely and organized fashion. Next, auto-induction media will be used to optimize the expression and production of Ig4 Patu2. The scope of the investigation will include circular dichroism (CD), nuclear magnetic resonance (NMR) spectroscopy, and protein binding assays with actin.

Uncovering the interactions of Patu2 Ig4 and actin has the potential to reveal how the mutation affects cell structure and motility. Performing protein assays with the wild type and mutated forms of Ig4 binding with actin will be the focus of the investigation. NMR spectroscopy has the potential to identify its structural differences in comparison to the wild type Ig4 domain. Such differences will aid in identifying how the mutation has affected palladin's ability to bind to actin. Investigations of the protein-protein interactions using actin cosedimentation assays and NMR spectroscopy will help explain the implications associated with the palladin Ig4 mutation. Further investigation of Patu2 will aid in understanding the metastasis involved in pancreatic cancer.

## Methods and Materials

### DNA Constructs

The palladin Ig4 mutant, Patu2, with a molecular weight of ~12K kDa, was the protein utilized with the auto-induction media. The DNA for the protein was obtained from the Beck Lab which was previously cloned into pTBMale-Ig4PaTu plasmid that contains the lac operon for overexpression, an ampicillin resistance gene for selection, and both hexahistidine and MBP tags for purification and solubility. Isolation of DNA/vectors began with the low-plasmid protocol in the GeneJET Plasmid Miniprep Kit (Thermo Scientific). A total of 10 mL Luria Bertani (LB) cultures were used for the DNA miniprep. The final concentration of pTBMale-Ig4 Patu2 was 66 ng/ $\mu$ L. The DNA concentration was measured utilizing ultraviolet (UV) spectral analysis measured at 260/280 nm. The MBP tag was incorporated into the Ig4PaTu plasmid utilizing MBP-F and MBP-R primers. Ig4 Patu2 contains 107 amino acid residues, and the MBP tag contains a sequence of 387 amino acids.

### Media

One of the key components of the auto-induction media is the supplementation of glucose into the medium. The auto-induction media utilized for this course of the study was ZYM-5052, which also required supplementing trace metals and phosphates into the medium (Studier, 2007). For the test growths of Ig4 Patu2, the overnight cultures were inoculated into standard Luria Bertani (LB) media, and another was inoculated into the ZY media (see Table 1). Stock solutions for the auto induction were made of the 1000x trace metals, 1 mol (M) MgS, 50x5052, and 50xM, and approximately 400 mL of ZY for overnight cultures (Table 1. Auto-Induction Media). All solutions were autoclaved and stored at room temperature following the Studier (2007) protocol. The 50xM contained 1.25 M NHP, 1.25 M KP, 2.5 M NCl, and 0.25 M NS with a pH of 6.7. The 50x5052 contained

2.5 g glucose, 10 g  $\alpha$ -lactose monohydrate, and 25 g of glycerol (weighed in a beaker) to make 100 mL. The trace metals had to be autoclaved, except for the 0.1 M FeC in 0.12 M HCl, which was added last to avoid precipitation. The remaining trace metals, 1 M CaC, 1 M MnC- 4 O, 1 M ZnS - 7 O, 0.2 M CoC- 6 O, 0.1 M CuC- 2 O, 0.2 M NiC- 6 O, 0.1 M NMo - 2 O, 0.1 M NSe - 5 O, and 0.1 M B were all autoclaved and stored at room temperature.

### Method of Ig4 Patu2 protein expression/growth of cultures in auto-induction media

The expression of Ig4 Patu2 began with small test cultures, one in standard LB media and the other in ZY media, which did not contain the salt (NaCl) commonly used in LB. A transformation was conducted incorporating 1  $\mu$ L of DNA plasmid (pTBMalE-Ig4Patu2) into 50  $\mu$ L BL21(DE3) cells. The cells incubated on ice for 30 minutes and were then placed in a water bath of 42 °C for 1 minute. The cells were placed on ice for 2 minutes and transferred to culture tubes with 900  $\mu$ L of sterile LB media. After shaking for 1 hour at 37 °C, cells were spun down at 2000 rpm for 10 minutes in a refrigerated tabletop centrifuge at 4 °C (Beckman Allegra 6 Series centrifuge was used). Next 700  $\mu$ L of media was removed and the pellet was resuspended and plated onto LB ampicillin plates and grown overnight at 37 °C.

Test cultures were prepared using 10mL of LB and 10mL of ZY media with 10 $\mu$ L

of ampicillin and 10 $\mu$ L of chloramphenicol after inoculation. A single colony from the transformation of BL21(DE3) contained pTBMalE-Ig4 Patu2. The test cultures grew for 12-16 hours at 37 °C with shaking and were then used to inoculate 50 mL of auto-induction media with 50  $\mu$ L of each antibiotic. Auto-induction media was grown at a temperature of 37 °C with shaking for approximately 3 hours prior to a temperature reduction to 18 °C for 19 hours with shaking. Another 50 mL of BL21(DE3)-pTBMalE-Ig4 Patu2 was grown at room temperature with shaking. The total time for both cultures was 22 hours.

After the 50mL cultures grew for 22 hours, they were placed in the Beckman Allegra 6 Series centrifuge at 3000 rpm for 20-30 minutes to pellet the cells. The supernatant was decanted, and the cell pellet was resuspended in 500  $\mu$ L of lysis buffer (20 mM Tris pH 8.0, 100 mM NaCl, and 5 mM Imidazole). Once the pellet was resuspended, the cells were lysed by sonicating for 5 seconds on and 10 seconds off for 10 cycles at 100% power. The lysate solution was then centrifuged at 15K rpm for 30 minutes at 4 °C. Throughout the process, the purification samples were collected from the crude supernatant, the pellet, and the lysed cells to measure the induction and expression by SDS-PAGE. After success with the test cultures of Ig4 Patu2, 1-liter flasks were grown. Due to the amount of protein expression obtained from the liter growths, the supernatant was placed in the ultracentrifuge at 45K rpm for 30 minutes.

**Table 1.** *Auto-induction media components*

ZYM-5052	1 Liter Volume	ZY Media	
960mL	ZY	10g	N-Z Amine or <b>Tryptone</b>
200 $\mu$ L	1M MgSO <sub>4</sub>	5g	Yeast Extract
20 $\mu$ L	1000x Trace Metals	960mL	Deionized Water
2mL	50x5052		
2mL	50xM		

## Purification of Ig4-Patu2

The purification method implemented for the palladin Ig4-Patu2 included the nickel affinity resin column, the cation exchange fast protein liquid chromatography (FPLC) S-column, and an amylose resin column following cell lysis. The nickel resin was Thermo Scientific Ni-NTA resin of approximately 20 mL per column. The Ni-NTA resin column allowed for the binding of the amino acid histidine, which is an affinity tag labeling the target protein to bind to the nickel resin beads. Increasing imidazole concentrations allows the protein to elute off of the column, creating pure protein samples. The column was regenerated with 100 mM NiS and re-equilibrated with Lysis buffer (Ig4 Patu2: 20 mM Tris pH 8.0, 100 mM NaCl, and 5 mM Imidazole). TEV digestion will cleave the His<sub>6</sub>-MBP tag from the Ig4 Patu2 protein and potentially elute the pure protein through further purification processes. The amylose column allowed for the use of Dithiothreitol (DTT), a reducing agent, which prevented the formation of disulfide bonds due to the cysteine substitution. Amylose will bind to the MBP tag, allowing for separation of the affinity tag from the cleaved Ig4 domain. The amylose column was equilibrated with 25 mM H<sub>2</sub>KPO<sub>4</sub> (pH 5.5), 25 mM NaCl, and 2 mM DTT.

## FPLC and Amylose Method

A cation exchange column on the FPLC was used to separate the MBP tag from Ig4 Patu2. The mutated protein was dialyzed into 4 liters of S-column Buffer A containing 25 mM H<sub>2</sub>KPO<sub>4</sub> (pH 5.5), 25 mM NaCl, and 2 mM DTT. Dialysis lasted for 5 hours in Buffer A, which was then split into 2 liters. One liter of Buffer A was used to make Buffer B by adding 1 mole of NaCl with a pH of 5.5. Dialysis was used to remove the imidazole from the eluted protein after Nickel column purification. An increase in the DTT concentration from 2 mM to 10 mM was initiated prior to purification implementing the FPLC. Due to the difficulty of cleaving,

the MBP tag from Ig4 Patu2, the remaining 2 liters implemented the amylose resin column, theoretically binding the cleaved MBP tag and releasing the purified Ig4 Patu2 as flow through.

A polyacrylamide gel was stained with Blue Safe Stain (Thermo Scientific) to observe the protein expression and purity. A 15% SDS-PAGE contained 40% acrylamide, 1.5 M Tris (pH8.8), 10% SDS, 10% APS, and TEMED for the running solution, and except for 1M Tris (pH6.8), the same ingredients were used for the stacking solution. The gel ran at a current of 200 V for 50 minutes in 1x SDS running buffer. The gel was washed for 30 minutes in Millipore water, stained in Blue Safe for 1 hour, and finally destained in Millipore water for five hours to obtain better clarity. Gel samples were 1:1, containing 50  $\mu$ L of 4x Sample Buffer and 50  $\mu$ L of the sample protein. Samples were then boiled for five minutes. Varying fractions were loaded onto the wells, depending on the cell density of the sample. For example, 10  $\mu$ L was loaded for the cell pellet and the supernatant samples and up to 20  $\mu$ L was loaded for elution samples.

## Results

### Patu2 Solubility Tag Cloning

The Patu2 mutated palladin sequence and the MBP tag were added to the wild type vector, and forward and reverse primers were incorporated to designate the position on the vector which needed to be removed. Three replicates were performed and sent for sequencing to confirm the mutation and that the MBP tag was incorporated into the vector. The Patu2 mutation was discovered in sequence ID number 86 where a G  $\rightarrow$  T substitution occurs in the 9<sup>th</sup> exon of AB023209 at position 1671 (Bretnall et al., 2011).

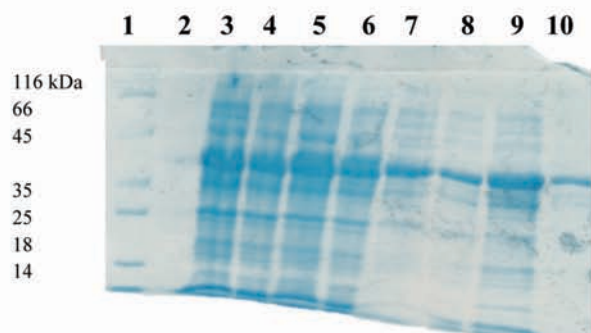
### Ig4 Patu2 expression

The results for Ig4 Patu2 expression and purification were observed on a 15% SDS polyacrylamide gel, and the samples were obtained after cell lysis by sonication (Figure 4,

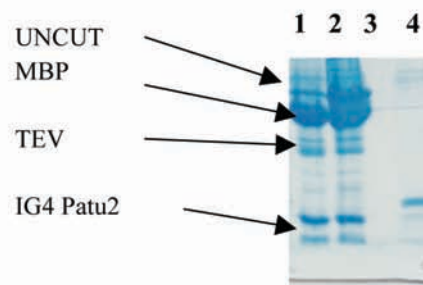
## Purification and Analysis of Ig4 Patu2

Temperature Samples). One hundred seven amino acid residues were used for the Ig4 Patu2 domain for *in vitro* analysis, yielding results of a molecular weight of nearly 12 kilodaltons (kDa) total, while the MBP tag had a mass of approximately 42 kDa. A triple protease mutant of the Tobacco Etch Virus (TEV), pH6TEV, was used to cleave the histidine and MBP tag from Ig4 Patu2. The molecular weight of the His6-TEV protease was approximately 28 kDa (Cabrita et al., 2007). The total mass of Ig4 Patu2 with the MBP tag was approximately 54 kDa. The mutated palladin domain exhibited an abundance of protein expression, and four 1-liter growths in auto-induction media were prepared. The final volume after the nickel column obtained from 4 liters of auto-induction media was approximately 100 mL. This was divided into two sterile tubes.

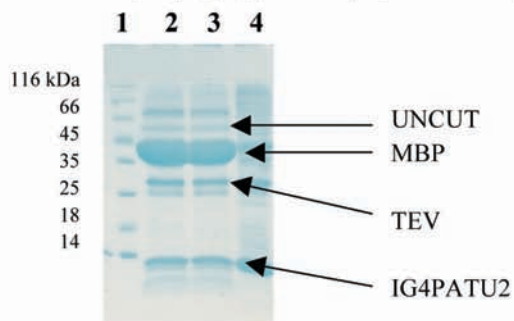
One 50 mL tube was at 4 °C with 4 mL of TEV at 60 μM concentration. The other tube contained the same amount of TEV and was kept at room temperature. To avoid overloading the binding capacity of the Ni-NTA and Amylose columns, only one tube was used. The room-temperature sample was saved as a backup. However, after the MBP tag was cleaved with TEV protease for 4 days and then run over the S-column, the protein rapidly degraded (Figure 7, FPLC Fractions). The second tube was utilized and the concentration of DTT was increased to 10-12 mM. The DTT should keep the Ig4 Patu2 from disulfide bond formation and prevent the precipitation/ degradation of the protein. The amylose column was utilized prior to S-column purification to potentially remove the MBP tag before implementing the FPLC. Once the amylose



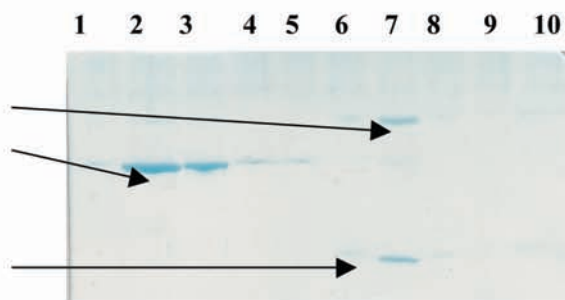
**Figure 4. Temperature Samples of Ig4 Patu2:** (1) Ladder, 4μL; (2) Empty; (3) Supernatant, 27°C, 10μL; (4) Supernatant, 37°C/18°C; (5) 27°C cell pellet; (6) 37°C/18°C cell pellet, 10μL; (7 and 8) lysate; (9) protein samples, 37°C/18°C, 20μL; (10) protein samples, 37°C/18°C 15μL.



**Figure 5. MBP Tag:** (1) Ig4 Patu2 27°C, 15μL; (2) 37°C/18°C, 4°C; (3) empty; (4) Ig3 as ladder



**Figure 6. MBP Cleaved In ~10 mM DTT:** (1) Ladder (2) Uncut Ig4 Patu2, MBP, TEV, and Ig4 Patu, 20 μL (3) Same as 2, 15 μL (4) Initial Amylose Column Run



**Figure 7. FPLC Fractions:** (1-5) MBP tag only (6 & 7) Uncut Ig4 Patu2 and Ig4 Patu2



column flow through was collected the protein was further purified on S-column. The FPLC elution peaks were collected in 4.5 mL fractions. The mutated protein still contained TEV and MBP in the eluted fractions. The S-column fractions were run over the amylose resin column again and purified Ig4 Patu2 was obtained (see lanes 1, 4, and 7 in Figure 6). The gel in Figure 1 contained 10 lanes with various sample volumes loaded into the well: (1) Ladder, 4  $\mu$ L; (2) Empty; (3) Supernatant at 27  $^{\circ}$ C, 10  $\mu$ L; (4) Supernatant at 37 $^{\circ}$ C for 3 hours then dropped to 18  $^{\circ}$ C, 10  $\mu$ L; (5) 27  $^{\circ}$ C cell pellet; (6) 37  $^{\circ}$ C/18  $^{\circ}$ C cell pellet, 10  $\mu$ L. Lanes 7 and 8 contain the lysate after sonication for 10 cycles. Lane 7 was loaded with 20  $\mu$ L. Lane 8 was loaded with 15  $\mu$ L. Lanes 9 and 10 contain the protein samples grown at 37  $^{\circ}$ C/18  $^{\circ}$ C and loaded with 20  $\mu$ L and 15  $\mu$ L, respectively. Figure 7 displays the uncut Ig4 Patu2, the MBP tag, and the cut Ig4 Patu2 in lane 1 that occurred at 27  $^{\circ}$ C with 15  $\mu$ L sample loaded into the well. Lane 2 was 37  $^{\circ}$ C/18  $^{\circ}$ C being cleaved at a temperature of 4 $^{\circ}$ C. Lane 3 was empty, and lane 4 was an Ig3 ladder. UV spectral analysis indicated a cell density at O of 2.15 for the 27  $^{\circ}$ C, and the 37  $^{\circ}$ C/18  $^{\circ}$ C was at 2.284.

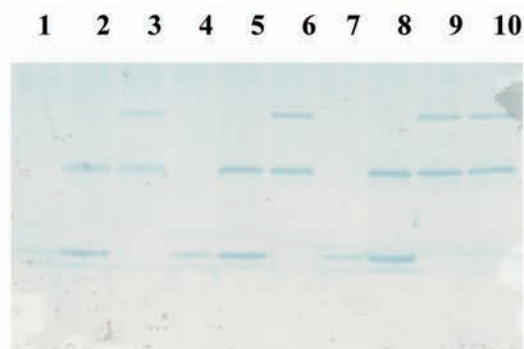
The amylose column was used to bind the cleaved MBP tag after increasing the DTT concentration to 10 mM. Figure 6 demonstrates the effectiveness of the amylose resin column in lane 4. After the S-column Ig4 Patu2 was still not effectively isolated (Figure 7: lanes 6 and 7), the samples were collected and run back over the amylose column using 10% 1 mM NaCl (Figure

8). A purified sample of Ig4 Patu2 was obtained and concentrated to approximately 50 ng/mL for a total volume of 3 mL.

## Discussion

Auto-induction media utilized glucose as the main carbon source during the log phase of the bacterial cell growth cycle. By utilizing glucose, cells were able to achieve maximal cell density prior to self-inducing protein expression. Expression did appear to increase significantly given the viscosity of the supernatant. However, once the mutant was stabilized in solution after increasing the DTT concentration, the protein yield increased from 30 mg/mL utilizing LB media in 4 liter growths to 50+ ng/mL utilizing only 2 liters. The protein expression was significantly enhanced by the implementation of the auto-induction media. The efficacy and ease with which auto-induction media can be applied increased overall yield using smaller growth volumes (2 liters as opposed to 4) and effectively reduced the time needed to concentrate the protein. Further studies will also implement replications of minimal auto-induction media to analyze Ig4 Patu2 with nuclear magnetic resonance (NMR) spectroscopy and circular dichroism (CD).

The increase in imidazole greatly contributed to the efficacy of the wash step in the nickel column purification process. The increased DTT concentration appeared to be effective for keeping Ig4 Patu2 in solution. A



**Figure 8. Second Amylose Column Purification:** (1) D Fractions from FPLC, 15  $\mu$ L (2) G Fractions FPLC, 15  $\mu$ L (3) Amylose Elution, 15  $\mu$ L (4) D Fractions from FPLC, 18  $\mu$ L (5) G Fractions FPLC, 18  $\mu$ L (6) Amylose Elution, 18  $\mu$ L (7) D Fractions from FPLC, 20  $\mu$ L (8) G Fractions FPLC, 20  $\mu$ L (9) Amylose Elution, 20  $\mu$ L (10) Amylose Elution, 20  $\mu$ L

10-12 mM concentration of the reducing agent will be maintained; however, complications arise with DTT when implementing the Ni-NTA Resin column. DTT is a reducing agent that will reduce the nickel metal ion and damage the column. In the future, an alternative Ni-NTA Resin that can withstand 10 mM DTT concentrations will be implemented to allow inclusion of DTT during purification on the

nickel column. The amylose column will follow the Ni-NTA resin column.

Purification of Ig4 Patu2 would allow *in vitro* analysis to interpret how palladin is involved in the metastasis of pancreatic cancer. According to our current model, this mutation alters the hydrophobic core of the Ig4 domain and affects the actin binding and/or bundling which results in metastasized pancreatic cancer.

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# Research Summaries

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# Horse-Human Behavior: The Effects of Grooming When in the Bonding Process

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## Summary

### Abstract

**T**his study shed light on the following questions: (1) “Is grooming experienced as positive?” (2) “What does positive behavior look like when engaging in the grooming bonding process with horses, if any?” (3) “Does the increased amount in grooming time also increase the pleasure derived from grooming, if any?” By observing the horses and recording their behavior patterns, the research sought some tangible information in regards to whether horses find grooming to be an enjoyable experience.

## Methods

A qualitative and quantitative research methodology was used for this study. Quantitatively, the independent variable was the amount of time spent grooming. The dependent variable was the behavior being observed while grooming. A base line was established by observing behavior without any grooming being performed. Each grooming was filmed. Qualitatively, researchers made their observations of the grooming process, then blind study participants watched the videos and recorded their perception of the behavior, in order to offset researcher bias. The researcher identified fourteen horses, then used a stratified random sample of horses with different housing arrangements, ages, genders, and breeds. The horses were categorized based on their living arrangements. All participants currently reside in a public location contracted with Wichita State University.

The experiment was conducted using a brush, camcorder, bridle, and treats. Researchers used treats to ensure the horse’s compliance. The bridle was used to lead the horse to the area where the study was conducted. The bridle stayed on the horse throughout the experiment, tethering the horse to the area fencing, to protect the horse as well as the researcher.

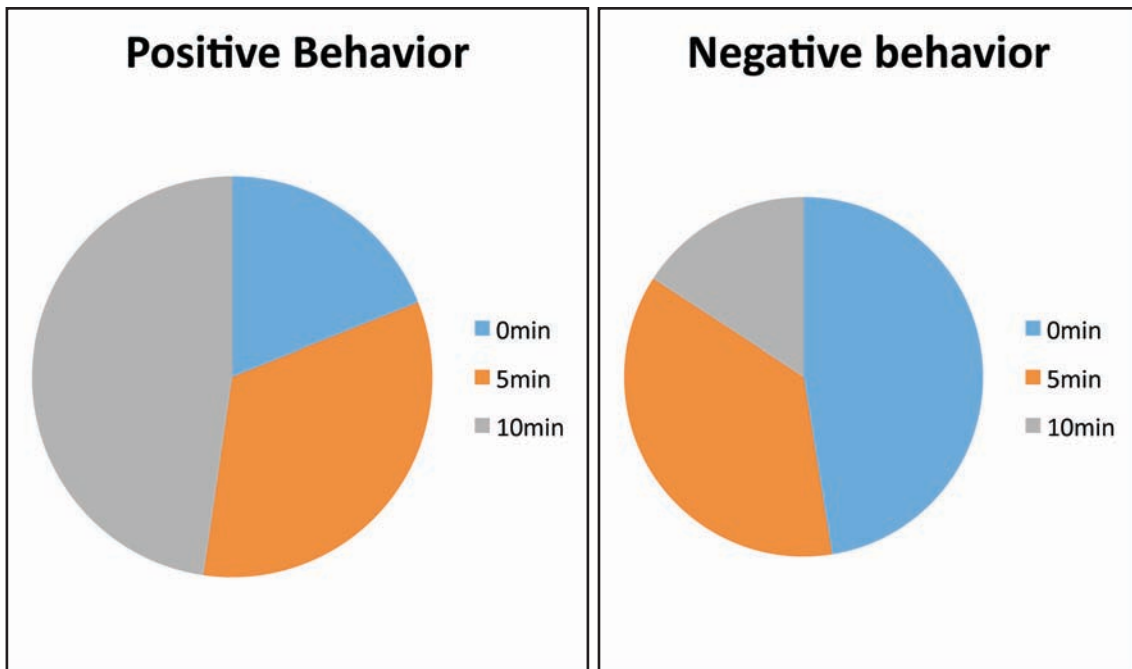
## Results

Ten to twelve horses responded positively in the ten minute grooming session. Six to twelve horses responded positively in the five minute grooming session. Four to twelve horses responded positively in the baseline session. Three to twelve horses responded negatively in the 10 minute grooming session. Seven to twelve horses responded negatively in the five minute grooming session. Nine to twelve horses responded negatively in the baseline session. Some of the horses were in both groups of behavior because both negative and positive behavior was observed during the grooming process (See Figure 1). Five minutes of grooming did not appear to have the relaxing effect hoped for, but 10 minutes of grooming brought most of the horses to a very relaxed state. Five minutes was a tease for the horses: as soon as they calmed down and started to enjoy the grooming it was over. Ten minutes produced the desired effect of positive behavior and relaxed demeanor, but it was not enough time for the groomer to finish the full amount of grooming needed.

During the 10 minute grooming sessions, the horses also had low hanging necks. They were more likely to exhibit eyes the longer the grooming went on. Toward the end of the 10 minutes, many horses cocked one of their back

**Table 1:** *This table randomized the data, keeping the variables and margin of error down.*

Number of horses in group 1	Number of horses in group 2	Phase I	Phase II	Phase III
6 Outdoor	6 Indoor	Day 1	Day 2	Day 3
Horse U	Horse A	0	10	5
Horse V	Horse B	0	5	10
Horse W	Horse C	5	0	10
Horse X	Horse D	5	10	0
Horse Y	Horse E	10	0	5
Horse Z	Horse F	10	5	0



**Figure 1:** *Positive Behavior vs Negative Behavior*

legs and swayed forward. Some horses stomped their hooves and held their heads high with their entire body stiff and alert.

There was a small range of variation noted. The horses that took the longest to relax were the ones less familiar with the area. Also, there were a few cases of human error: dropped brushes startled the horses, requiring researchers to start over. A few of the horses were in the middle of eating prior to the research session. Being taken away from food set the mood in the negative range; the horses did enjoy the grooming, but seemed bitter for having been taken away from feeding.

## Discussion

The most important result of this research was the determination that horses react positively to grooming. Horses do prefer a thorough grooming to a fast and half-done grooming. The major patterns in the observations are environment and time. The environment, if not familiar to the horse, will result in stress if the time for grooming

is 0 or 5. A relationship was found between positive behavior and the time allotted for grooming; there is also a relationship between positive behavior and environment. A trend that was noticed was that the more the groomers were aware of their horse the more the horse was soothed. When grooming, if one familiarizes the horse with the location and grooms the horse for at least ten minutes, all the while paying close attention to the horse's behavior, a person stands to gain much out of the grooming process, as does the horse.

## Conclusion

This research found that horses find grooming to be positive and that an adequate time for grooming horses is at least 10 minutes. It's been concluded that horses are emotionally driven animals, and like humans, they too need to have a social network. This study helps humans better understand the horse "love language" and how to speak it; thus, giving both parties the relationship desired.



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# Community-based Prevention Programs as a Venue for Reducing Recidivism: A Qualitative Study of Selected Former Juvenile Offenders

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## Summary

### Introduction

Since the beginning of crime, society believed punitive measures were correct in dealing with criminals. The great minds of the positivist era, established in the 18<sup>th</sup> century, recognized the importance of empirical sciences to create realistic ways to deter criminals in order to protect society (Stohr & Walsh, 2012). The decision to separate juveniles from adults in the correction system and the addition of the rehabilitative model led to great advances in the rehabilitation of offenders in the criminal justice system both for juveniles and adults (Cullen & Gendreau, 2000). The addition of empirically-based programs has helped to jumpstart a new era of rehabilitation.

### Research Statement

This study will investigate the success of community-based programs as perceived by juvenile offenders themselves. This research seeks to determine which community-based programs were the most effective based on the offenders' experiences. The following hypothesis will be examined: strengthening ties between community-based programs and juvenile offenders will result in a decrease in recidivism.

### Method

A qualitative methodology was implemented. Participants were male, ages 18 to 25, and had been involved in the juvenile justice system. The four participants were interviewed in-depth about their experiences with various community-based programs. Semi-structured interview questions were created. All interviews were recorded and analyzed. Reoccurring themes were determined and used as raw data for the findings.

### Findings

All participants had been in trouble in school prior to their first arrest, and two of the four had been expelled. All participants had been incarcerated because of misbehaviors before the age of 15. Three of the four participants had failed a drug test, but all admitted to some type of substance addiction. Respondents participated in community-based programs that included drug treatment, alcohol treatment, and group homes. Participants who were placed in group homes also received anger management, moral reasoning and independent living classes, education advancement, and counseling. Participants noted that drug and alcohol treatment classes did not help keep them sober.

Crimes committed by participants varied in severity from misdemeanors to felonies. Programs offered resources that may have helped them to desist partially from crime. Although all

participants reported unhealthy family dynamics, certain respondents stated that their families were partially responsible for their changes. Another reason noted for desisting from crime was the perception respondents thought society might have of them. However, being in these community-based programs did not deter them from accumulating an adult criminal record.

### Discussion

Environmental factors, as well as immersing juveniles in the criminal justice system, have negative effects on future recidivism. Stohr and Walsh found that youths' environments push them to volunteer themselves to committing crime: they are not hedonistic or born criminals. One participant in this study reported that he felt pushed into selling crack to feed himself, because his father would not. Abrams (2011), as well as Holman and Ziedenberg (2006), noted that available evidence indicates that 50% to 70% of juveniles that had contact with the juvenile system go on to have future contact with the system. These juveniles had multiple contacts with the juvenile justice system before the legal age of adulthood and continued accruing an adult criminal record. Keeping juveniles from the criminal justice system may have benefits to society.

### Conclusion

History and research has shown that punishment does not divert juveniles from crime. There is not a "one way fits all" for the youth in rehabilitation today, making it imperative to continue in the positivists' footsteps by finding and establishing realistic ways to deter youth from crime. Research has shown that after initial contact with the juvenile justice system, youth have a greater possibility of having repetitive contact with the system. Community-based programs offer alternatives for incarceration that may deter these juveniles from the continuous

cycle of repetitive contact with the system. Individualizing programs to fit the youth's needs could have a greater impact on reducing recidivism. Evaluating and individualizing juveniles during their first arrest and shaping their plan for success around their needs may deter juveniles from future crime and and the cycle of repetitive contact with the justice system.

### Future Recommendations

The participants in this study reported getting in trouble in school prior to their

criminal behavior, suggesting that intervention may be helpful in a school setting. Providing counseling sessions such as anger management and moral reasoning to youth with behavior issues, might equip them with tools to behave in socially acceptable ways. Future research should determine what counseling strategies work best in a school setting. Two participants in this study also discussed getting expelled from school and having nothing to do during that time period. Further research should also look at reasons for expulsion and the effects of zero tolerance policies on juvenile offenders.

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# Youth Sport Coaches' Perceptions of Organizational Policies of Child Protection and Maltreatment

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## Summary

### Introduction

**N**early 70% of children between the ages of six and 17 participate in team sports, creating a growing demand for youth sport programs that provide advanced instruction and training (Sport & Fitness Industry Association, 2011). Youth sports are one of the largest segments of the sport industry, generating over \$5 billion annually (Wagner et al., 2010). Each year, 30 to 40 million children participate in a variety of programs throughout the United States offered by private, public, and non-profit organizations (Wagner et al., 2010). Growing concern over childhood obesity has led to



emphasis on programs promoting health and fitness (Hofferth et al., 2005). Bailey (2006) maintains that “the benefits of participating in physical activity and sports continue to be emphasized at local and national levels, as they contribute to the overall development of physical, cognitive, social, and affective domains, and promote active, positive lifestyles for those who participate.”

Because of the significant child population, it is paramount for sport organizations to implement measures for child protection (Sterling & Kerr, 2008). Of particular concern for youth sport administrators is the abuse and maltreatment of participants in their sport programs (Cox, Noble, & Vermillion, 2013). Sterling (2008) concludes that the development of a prevention and intervention initiative would ideally include the inter-relations of four components: advocacy, policy, education, and research.

## Literature Review

Youth sport coaches are in a unique position to observe and address individuals who may have the potential to engage in relational maltreatment. Relational maltreatment is a form of abuse and neglect that occurs within a critical relationship—one that is “important for an individual’s sense of safety, trust, and fulfillment of needs” (Crooks & Wolfe, p.17). Relational maltreatment includes child emotional abuse, child neglect, child physical abuse, and child sexual abuse.

The purpose of this research is to identify youth sport coaches’ perceptions of organizational policies of child protection and maltreatment.

## Methodology

### Participants

This research examined a purposive sample of current and former youth sport coaches from 182 organizations. The participants were affiliated with public recreation departments, non-profit organizations, educational, (middle & high school), and private (for-profit) businesses. The

contacts were targeted through Internet search (i.e. PCA, governing bodies, State High School associations, YMCAs, etc.). An electronic survey was administered via e-mail. Coaches under 18 were asked not to participate. The survey took approximately 2-3 minutes.

## Instrument

The Coaches and Child Maltreatment Questionnaire (CCMQ), adapted from Kenny (2001) and Brackenridge (2002) was used for this study. It consisted of 13 Likert-type statements related to (a) self-reported confidence in their abilities to identify four different types of child abuse and neglect, (b) knowledge and awareness of organizational policies and procedures pertaining to the reporting of child maltreatment, and (c) attitudes toward organizational training regarding their policies and procedures on child maltreatment. Demographic information such as age, gender, ethnic background, years of experience in coaching, years in their current position, and educational background was included.

## Analysis

The responses were loaded into SPSS (v:20) and tabulated, examined, and statistically analyzed to examine coaches’ perceptions of child maltreatment.

## Results

There were 327 responses from 182 organizations (n=327). Relatively few questions were skipped, enabling us to use all 327 surveys. From the four types of agencies represented, 76% coach high school, 38% non-profit, 20% public agencies, and 10% are from private agencies. Fifty percent of participants have 7 or more years with their organization, and 49% have over ten years’ experience working in youth sport settings. Sixty-nine percent of respondents were male. Seventy percent possess a bachelor’s degree or higher.

Seventy percent of respondents indicate they have never made a report of suspected child abuse.

Coaches report confidence in recognizing physical abuse (88%), neglect (79%), emotional abuse (72%), and sexual abuse (58%).

## Discussion

Results of this study indicate coaches have confidence in their abilities to identify most forms of maltreatment, although the study shows coaches do not believe their organizations provide adequate training or awareness of policies pertaining to maltreatment. Nearly two-thirds of the respondents indicate they are confident in handling maltreatment issues; however, it is important to note that the remaining third is not confident with its abilities. Seventy-five percent of coaches are aware of their organizations' policies and confident of support (85%) from their superiors should they submit a report of suspected abuse. Though an overwhelming majority (70%) have never made a report of abuse, every year there are over 3 million reports of child abuse in the United States, involving more than 6 million children (U.S. Department of Health and Human Services, 2011).

## Recommendations

Youth sport organizations can enhance the awareness and knowledge of their employees

by providing appropriate training and support (Kenny, 2004; Sterling & Kerr, 2008). Additional studies should further address potential differences based on group (i.e. ethnicity, sport coached, etc.), as well as policy differences between the types of agencies represented. More representation from private, public, and non-profits is needed, as well as expanding the study to include coaches' definitions of abuse and neglect and examining if repercussions by parents would affect the reporting. Coaches should explore management — and leadership — theoretical implications. For example, the Porter and Lawler (1968) Model of Motivation and Transformational Leadership by Bass (1985) are highly recommended.

## Limitations

The participants in this study were self-assessed. Although they were spread over the United States, the majority were affiliated with educational institutions. There is need for further examination of non-profit/community and private organizations.

## Conclusion

Research like this will hopefully contribute to policy development in youth sport organizations. Safety and well-being for youth participants should become number one for the youth sport organization's success.

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# Determining Who Benefits Most from a Youth Empowerment Program

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## Summary

### Introduction

Students battle adversity and negativity across the U.S. that can affect academic and social performance and hinder their futures. African-American students, specifically from low-income households, struggle to perform well in school. Poor family and peer support and high risks in a student's neighborhood have a negative effect on their overall GPA (Gonzales, Cauce, Friedman, & Mason, 1996). Interventions are necessary for students who may not realize the impact their environment may have on the future. Few studies have focused on interventions for low-income African American adolescents, although many programs aim to improve the academic and social lives of this demographic. The Youth Empowerment Implementation Project (YEIP) was a three-year long study created to increase academic achievement, encourage career aspirations, and reduce substance use

among a predominately African American group of middle school students. Over the span of the program changes in participants and sample size varied each student's exposure to the program. This study hopes to determine who benefited most out of students who had abundant or limited participation in YEIP.

## Methodology and Population

Thirty-one students were selected to serve as the sample in this study: 20 females and 11 males from Gordon Parks Academy, a middle school in Wichita, Kansas. The school social worker referred to the program youth from certain zip codes that were typically high-crime and low-income. Permission for each student to participate was acquired through consent forms sent home to parents and guardians. All participants could leave the program at any time in the study. The students participated in an array of enrichment and empowerment programs supported by their surrounding community. Every student included in the study participated in a gender-specific program, Boys 2 Men or Girl Empowerment. Sessions were held once a week during lunchtime to illustrate good decision making and how to handle emotional and social issues. In addition to the mandatory Boys 2 Men and Girl Empowerment, four programs in particular produced the strongest data, as this was a point in the study when participants were abundant and consistent in attendance. Participants' attendance at two separate WSU Summer Enrichment programs, the Boys & Girls Club and Strengthening Families sessions were used to determine how active each student was in YEIP. From this data they were divided into four groups: High (participated in 3 or 4 of 4 programs), Medium (participated in 2 of the 4 programs), Low (participated in 1 of 4 programs), or Limited (participated in 0 of 4 programs).

From the groups, students' grades from spring of 2010 (Time 1) and spring of 2011 (Time 2) were averaged and compared. The amount of behavioral incidents for all of the students in spring of 2010 and 2011 were also compared.

## Results and Discussion

A decrease in the overall GPA of the students in the study was observed between Time 1 to Time 2, dropping from a mean of 2.92 in spring of 2010, to a mean of 2.87 in spring 2011. In contrast, it was observed that students who participated most in the program, those placed in the High Participation category, had the highest average GPA ( $M=3.12$ ), while students in the Low ( $M=2.59$ ) and Limited ( $M=2.73$ ) groups had lower GPAs. Also, the number of behavioral incidents decreased from 25 incidents in 2010 to 18 in 2011. Statistical significance was not found for the sample, thus the conclusion that YEIP created these changes is not certain. YEIP may have had an effect on the students' academic and behavioral performance; however, without a comparison group, we cannot definitely attribute any changes in the participants' behavior to the intervention.

## Limitations

The small sample size was the main limitation of the study. Having a small amount of quantitative data in analyses like the paired *t*-test makes it difficult to find significance for the sample, whether it exists in the sample or not. The lack of a control group also made it impossible to compare the students' performance. Also, attrition toward the end of the program further restricted the amount of data available for analysis.

## Further Research and Conclusion

Numerous programs for at-risk African American youth can be found in the U.S.;

however, additional research is necessary to identify how these improve students' lives. A major limitation of the present study was a small sample size that weakened the strength of the findings. More interventions with larger samples should be developed and tested with at-risk African American populations. This study suggests that high participation results in higher GPAs and a decrease in overall behavioral incidents. Qualitative data paired with test scores, grades, and incident reports will strengthen the

credibility of the results in subsequent studies as well. Students may learn the importance of academic success and how to function as adults by collaborating with community groups. Intervention studies must be employed to help improve the lives of at-risk African American youth. Adolescents are greatly influenced by their environment, and the consequences can be detrimental. Positive influences can be a catalyst for positive changes and academic gains.

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# Diversity and Evenness of Aquatic Invertebrates Inhabiting Ephemeral Ponds of South-Central Kansas

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## Summary

### Introduction

**E**phemeral ponds are small, freshwater aquatic systems of standing water. Conservation strategies that work to protect more permanent systems may not address the threats ephemeral ponds face. Temperature is a major factor that influences species composition in aquatic systems. Global warming may leave organisms in ephemeral ponds more vulnerable to temporal variation than those of larger systems. This study examined two ephemeral ponds in Kansas, hypothesizing that temporal variation in the water of ephemeral freshwater ponds has a greater impact on the abundance, diversity and species richness of the invertebrate community than other environmental factors.

## Study Site and Methods

Samples were collected biweekly using plankton nets and examined using light microscopes. Change in volume between samples was measured using markers. Air and water temperature were taken using glass thermometers.

Organisms were divided among taxonomic groups and counted. The number of species or species richness was recorded for both the individual samples and the final combined sample. For further calculations, the number of individuals from each species was recorded. Estimates of biodiversity were calculated using the Shannon-Weiner Diversity Index, and species evenness was calculated using Peliou's Evenness Index.

## Results

### Richness, Diversity and Evenness

Results from Site A do not reflect correlation between water temperature and species richness. Results from Site B indicate a slight positive correlation between water temperature and species richness, with higher individual counts found in warmer water.

No correlation was found between species diversity and temperature at Site A. A slight negative correlation was found between species diversity and temperature at Site B. Diversity decreased as the temperature increased at Site B

Results suggest no correlation between species evenness and temperature at Site A. There was a strong negative correlation between evenness and temperature at Site B. Evenness decreased as the water temperature increased at Site B.

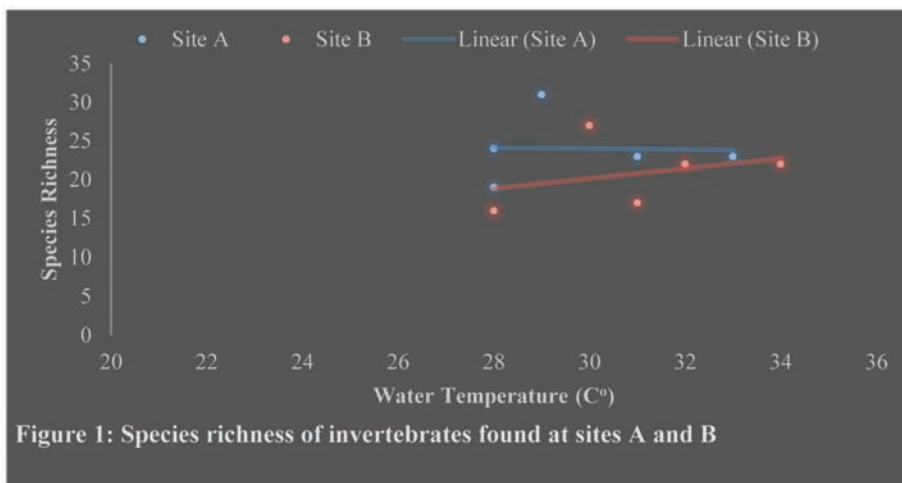
### Water Temperature

Temperatures of the samples were not significantly different between Sites A and B; the greatest difference was 3°C. Temporal variation between collections followed a similar pattern for both Site A and B. The greatest difference was recorded between samples three and four: temperature increased by 2°C at site A, whereas it decreased by 2°C at site B.

## Discussion

### Richness, Diversity, and Evenness

The results for site B suggest that temperature could affect species richness. It could be argued that Site A, the larger of the sites, would offer a more even temperature and provide a more stable habitat, protecting diversity from temperature change (Brönmark, 2005; Bagella & Caria, 2013; Holbrook et al., 2008). Both sites experienced heavy rainfall, and diatoms exhibited population increase, while Volvox, Ciliophora, Mollusca and Coenagrionidae exhibited decrease. Between these samples, there was no significant change in temperature, suggesting that the



influx of rain may have been responsible for the change in community composition.

The data again revealed no correlation between species diversity and water temperature at Site A. The data for Site B did suggest that water temperature could affect diversity, but this should be considered with caution, as other characteristics of the ephemeral pond may have been significant limiting factors on diversity.

The data showed no correlation between evenness and temperature at Site A, but demonstrated a strong negative correlation between evenness and temperature at Site B. However, each sample revealed a large range of error and significant overlap.

## Water Temperature

The temperatures of the samples taken during collection were not significantly different between Sites A and B; at most, the temperatures between the sites varied by only 3°C. This does not support Brönmark's assumption that a larger body of water is better protected from changes in temperature. However, the differences between the sites' water volume may not have been great enough to assess the buffering ability of the water.

## Conclusion

Despite the gap in ecological data, this study

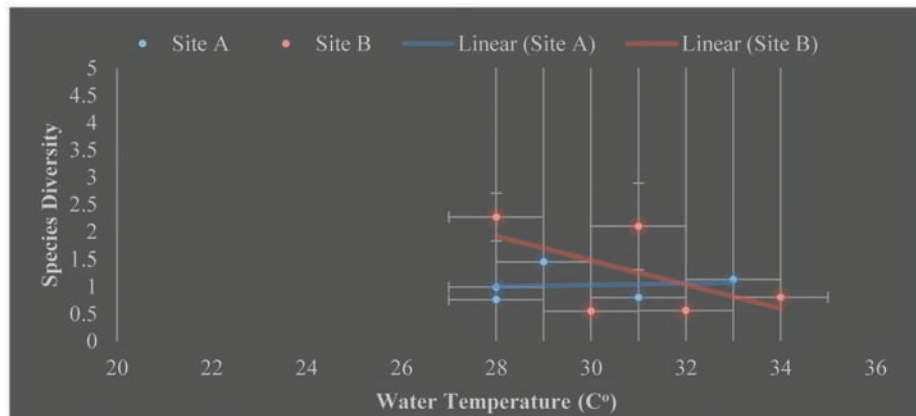


Figure 2: Species diversity of invertebrates found at sites A and B

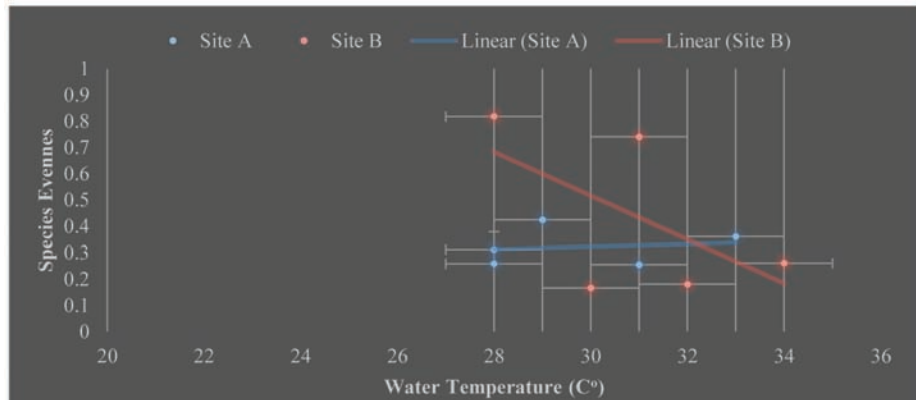


Figure 3: Species evenness of invertebrates found at sites A and B

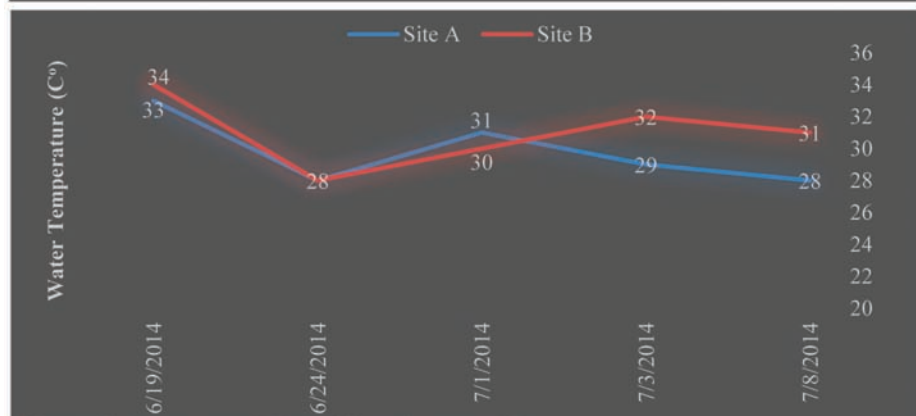


Figure 4: Temperature Collected from sites A and B

and previous research suggest that temperature may influence invertebrate populations within ephemeral ponds. To better understand these temporary systems, future research should monitor the influence of water volume, water temperature, ambient air temperature and climatic events, such as precipitation, on the invertebrate communities within freshwater ponds.

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# The Effects of Play Therapy on Autonomic System Arousal as Measured by Heart Rate

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## Summary

### Introduction

**T**his project seeks to discover how play therapy affects the autonomic arousal system in preschool children and examines play behaviors and play therapy. The goal is to show how play therapy is a method to improve externalizing behaviors and social-cognitive skills among preschool children. Play therapy has proved generally effective as an intervention for children who display problems in these areas.

### Methodology

This study took place at the Wichita State University Development Center with children between



the ages of three and six years old. There were three phases. During all phases, children wore heart monitors to measure arousal levels during free play and play therapy sessions. This helped the researchers examine improvements in behaviors, arousal, and social-cognitive skills. Teachers were asked to answer survey questions about the children's social cognitive skills and behaviors. In the intervention phase, a group of eight to ten children who displayed problematic externalizing behavior participated in a play therapy intervention. In the posttest phase, the assessments and surveys will replicate the pretest phase. Throughout the intervention phases, the play therapy group children were observed during free play in their classroom environment. In addition, the children who received the play therapy intervention wore heart rate monitors to measure autonomic arousal levels (and therefore emotional regulation) during the children's free play and play therapy sessions.

## Results

### Teacher-Rated Aggression and Prosociality

At pre-test, the play therapy group had higher physical aggression scores than the control group ( $p = .002$ ). For the play therapy group, teacher ratings of proactive, physical, verbal, and relational aggression all increased from pre- to mid-point testing ( $p$ -values  $< .03$ , although  $p = .06$  for physical aggression). This increase in aggression was not observed in the control group ( $p$ -values  $> .05$ ). Both groups had similar ratings of prosociality at pre-test, but at mid-point the control group had higher scores than the therapy group ( $p = .005$ ).

### Autonomic Arousal

The heart rate data is currently incomplete. In a preliminary test of change in autonomic arousal, a paired samples t-test of the maximum heart of the play therapy participants was conducted. The play therapy participants had an overall decrease in maximum heart rate ( $p$ -values  $< .05$ ).

## Discussion

In this study, results deviated from what was predicted. Aggression and externalized behaviors increased rather than decreased with play therapy over the course of eight weeks. An eight-week course may not be long enough to determine the effects of play therapy on children who display aggression and externalized behaviors. This research will continue for a longer time span to determine if play therapy affects the autonomic arousal system.

The study provides several types of evidence. The increase in aggression seen at mid-point validates Norton and Norton's (2002) developmental model of the stages of play therapy. In the Norton and Norton model, children move through the stages of exploratory play, a limit testing phase, a dependency stage where problem behaviors often increase, a therapeutic growth stage (where problem behaviors begin to resolve), and finally a termination phase. Play therapy researchers have hypothesized that a minimum of eight weekly sessions are needed to see improvement (Bratton, Ray, Rhine, & Jones, 2005). However, the results of this study provide evidence that more than eight sessions may be necessary for meaningful change, important information for those designing interventions for the educational setting.

The study is significant as well because it was conducted in an educational preschool environment. The number of play therapy studies conducted in such a setting are limited (Bratton et al., 2005). The study provides evidence of the potential of play therapy as an educational intervention in the preschool setting.

In addition, the study is one of the few outcome studies conducted in play therapy that uses a control group. Phillips (2010) and LeBlanc and Ritchie (2001) have called for additional studies using control groups and treatment fidelity in evaluating the effectiveness of play therapy. The current study provides a control group design and treatment fidelity. A longer

duration will be valuable in evaluating of the effectiveness of play therapy as an intervention in the preschool setting.

Further analysis is needed for the heart rate data. Comparison analysis between the heart rate of the control group and the treatment group is needed. In addition, time series analysis will be conducted on the heart rate data for the treatment group to measure change in heart rate over time.

## Conclusion

Overall, we have determined that play therapy may have a negative effect. The effects

of play therapy on the autonomic system are a new area of study. Researchers have yet to fully understand the full effect of play therapy on the autonomic arousal system. Previous research has shown that there is some type of correlation between the two variables. The autonomic arousal system has been fully examined by different areas in research; however, research regarding play therapy and the autonomic arousal system is relatively new. Further research could examine how play therapy affects the autonomic arousal system not only children, but in adolescents. Future research could also explore how environment plays a role in behavior.

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# Shaping the Ideal Stepfamily: Myths and Stressors

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## Summary

### Introduction

**W**ith a divorce rate that is 10% higher than the traditional married couple, remarried couples have to strive even harder to keep their stepfamily together. Stepfamilies often experience stressors that are not common to the traditional married couple. For example, managing the relationship with an ex-spouse can result in ambiguous roles for the stepparent and “abrupt changes in living arrangements” for the entire stepfamily (Coleman et al., 2001, p. 56). The purpose of this exploratory study was to investigate the perpetuation of myths and stressors that affect the functioning of the stepfamily. It was hypothesized that adherence to myths would vary based on whether or not someone was in a stepfamily or knew a friend or family member in a stepfamily, how many years they had spent in a stepfamily, and also by age.

## Methods

To test these hypotheses, a survey on stepfamily myths was completed online by Wichita State University students recruited through an on-campus psychology course and through a variety of sociology courses. The majority of participants are female (80%), Caucasian (67%) and between the ages of 18 and 23 (71%). Fewer than half of the participants were current members of a stepfamily (45%). Among those currently in a stepfamily, 15% report being a stepsibling, only 8% are stepparents, and 13% of those reported that they hold multiple statuses within a stepfamily. In a society where the divorce rate is 50%, surprisingly only 9% of our participants reported that they do not have a family member and/or friend who are part of a stepfamily. The survey consists of nineteen items: seven demographic questions and questions regarding their attitudes toward twelve common stepfamily myths. A series of independent sample t-tests and an ANOVA were performed for the purpose of examining the following questions:

1. Are there differences in perception of myths between those in and not in a stepfamily?
2. Are there differences in perception of myths between those who have a friend/relative in a stepfamily and those who do not?
3. Do participants' perceptions of myths vary by the number of years they have been in a stepfamily?
4. Do participants' perceptions of myths vary by age?

## Results

Results revealed no real significant differences for myth perception between groups, with an exception in the findings for question 3 ( $p < .05$ ). However, several trends did emerge.

With regard to significant findings, an independent sample t-test revealed a difference for myth 4 (“The couple relationship is the

foundation of a strong stepfamily”), in relation to question 3, number of years in a stepfamily. Results indicated the number of years in a stepfamily does affect an individual’s view of whether the couple is the foundation of the stepfamily ( $t = 2.095$ ,  $DF = 49$ ,  $p = .041$ ). Those who have been members of a stepfamily 10 years or less ( $N = 26$ ,  $M = 3.846$ ,  $DF = 1.12044$ ) are notably more likely to view the couple as the foundation of the strong stepfamily than those who have been in a stepfamily for 11 or more years ( $N = 25$ ,  $M = 3.200$ ,  $DF = 1.08012$ ).

Several significant trends ( $p < .10$ ) were found for each question explored. In relation to question 1, T-test analysis revealed participants who were members of a stepfamily ( $N = 45$ ;  $M = 2.9778$ ,  $SD = 1.27$ ) were slightly more likely than those not in a stepfamily ( $N = 54$ ;  $M = 2.5370$ ,  $SD = 1.16$ ) to believe myth 7 (“The absence of a biological parent makes transitioning into a stepfamily easier”) ( $t = -1.802$ ,  $DF = 97$ ,  $p = .075$ ). In relation to question 2, participants who did not have a friend or relative in a stepfamily ( $N = 9$ ,  $M = 3.6667$ ,  $SD = 1.5000$ ) were slightly more likely than those that had a friend or relative ( $N = 90$ ,  $M = 2.8111$ ,  $SD = 1.27106$ ) to believe myth 6 (“There are few differences between a nuclear family and a stepfamily”) ( $t = -1.895$ ,  $DF = 97$ ,  $p < .061$ ). In relation to question 3, those in a stepfamily 11 or more years ( $N = 25$ ,  $M = 1.8462$ ) were slightly more likely than those in a stepfamily for 10 years or less ( $N = 26$ ,  $M = 2.3200$ ) to believe myth 10 (“A second marriage is easier than a first marriage”) ( $t = -1.900$ ,  $DF = 49$ ,  $p < .063$ ). And finally, in relation to question 4, a one-way analysis of variance (ANOVA) was calculated for participants’ myth perception based on age ( $f(2, 96) = .74$ ,  $p = .086$ ). Findings revealed participants’ aged 30 or over ( $N = 9$ ,  $M = 4.4444$ ,  $SD = .73$ ) were more likely to believe myth 4 (“The couple is the foundation of a stepfamily”), than those aged 18-23 ( $N = 70$ ,  $M = 3.7286$ ,  $SD = 1.01$ ) and those aged 24-29 ( $N = 20$ ,  $M = 3.5000$ ,  $SD = 1.32$ ).

### Discussion

The expectation that members of the traditional nuclear family would have a greater acceptance of the stepfamily myths than the members in a stepfamily was not confirmed in this study. The one significant difference in myth perception was found among those in a stepfamily and related to the number of years associated with a stepfamily. Individuals with less than 10 years of experience were more likely to view the couple's relationship as the foundation of the stepfamily than those with longer experience. However, it should be noted that a closer look at the results revealed a potential discrepancy in the reported number of participants who said they were in a stepfamily (N = 45) versus the number of participants reporting the length of membership in a stepfamily (N = 51). This discrepancy warrants further attention and future research to verify the results.

Interestingly, of the 99 participants in the study, 54% did not view the married couple as the foundation of a strong stepfamily. This is contrary to previous literature. This research suggests that the intimacy and establishment of the remarried couple's bond are important to the development

of the stepfamily and keeping it intact (Furrow & Palmer, 2007). One study found that a spouse who brings the components into his or her current relationship that were responsible for the unraveling of their first marriage would experience lower marital satisfaction and the eventual eroding of the marital foundation (Saint-Jacques, Robitaille, Godbout, Parent, Dropeau, & Gagne, 2011). Previous research does not indicate the parent-child bond was the foundation of the stepfamily; however, studies have indicated that a spouse who appoints the parent-child relationship as having priority over the couple's relationship threatens couple satisfaction (Saint-Jacques et al., 2011).

The findings of this study may indicate that whether one is a member of a stepfamily or a traditional nuclear family, stepfamily myths no longer stigmatize the stepfamily the way they did two decades ago. This may suggest that the stepfamily is becoming more institutionalized (or normative) as Cherlin (2004) predicted. Further research is warranted in order to help assist stepfamily development. It is not enough to focus on only the problems faced by stepfamilies. Research must help formulate solutions in order to support success of the stepfamily.

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# Bilingualism: The Repercussions of Being Denied the Spanish Language and the Significance of its Preservation

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## Summary

One of the most distinctive qualities of a culture is its language. Losing one's native language may result in the interruption of one's cultural identity; hence, one's sense of being. The people of the United States have expressed such contempt over the use of the Spanish language that the preservation of this language and its culture are at great risk. Pete Farrugio suggests, "assimilation pressures on children from schools and communities to abandon the use of Spanish increase[s] parents' anxiety about the potential loss of cultural values" (8). These pressures result from government and state statutes. Historically, the 1921 and 1924 Immigration Acts and English-Only statutes in schools were early examples of these pressures, while more recently, 1998's Proposition 227 and the many English-only movements have continued this trend.

The evolution of the Spanish language began with the arrival of the European Spaniards into America, the New World, bringing with them their Spanish language, culture, and religion. Preservation of the Spanish language was not only maintained within the Spanish people but bestowed upon the indigenous people. Tension surrounding the Spanish language, however, surfaced during the Great Depression. According to Victoria-Maria MacDonald, this “prompted xenophobic measures against immigrants resulting in passage of the restrictive 1921 and 1924 Immigration Acts and English-Only Statutes in schools” (309). Although the Immigration Acts were solely intended for Asian passage into the United States, this was the first law that stipulated English-only and applied to everyone; hence, societal pressures and discrimination towards people speaking in their native tongues. 1968 marked the enactment of the Bilingual Education Act, the first federal legislation that mandated schools to offer bilingual education programs. However, this was to be eliminated three decades later when California passed 1998’s Proposition 227, mandating that all schools cease bilingual programs and instruct in English only. This was later followed by Proposition 203, a similar bill passed by other states, including Arizona, Massachusetts, and Colorado.

As a consequence of these laws, the Spanish language and the culture that it represents took a negative turn that put its preservation at risk. According to the US Census Bureau, the total Hispanic population in the US increased by 15.2 million between 2000 and 2010 (Ennis, Ríos-Vargas & Albert, 2010). However, Spanish language use among the Hispanic Latino community in the United States decreased. Based on the Census data, in the year 2010 there were 50.5 million Hispanics in the United States; however, only 36,995,602 of these Hispanic Latinos actually make use of the Spanish language. Preservation of the Spanish language fosters a cultural awareness, thereby constructing a sense of being. There is a large population of Hispanics in

the United States, many of whom do not actually speak the language and may feel alienated by the loss of their culture.

Although California’s Proposition 227 mandated English-only instruction, it did allow for bilingual educational programs with a signed waiver. Amy Lutz suggests, “The majority of parents, regardless of background, see the benefits that bilingual education provides. However, there are some parents that do not want their children to learn the Spanish language or be taught in their native tongue” (3). Parental choices often determine the direction of their children’s future, as they are the ones that make the ultimate decision regarding preservation of the Spanish language use and the cultural identity that comes along with it. Martinez and Hinojosa discovered parents had a strong desire to preserve the mother-tongue and were often given the opportunity to select bilingual education programs for their children. However, due to their limited English abilities and lack of understanding of such programs, many do not choose bilingual education for their children.

Parental views on bilingual education and heritage preservation are strongly influenced by the parents’ personal assimilation experience into the US. As stated by Pete Farrugio, “Spanish preservation is important to immigrant parents because it supports the need to strengthen family unity for survival in a harsh economic environment” (5). Upon entry into the US, the priority is to obtain immediate employment as a means of supporting families. For this reason, learning the English language is not the top priority for immigrant parents. Parents appear to understand the benefits of bilingualism, yet according to recent studies, they do not encourage their children to use their mother-tongue or enroll them in bilingual education. Winnie Mucherah’s study suggests, “parents perceive their native language positively, desire that their children use it alongside English, and perceive negative consequences related to speaking their native language” (188). The parents’ reason for discouraging their children from using their native language is to keep their children from

having to endure discrimination and hardship, making it easier for them to transition into a future they believe will be better.

Bilingualism, however, has many benefits. Being bilingual in both the Spanish and English language is more beneficial than simply speaking just one of the two. Anita Pandey argues that the mother-tongue represents a comfort zone, which is essential for learning during the children's early years, and she describes how stress could interfere with learning (63). Further, Pandey suggests, "ignoring or minimizing use of the Mother-Tongue in a child's life also causes other problems, including misdiagnosis of learning disabilities" (63). Pandey suggests that there are many challenges facing the use of the Spanish language. A few problems are as follows: Not enough trained teachers who can discuss the value of bilingualism, too many doctors and special educators forcing linguistic assimilation upon parents who use Spanish at home, undue pressures to fit in to be American, continued anti-immigration sentiments in the US, and lack of awareness of the value of the mother tongue (66). Although parents agree bilingualism is ideal, many remain reluctant in maintaining the preservation

of the Spanish language within their homes due to external pressures.

Knowledge of two languages expands one's academic achievements, social involvement, career opportunities, cultural understanding, and sense of being. One benefit of bilingualism, according to Amy Lutz, is that it offers an advantage in the labor market, as its importance has increased in the local and international economies, thus providing more lucrative careers. Spanish can be viewed negatively within some English-only work environments, while in others, bilingualism is seen as an asset and in demand due to an influx of new Spanish speakers in professions such as health care, insurance, education, as well as international firms located in Latin America (56).

In conclusion, research has confirmed bilingualism in Spanish and English is an asset in economic growth domestically and internationally. It has also confirmed that children take on a cognitive advantage leading to academic achievement, in addition to possessing self-identity through cultural awareness. Bilingualism is an asset; therefore, society should allow and encourage the Hispanic Latinos to exercise the right to preserve their mother-tongue.

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# Effects of Kinesio Tape v. White Athletic Tape on Ankle Stability and Agility

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## Summary

### Introduction

**A**nkle injuries are the most common injury seen in athletes. A vast amount of research has been conducted to identify the most beneficial methods to prevent injuries and prevent reoccurring injuries. Traditional white athletic tape is the most common tape used on athletic injuries. The technique used with this tape requires two anchor points.<sup>14</sup> One anchor is located on the high anklebone, and the second around the bottom of the foot. Tape is then applied around the foot in alternating directions between the two anchor points. A new taping method is Kinesio tape (KT). The tape is approximately the thickness of the skin's epidermis and made of 100% cotton fibers.<sup>1-2, 5-6</sup> This porous tape has the ability to stretch up to 140% of its original length.<sup>1-2, 5-6</sup> This stretching applies tension to the area of application.<sup>1-2, 5-6</sup> The tape is purported to aid in healing as well as allowing increased range of



motion (ROM).<sup>1-2, 5-6</sup> Athletes often sacrifice ROM when using traditional athletic tape. KT application uses three strips of KT: one anchoring on the top of the anklebone and the other two anchoring on the foot.<sup>15</sup> All strips are stretched at 50%.<sup>15</sup>

The purpose of this study is to identify whether KT provides stability to injured ankles without reducing ROM. There is minimal research to support the benefits or lack of benefits of KT.<sup>4</sup> Some research has shown that KT provides support without reducing ROM. However, results are inconclusive. Others found that when compared to traditional athletic tape, KT does not offer more benefits.<sup>7</sup> No definite conclusion to the argument exists. This study hopes to add more data to the KT benefit debate.

## Methodology

This study used the vertical jump test and the “T”- agility test to measure power and agility. The two functional performance tests used measure stability and range of motion, respectively.<sup>8-11</sup> Vertical jump was measured using a Vertec. The “T”-test used four cones resembling the letter “T.”<sup>8, 12</sup> Fifteen participants performed both series of tests. Each performed three trials of vertical jump and agility while being taped with white tape, KT, and no tape. Participants were selected if they had an ankle injury due to an athletic incident. The mean age of the participant group was 17.27 years.

## Results

The data collected from the study group was analyzed using an ANOVA analysis. The results of the vertical jump test showed no significant difference among the three taping variables. The results from all three taping methods were compared to the alpha factor ( $p=0.0-5$ ). The value produced by the three data analysis sources had to be less than 0.04 to demonstrate a significant difference. Neither taping style could be identified as the most beneficial for vertical jump. One tape

did not provide more support than the other. However, the “T”-test analysis showed there was a significant difference between the three taping variables. The differential mean compared the results of each taping method to the others. This analysis showed that the white athletic tape was the worst for agility. There was minimal difference between KT and no tape results. The lack of significant difference between KT and no tape could be due to how closely KT mimics human skin. Agility correlates directly with ROM. The KT agility measurements may have been better due to its elasticity. Unlike traditional tape, KT does not restrict the ankle movement. The reason KT and the ‘no taping’ results showed no significant difference could be due to the fact that both KT and skin have considerably large amounts of elasticity.

## Discussion

Based on the results of this study, it could be assumed that KT is better than the traditional taping method. The vertical jump test shows that the traditional tape *does not provide more stability* than the KT. However, results indicate that KT *does provide more* ROM than traditional tape. Athletes using KT will get the same amount of support as from traditional tape but not be restricted in their ROM.

## Limitations and Further Study

The limitations of this study include the following: small sample size, pattern of testing, consideration of age and gender. The study group was fairly small. The size of the group could affect the significant differences produced by the ANOVA data analysis. This limits the consistency of the results. Age was not considered in this study. The age of participants ranged from 16 years old to 18 years old. This may have affected the speed, power, and coordination of some

participants. As age increases, muscle strength and coordination decrease. All of these factors may have affected the results of both functional tests used in this study. Gender was also not considered in this study. Anatomically, males and females are built differently. The anatomical differences could affect the stability of the ankle. Females tend to have more ankle laxity, which affects

their joint and ligament stability.<sup>1</sup> To enhance the data collected from this study, further research should consider these factors. Gender should be factored into the data analysis. Larger groups of participants may provide more accurate and consistent data. Also, testing a wider variety of age groups could provide more information about the benefits of KT tape for multiple age-groups.

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# Climate Effects on Hospitals' Energy Consumption

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## Summary

### Abstract

From 2007 to 2012, Kansas winters have been less severe while summers have become hotter. This can cause an unequal use of energy for heating and cooling systems. Hospitals are responsible for emitting many harmful greenhouse gases to the environment and must analyze energy consumption in order to identify any cost and energy tradeoffs. The analysis can be approached in many different ways.

This study will attempt to determine whether less severe winters compensate for the extreme summer heat. Monthly energy consumption for the years 2007 through 2012 were gathered as data using Hospital A and B's electric and gas bills. Heating and cooling degree day data were provided. Plots of data were constructed to demonstrate differences in energy consumption and degree days for years studied. The plots showed that

while the cooling degree days were much higher for years 2011 and 2012, electricity consumption did not change because of hospital efficiency upgrades in HVAC. The effects of energy upgrades were removed using degree days. Adjusted energy consumption numbers were then used to compare heating and cooling energy differences by year.

## Introduction

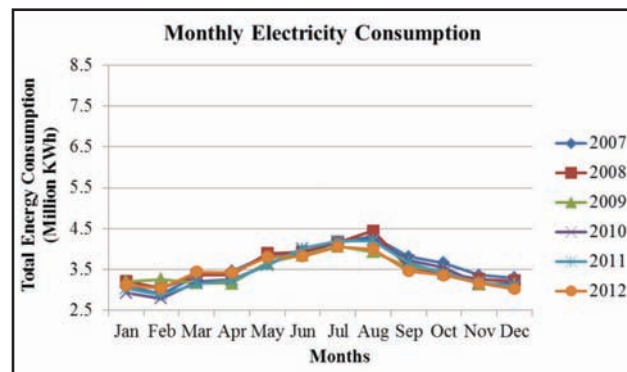
As the climate of the world warms, it is important to take a closer look at energy usage. Energy inefficiency can cause problems such as greenhouse gas emissions and increased heating and cooling costs. Hospitals consume a great deal of energy, contributing to the greenhouse gas emitted into the atmosphere. Rabanimotlagh, Overcash and Twomey (2014a) found that a large portion of the energy consumed by hospitals is used for the HVAC systems. This research will focus on the effects of the climate change on the energy consumption of the HVAC system. Climate changes have caused debate over whether improvements should be focused on cooling or heating systems. Research is needed to determine HVAC requirements as temperatures warm. It is known that, in Kansas, summers have been extreme and winters less severe. This could indicate that in the summer more electricity would be consumed to cool the building, but winters would require less gas to warm it. Would this cause the consumption to zero out? This research seeks to determine whether or not less severe winters compensate for the extreme summer heat.

## Methodology

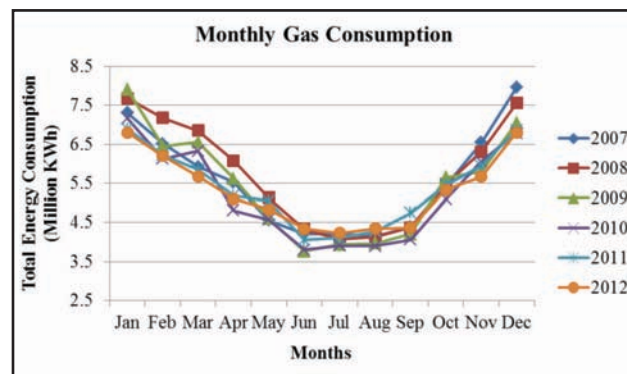
The electricity and gas bills for two hospitals were provided by Via Christi Health, the largest provider of health care services throughout Wichita and central Kansas. The data includes upgrades and improvements made on HVAC systems. The gas bill data was converted from Therms to Kilowatt hours (KWh), so that it could be compared to the electricity.

## Results and Discussion

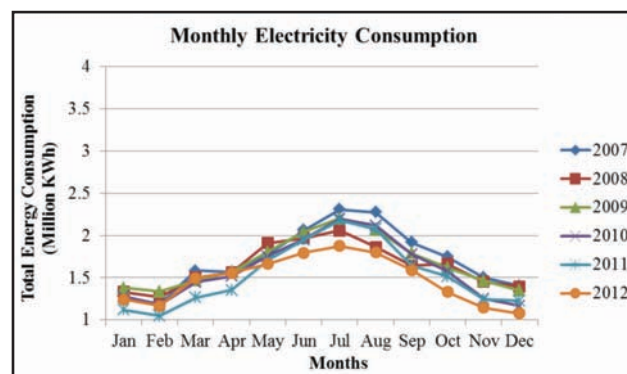
Graphs 1 and 2 show the monthly electricity and gas consumption respectively for Hospital A, and Graphs 3 and 4 show the same for Hospital B.



Graph 1: Monthly Electricity Consumption, Hospital A



Graph 2: Monthly Gas Consumption, Hospital A

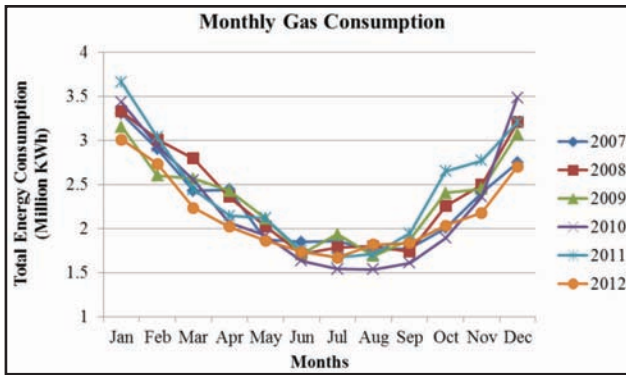


Graph 3: Monthly Electricity Consumption, Hospital B

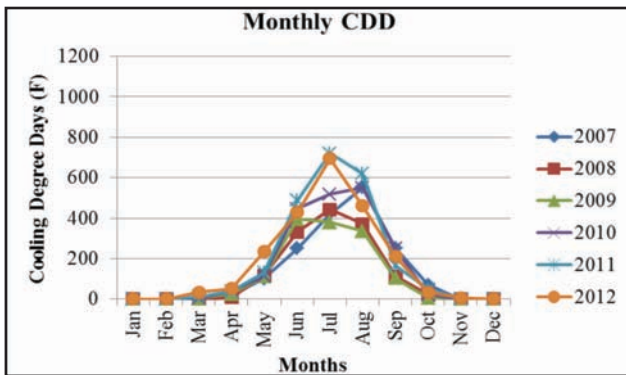
According to the graphs, more energy was consumed during May through September (the summer months).

Similar trends of extreme summer months were observed when looking at the cooling and heating degree days (CDD and HDD,

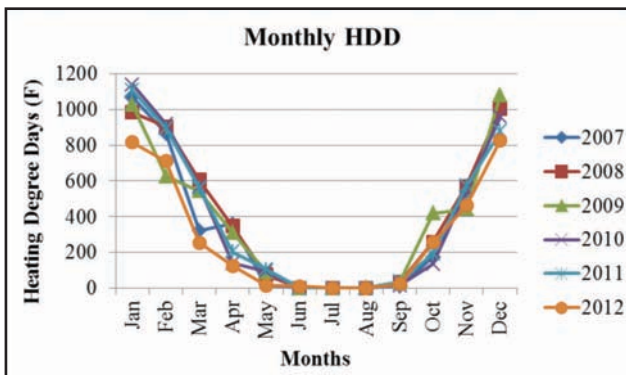




Graph 4: Monthly Gas Consumption, Hospital B



Graph 5: Cooling Degree Days



Graph 6: Heating Degree Days

respectively). The National Oceanic and Atmospheric Administration defines a degree day as “a measure that gauges the amount of heating or cooling needed for a building based on a specific baseline temperature and the varying outdoor temperature” (as cited in Rabanimotlagh et al., 2014b).

The CDD and HDD were provided by a research team from the Industrial Engineering Department at Wichita State University. Graphs 5 and 6 show the monthly CDD and HDD

respectively.

Comparing electricity consumption and CDD, Graph 5 shows that the CDD for 2012 was higher. In the same year, energy consumption was lower. If CDD were higher the electricity consumption would be higher as well. This is not observed in the graphs because of the upgrades and improvements that have been made to the HVAC system over the past years. In order to answer the research question, the data was adjusted so that it would not include these updates, using an equation from Rabanimotlagh et al. (2014b).

In 2008 and 2009, the gas consumed was higher than the electricity consumed for both Hospital A and B. In 2010 through 2012, the electricity consumed was higher than the gas consumed for both Hospital A and B. If the energy consumed in the summer compensated for the energy consumed in the winter then electricity and gas consumption would be equal reciprocals. However, the data revealed that energy consumed in the winter did not compensate for the energy consumed in the summer. The balance of energy consumption has changed from consuming more gas in years 2008 and 2009 to consuming more electricity in years 2010 through 2012.

## Limitations

Further research should incorporate data on the size of the two hospitals. Comparing the energy consumption graphs, one can assume that the hospital that consumed less energy is the smallest. The size of the hospitals may be important information, particularly if a smaller hospital is consuming more energy.

## Conclusion

The results of this research show that the energy consumption in the winter does not compensate for the energy consumption in the summer. Because of this, in the short term hospitals cannot rely on the compensation and must plan for upgrades and improvements.



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# Examining the Relationship between Substance Abuse and Suicide in the Mentally Ill Population: A Review of the Literature

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## Summary

### Introduction

When an individual suffers from a mental disorder and also has a problem with drugs and/or alcohol, this is referred to as dual diagnosis (National Alliance on Mental Illness, 2014). Oftentimes those who suffer from a mental disorder lack the care they need; therefore, they self-medicate. Quite often this is via drug, alcohol, or some other form of substance abuse. These individuals are not easily integrated into either the mental health care system or substance abuse treatment centers, and may be treated for only one aspect of their problem by one or both of these systems (Kandel, 2007). People who are affected by a mental disorder are more vulnerable to the

intoxicating and addicting effects of illicit drugs. It is necessary to further study the correlation between substance abuse and suicide in those with a diagnosis of schizophrenia or depression. Both components of dual diagnosis (mental illness and substance abuse) have the potential to increase suicidal ideations.

This research is necessary in order to construct intervention policies and procedures that will successfully assist individuals in dealing with both mental illness and substance abuse problems. Proper assessment, diagnosis, and treatment will help reduce the rate of suicide in this particular population. Practitioners in social services can use this information to provide quality therapeutic services, interventions, and treatment to those who are treated for dual diagnosis.

## Depression and Schizophrenia

Depression and schizophrenia are mental disorders affecting Americans daily. Depression has severity levels of mild, moderate, and severe. Specific symptoms of depression include depressed mood or irritability throughout most of the day, decreased interest or pleasure in most activities, significant weight change, changes in sleep patterns (Eastwood, Doering, Hays, Macabasco-O'Connell, & McGuire, 2014), changes in activity, fatigue and loss of energy (Eastwood et al., 2014), feelings of guilt and worthlessness, loss of ability to concentrate, and suicidality.

Schizophrenia is a more complex disorder that encompasses a wide range of symptoms. The *DSM-IV-TR* (p. 298) criteria require two or more of the following symptoms for diagnosis: delusions, hallucinations (Kumari, Chaudhury & Kumar, 2013; "Schizophrenia," 2014), disorganized speech, and grossly disorganized and/or catatonic behavior (p. 298). According to one study, schizophrenia is a group of pathological mental disorders that disrupts cognitive processes

and causes personality disintegration and separation from the social system.

## Substance Abuse

The essential feature of substance dependence is a cluster of cognitive, behavioral, and physiological symptoms. The individual continues using the substance of choice despite significant substance-related problems (*DSM-IV-TR*, 2010). Once an individual becomes dependent upon a substance, he or she will use it regardless of what additional problems this creates. Substance abuse has consequences on both the physical and mental health of individuals. Excessive use of alcohol and other substances, or even minimal use of alcohol in combination with prescription and over-the-counter medication, can seriously affect the physical health of those with mental disorders. This can lead to higher rates of hospitalization and increased suicidal ideations.

## Suicide

Suicide is the eighth leading cause of death in the United States (Benda, 2005). Benda (2005) reports that the overall lifetime prevalence of suicidal ideation ranges between 2.6% and 14.6% for the population suffering from mental disorders compared to 1.5% and 4.2% for suicide attempts in the general American population. The reported rates of substance use are higher among persons who experience serious mental illness and adults in the general population, and the use of drugs and alcohol is known to worsen the course of many major mental health conditions (Bahorik et al., 2013).

Literature shows that those who are diagnosed with depression or schizophrenia are at greater risk for committing suicide. In a study by Thong, Su, Chan, and Chia (2008) that focused on psychiatric patients who committed suicide from 2003-2004, the most common principal diagnoses among suicide subjects were schizophrenia (46.3%) and depression (26.8%).

This may indicate the likelihood of a positive correlation between substance abuse and suicide in those with mental disorders. A positive correlation may also be found between the level of substance abuse and the rate of suicide in those with mental disorders. Conceivably, as the level of substance abuse is elevated, the potential for suicidal ideations may also increase. It is also possible that those who have more frequent and recurrent suicidal ideations may also have higher rates of substance abuse.

## Conclusion

The prevalence of substance abuse among individuals who suffer from a mental disorder is higher than that of the general population. This is also true for the rate of suicide in those who suffer from a mental disorder. Previous research has found that one has the potential to impact the

other; however, no direct link has been found. Additionally, a significant correlation does not constitute a cause-effect relationship (Horsfall et al., 2009). When reviewing literature regarding correlations between substance abuse and suicide in those who suffer from mental illness, several studies were found to focus on substance abuse in this particular population; however, there is a dearth of data regarding how substance abuse impacts suicide rates in this population. There is also a lack of research that studies the relationship between substance abuse and the role it plays in suicidal ideations in individuals dealing with mental illness. The components of dual diagnosis have the propensity to increase suicidal ideations; therefore, future research in this area is necessary in order to provide quality therapeutic services, interventions, and treatment to those with depression or schizophrenia to minimize the risks of suicide.

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