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CARDIOVASCULAR DISEASE RISK FACTORS AMONG EMERGING ADULTS
IN COLLEGE

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Nursing
at the University of Kentucky

By
Demetrius Alexander Abshire

Lexington, Kentucky

Director: Dr. Terry A. Lennie, Professor of Nursing

Lexington, Kentucky

2014

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ABSTRACT OF DISSERTATION

CARDIOVASCULAR DISEASE RISK FACTORS AMONG EMERGING ADULTS IN COLLEGE

The purpose of this dissertation was to examine factors associated with cardiovascular disease (CVD) risk among emerging adults in college aged 18-25 years. CVD risks that develop during this period often persist into adulthood making it an ideal time to target CVD prevention. The specific aims of this dissertation were to 1) explore perceptions of cardiovascular risk among emerging adult men in college; 2) compare differences in unhealthy behaviors and obesity between emerging adults in college living in rural, Appalachian Kentucky and urban Fayette County, Kentucky; and 3) compare measures of general and abdominal obesity in predicting blood pressure among emerging adults in college.

Specific Aim One was addressed by a qualitative study of perceptions of cardiovascular risk in 10 emerging adult males in college. Specific Aims Two and Three were addressed by a study of emerging adult college students living in rural, Appalachian and urban Fayette County, Kentucky. We hypothesized that students in rural, Appalachian Kentucky would engage in more unhealthy behaviors and be obese due to living in an austere environment with barriers to healthy behaviors. Although obesity and hypertension are known to be related, researchers have not determined whether body fat distribution, general vs. abdominal, is predictive of blood pressure in emerging adults. Knowing which body fat distribution is the strongest predictor of blood pressure may help in evaluating cardiovascular risk in emerging adults.

Emerging adult men emphasized difficulty engaging in CVD health behaviors while attending college and choose to ignore long-term CVD risk. Overcoming college-specific and developmental barriers to engaging in healthy behaviors is critical to reducing cardiovascular risk in this population. Students living in rural, Appalachian Kentucky had more CVD risk behaviors and more were obese compared to those in urban Fayette County, Kentucky. Reducing CVD risk behaviors and obesity among students in rural Appalachian Kentucky may help

decrease the high burden of CVD in this region. Findings suggest that waist circumference was the best predictor of systolic blood pressure among emerging adults in college.

KEYWORDS: cardiovascular disease risk factors, college, emerging adults, Appalachia, abdominal obesity

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Date

CARDIOVASCULAR DISEASE RISK FACTORS AMONG EMERGING ADULTS
IN COLLEGE

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CHAPTER ONE:

Introduction

1. Cardiovascular Diseases and Importance of Risk Factors

Over 23 million individuals worldwide will die from cardiovascular diseases (CVD) in 2030.¹ In the United States, approximately 84 million American adults have CVD² with heart and cerebrovascular diseases being the first and third leading causes of death, respectively.³ In 2010, the overall death rate from CVD was 235.5 per 100,000 with one American dying of CVD every 40 seconds.² Cardiovascular diseases are also economically burdensome. The direct and indirect costs of CVD were approximately 315.4 billion in 2010,² an increase of more than 10% compared to 2007.⁴

A healthy lifestyle is a fundamental component of CVD prevention and ideal cardiovascular health. In 2010, the American Heart Association (AHA) defined national goals for ideal cardiovascular health that included meeting lifestyle-related recommendations for physical activity and dietary behaviors, not smoking, and a body mass index (BMI) less than 25kg/m².⁵ Data from several large epidemiological studies have shown that risk for developing CVD⁶ and risk of CVD mortality^{7,8} is significantly reduced in those with lower risk factor profiles.

2. Emerging Adults, College, and Cardiovascular Disease Risk

Given the association of healthy lifestyles with lower risk factor burden in CVD prevention, it is important to study populations whose lifestyles place them at risk for CVD. Emerging adulthood is a distinct period of development among those 18-25 years of age⁹ when behaviors that threaten health may develop and

extend into later adulthood.¹⁰ Emerging adults are distinct because they are beyond the period of dependency in adolescence but have not taken on full responsibilities of adulthood.¹⁰ This population may be at greater risk for developing unhealthy behaviors due to less parental monitoring, growing independence, and financial instability. A growing population of at-risk emerging adults are those attending college. In 2011, 42% of 18-24 year old emerging adults enrolled in college compared to 36% in 2006.¹¹ Many college students develop unhealthy lifestyle behaviors that increase CVD risk including diets low in fruits and vegetables, frequent consumption of fast foods, and physical inactivity.¹²⁻¹⁷

There is growing awareness regarding the importance of addressing CVD in high-risk environments such as rural, Eastern Appalachian Kentucky.¹⁸ Emerging adults in college from rural areas may be at greater risk for CVD compared to those living in urban areas due to poorer socioeconomic conditions and environmental barriers such as limited access to parks and recreation facilities for physical activity. Lower income^{19,20} and lower education^{21,22} are associated with unhealthy behaviors, and living in a socioeconomically disadvantaged environment carries a risk of heart disease independent of individual characteristics and behaviors.²³⁻²⁵ Unhealthy behaviors that develop during emerging adulthood among those living in rural areas may partially contribute to higher rates of CVD observed in older adults in these regions. Attending college is associated with behaviors that increase CVD risk regardless of location; however, college students living in rural areas may be at greater risk.

Determining whether regional differences in CVD risk factors exist among emerging adults in college may lead to developmentally appropriate health-promoting interventions to reduce CVD disparities in rural areas. Healthy behaviors that are initiated during emerging adulthood can translate to the maintenance of optimal cardiovascular health through adulthood.^{5,10}

Numerous investigators have demonstrated that weight gain is common in college students^{14,15,26,27} leading to general²⁸ and abdominal obesity^{29,30} in this population. Many college students also have hypertension.^{25,26} Although general and abdominal obesity are risk factors for hypertension,³¹⁻³³ the relationship between body fat distribution and blood pressure in college students has remained largely unexplored. Further, researchers have yet to establish which simple measure of obesity is the best predictor of blood pressure. A better understanding of the relationship between body fat distribution and blood pressure among college students may assist healthcare professionals identify those at high risk for hypertension so that appropriate risk-reducing interventions can be implemented.

3. Characteristics of Rural Appalachia Kentucky

Kentucky is part of the Appalachian region, which spans 13 states from northern Mississippi to southern New York and encompasses 205,000 square miles (Figure 1.).³⁴ Appalachia's geographic boundaries were defined by a 1965 act of Congress that also established the Appalachian Regional Commission (ARC).

Of Kentucky's 54 Appalachian counties, all but four are considered nonmetropolitan or rural.³⁵ Approximately 27% of Kentucky's population reside in Appalachia.³⁶ Appalachian Kentuckians have significantly fewer years of formal education compared to the rest of the nation. More than 26% of Kentucky Appalachians have less than a high school education compared to roughly 14% for both non-Appalachian Kentuckians and the nation. Further, only 13% of Appalachian adults aged 25 years and older have at least a bachelor's degree compared to almost 24% among non-Appalachian Kentuckians and 29% nationally. The median household income among Appalachian Kentuckians is about \$14,500 less than non-Appalachia Kentuckians and almost \$21,000 less than the national median household income. Similarly, poverty rates in Appalachian Kentucky (25.1%) are significantly higher compared to non-Appalachian Kentucky (16.1%) and the nation (14.9%). The majority of Appalachian Kentucky counties are considered "distressed" indicating they rank economically in the bottom 10% of all counties nationwide.³⁷ Living in a distressed Appalachian county is independently associated with developing diabetes,³⁸ and diabetes is diagnosed earlier among people living in distressed counties.³⁹ Given these findings, CVD risk behaviors may also be greater among emerging adults attending college and living in distressed rural Appalachian counties.

4. Cardiovascular Disease in Kentucky

In 2013, Kentucky had the 8th highest rate of CVD mortality at a rate of 299.8 per 100,000 people.⁴⁰ Several health behaviors and factors may be

associated with these high mortality rates. Kentucky currently ranks 9th in adults with obesity at 31.3%,⁴⁰ which is a 10% increase since 2000.⁴¹ Nearly 30% of Kentucky adults are physically inactive, the 5th highest in the nation.⁴⁰ Kentucky also has the highest percent of adult smokers in the nation at 28.3%. Kentucky ranks 5th worst nationally in percentage of adults with hypertension with approximately 39% affected.⁴¹

Significant regional differences exist in cardiovascular mortality in Kentucky. Age-adjusted cardiovascular death rates are much higher in rural, Eastern Appalachian Kentucky compared to more urban, central Kentucky.⁴² Several CVD risk factors including obesity, physical inactivity, depression, and anxiety are also higher among adults in the rural Eastern Appalachian region of the state.⁴³ Regional differences in risk factors may be even greater among emerging adults in college due to environmental influences and changes in behaviors that occur during this period. However, researchers have yet to examine if there are regional differences in CVD risk factors in this population. Identifying risk factors that are greater among emerging adults in college living in rural Appalachia Kentucky will assist researchers in developing targeted interventions to reduce the high burden of CVD in this region.

5. Purpose of Dissertation

The purpose of this dissertation was to examine factors associated with CVD risk among emerging adults in college. In each of the three studies, a different facet of cardiovascular risk was examined. First, a qualitative research study was conducted to examine perceptions associated with cardiovascular risk

among men in college. Second, a cross-sectional study was conducted to compare differences in CVD risk behaviors and obesity between emerging adults in college living in rural, Eastern Appalachian Kentucky and urban Fayette County, Kentucky. Third, a cross-sectional study was conducted to compare measures of general and abdominal obesity in predicting blood pressure among emerging adults in college.

6. Summary of Subsequent Chapters

Chapter Two is a report of a qualitative descriptive study to examine perceptions related to CVD risk among emerging adult males in college. Among emerging adults, the prevalence of CVD and many risk behaviors are higher among men than women. Despite emerging adults having knowledge of CVD risk, many do not engage in healthy behaviors, even if they are at high risk for CVD. Prior qualitative researchers explored college students' perceptions of general health and weight-related behaviors, but did not include perceptions specific to CVD risk among men in college. To address this gap, 10 male college students who were free of CVD and were not enrolled in a health major were recruited. Data were obtained from audio-recorded interviews that took place at mutually agreed upon college locations. ATLAS ti (v5) was used to manage the data, and content analysis was used for data analysis. A key finding of this study was the influence of environment on CVD risk behaviors discussed by college men. This led to the hypothesis tested in the study reported in Chapter Three that students living in rural, Eastern Appalachian Kentucky would have more CVD risk behaviors and obesity than those in urban, Fayette County, Kentucky.

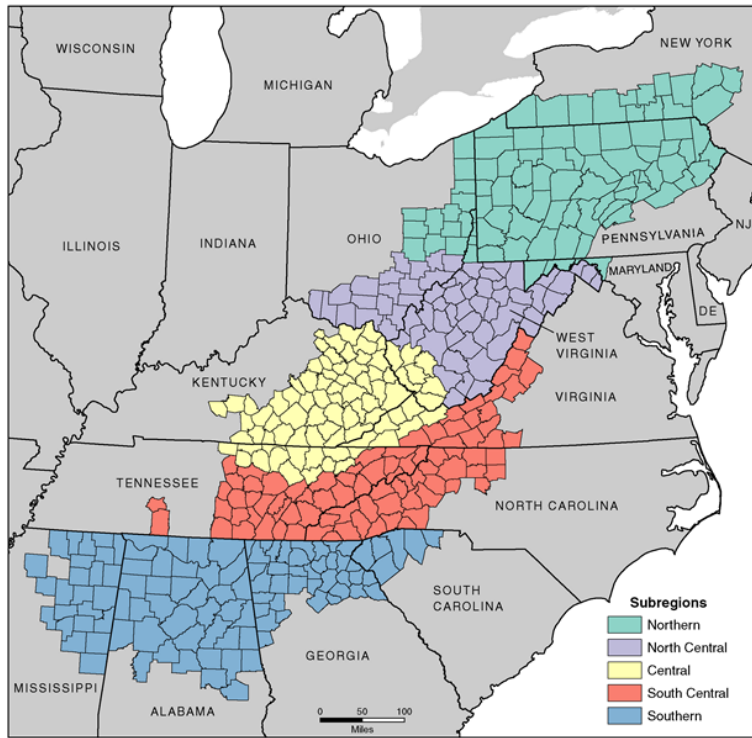
This is the first study to compare differences in CVD risk behaviors and obesity between emerging adults in college from rural, Eastern Appalachian Kentucky (n = 61) and urban Fayette County, Kentucky (n = 57). Students were eligible if they were (a) currently enrolled in college, (b) ages 18-25 years (c) were lifetime residents of Perry and surrounding counties or Fayette County, (d) free of CVD, and (e) not pregnant. Self-administered questionnaires were used to collect data on physical activity, fruit and vegetable intake, frequency of fast food consumption, and smoking. A brief health examination was conducted to obtain height and weight, which were used to determine obesity and to obtain abdominal obesity. The high prevalence of general and abdominal obesity found in this study led to the study reported in Chapter Four to compare measures of general vs. abdominal obesity in predicting blood pressure in emerging adults in college.

Chapter Four is a report of the comparison of the ability of measures of general vs. abdominal obesity to predict blood pressure in emerging adults in college using data collected in the study described in Chapter Three. Researchers have not established which measure of body fat distribution, general or abdominal, is the strongest independent predictor of blood pressure in this population. Self-administered questionnaires were used to collect data on sociodemographics, behavioral characteristics, depressive symptoms, anxiety, and parental history of hypertension. A brief health exam was conducted to obtain measures of general obesity, abdominal obesity, and blood pressure.

Multivariable linear regressions were conducted to determine which measure of obesity was most predictive of blood pressure among emerging adults in college.

Chapter Five is a discussion of CVD risk among college students that synthesizes data from the three studies in this dissertation to address gaps in the literature and provide direction for future research and practice regarding the cardiovascular health of this population. Special emphasis is placed on interventions to reduce CVD risk, particularly in college students who live in high-risk areas such as rural Appalachian Kentucky.

Figure 1. Map of the Appalachian Region



CHAPTER TWO:

Perceptions Related to Cardiovascular Disease Risk in Emerging Adult

College Males

1. Introduction

Cardiovascular disease (CVD) affects nearly 84 million adults in the United States and approximately half of those are under 60 years of age.¹ Investigators suggest that the lifetime risk for developing CVD is higher among men than women² across most age groups.³ Because subclinical atherosclerosis begins early in adulthood,⁴ factors that are associated with greater cardiovascular risk among young men should be identified so that appropriate risk-reducing interventions can be developed. Emerging adult males, those 18-25 years of age,⁵ may be particularly at risk for engaging in CVD risk behaviors due to greater independence, less parental monitoring, and financial instability. Cardiovascular risk factors established during adolescence and emerging adulthood have been shown to extend into later adulthood,⁶⁻⁸ increasing the risk for CVD.

An important time to examine factors associated with CVD risk among emerging adult men is during the college years. College students engage in several high risk behaviors associated with CVD development including cigarette smoking, alcohol abuse, physical inactivity, and low fruit and vegetable consumption.⁹⁻¹² Weight gain is also common among college students¹³⁻¹⁶ with the frequency and magnitude of weight gain greater among men than women.^{17,18} Men in college also consume fast food more frequently than

females,^{19,20} which may explain greater weight gain among men. Students also perceive that it is acceptable to engage in unhealthy behaviors during their college years,⁹ which may be a barrier to incorporating CVD preventive behaviors. Because CVD risk behaviors such as physical inactivity, obesity, and smoking increase during the transition from adolescence to emerging adulthood,²¹ it is critical to have a greater understanding of perceptions related to CVD risk among emerging adults in college.

Emerging adults may perceive they are at low risk for developing CVD and may lack awareness of risk factors for future CVD. Vanhecke and colleagues reported that nearly 17% of college students in their sample perceived CVD as their greatest lifetime risk.²² Participants in the Coronary Artery Risk Development in Young Adults (CARDIA) study generally lacked knowledge about CVD risk factors.²³ However, changes in CVD risk factors after 10 years of follow-up were similar in those with the most knowledge compared to those with the least knowledge. Researchers have also found that emerging adults, including those with an established cardiovascular risk factor, do not make improvements in health-risk behaviors when family members experience a heart attack or stroke.²⁴ These data suggest that emerging adults may not make lifestyle changes to reduce future risk of CVD despite their knowledge and awareness of CVD risk factors.

Qualitative studies are needed to understand perceptions related to CVD risk among emerging adult males in college so that appropriate risk-reducing interventions can be implemented. Among community college students, Boyd

and colleagues found that perceived invincibility to illness was a barrier towards healthy eating and exercise.²⁵ This may help explain why emerging adults don't make healthy lifestyle changes despite having knowledge of and risk factors for CVD. African American males in college perceive stress is the most important factor associated with hypertension, and relatives and close friends were perceived as having the strongest influence on healthy behaviors.²⁶ Additional qualitative studies exploring perceptions related to cardiovascular risk among emerging adult males in college may offer additional insight regarding factors that influence CVD risk behaviors. Therefore, the purpose of this study was to explore male college students' perceptions related to CVD risk.

2. Methods

2.1. Design

A qualitative descriptive design was used to understand male college students' perceptions related to CVD risk. A qualitative descriptive study is most appropriate when descriptions of phenomena are wanted.²⁷ Qualitative descriptive studies produce findings that are closer to the data as provided by participants.²⁸

2.2. Participants

Purposive and snowball sampling were used to select 10 participants for this study. Inclusion criteria included the ability to speak English, Caucasian, male, ages 18-25 years, self-described as in good health, and a current undergraduate student. Exclusion criteria were being enrolled in a health-related major or having a cardiovascular-related medical diagnosis. Students enrolled in

a health-related major or having a cardiovascular condition may have different perceptions regarding cardiovascular risk and may engage in health promoting behaviors due to their education or disease management.

Participants were initially recruited with the assistance from a graduate research assistant who had a close relationship with a key informant in the desired population. The key informant approached members of the general college population whom he thought would be appropriate to interview and who met eligibility criteria. Those who were interested in participating in the study contacted the principal investigator ([PI], DAA) for additional information. The PI and student scheduled a date, time, and location to conduct the interview after determining eligibility criteria were met and the student confirmed his desire to participate.

2.3. Data Collection

Institutional Review Board approval was obtained prior to conducting the study. All participants provided signed informed consent prior to the interviews. Each participant was interviewed individually and completed a short demographic questionnaire prior to the interview. The PI conducted all interviews, which were semi-structured and followed an interview guide. Examples of questions included “Tell me about what the risk for cardiovascular disease mean to you,” “Discuss your risks for future cardiovascular disease,” and “What influence does your healthcare provider have on your perceived risks for cardiovascular disease?”

The interviews were conducted in a quiet, private setting that was mutually agreed upon between the participant and PI. Each interview lasted

approximately 30-45 minutes. Each participant received \$10 for completing the interview. All interviews were audio recorded and later transcribed verbatim by the PI.

2.4. Data Analysis

Content analysis was used to analyze the data.²⁷ Data analysis was ongoing beginning at the start of the study. Data saturation was achieved by the 10th interview. The PI independently transcribed, coded, and analyzed the data.

The analysis process began by comparing the audio-recorded interviews to the transcriptions to correct any transcription errors and to assure accuracy. The data were managed, coded, and analyzed using Atlas. Ti 5.0 (Berlin, Germany). After the data were coded, similar codes were combined in a data display to facilitate the emergence of categories and themes. A list of *a priori* codes was generated prior to analyzing the data. Examples included physical activity, stress, and smoking. Additional codes emerged during data analysis. Examples included habits, inconvenience, and time constraints. Data displays depicting the frequencies of the codes were created to guide the reduction of the coded data into broader categories. This process resulted in a description of perceived factors related to cardiovascular health as provided by the participants.

2.5. Rigor

We used two strategies recommended by Creswell²⁹ to enhance the rigor of our study. Credibility of our findings was confirmed by performing member checks with three of the participants. The PI contacted these participants and provided a brief overview containing themes and subthemes from the data. The

PI asked the participants whether the themes and subthemes accurately reflected their perceptions as provided during the interview; each participant confirmed the findings. We acknowledged researcher bias prior to the initiation of the study by writing down assumptions, prejudices, and biases about perceptions we expected to hear from the students.

3. Results

Two themes emerged from the analysis: (a) barriers to implementing healthy lifestyle choices and (b) perceptions about modifiable and non-modifiable CVD risk factors. Several subthemes within each theme were apparent. The direct quotes that are listed in each section reflect the men's statements regarding various themes and subthemes.

3.1. Barriers to Implementing Healthy Lifestyle Choices

3.1.1. Unhealthy food options outnumber healthy ones.

According to the participants, healthy food options were available on campus. However, these healthy options were overshadowed by availability of a greater number of unhealthy ones. One participant stated:

"I've gained some weight since coming to college. I think that there is a more of a lack of accessibility to those sorts of things [healthy foods]. Maybe not necessarily a lack, but an excess of the things that aren't so good for you. Kind of harder to choose the healthier stuff with all the poor stuff."

Six participants also discussed the all-you-can eat buffet style dining on campus. These participants spoke about how this type of dining promoted

unhealthy eating because they wanted to get the most food for their money. They also discussed how students overeat and choose unhealthy options in this setting. One participant noted:

“On Saturdays we’d get up after a long night and go and spend an hour there and just eat and eat and eat. You kind of...My roommate and I would go throughout the day and almost fast....cause when you ate at Dining Area A...probably isn’t good...but we’d gorge ourselves. So it’s kind of...It’s there there’s so much to eat you can...so you just do it.”

Another participant stated:

“If you go to Dining Area A or Dining Area B it’s all you can eat buffet for a [single charge to a prepaid card]. I tend to think that people overeat and make poor health decisions when you’re in that setting.”

3.1.2. Time constraints.

Time constraints were considered a major barrier to living a healthy lifestyle. Participants discussed having various responsibilities while being a college student such as classes, course work, employment, and social commitments. Participants often felt it was difficult to engage in healthy behaviors while having to manage their other responsibilities. One participant noted:

“For me personally, I’m involved with my church and that takes up some time...and I’m involved with the campus ministry which takes up some time. Obviously school work taking 19 hours each semester...and um...homework and papers...and the social life...uh...trying to balance all

of that you have to cut some stuff out...I probably made a poor choice to cut exercise out.”

3.1.3. Convenience.

Participants indicated that lack of convenience was a barrier to engaging in healthy behaviors. Those who lived on campus discussed the challenges of using the recreational facility due to distance to the facility and limited parking nearby. They felt that having smaller exercise areas in each dorm would facilitate being more active. Participants who lived off-campus in housing with an exercise facility felt that they would be less likely to exercise if an exercise facility was less available.

Participants’ diets were also influenced by convenience. Those who lived on campus indicated they would most often eat at the campus dining area closest to their dorm. For some participants, however, the most convenient dining area was perceived as having unhealthy food options. Although other campus dining facilities offered healthier food options, the convenience of dining close to their dorm was a stronger factor influencing the students’ dining location. One participant explained:

“You live in Dorm A, Dining Area A is right there...so convenient...the easiest thing to do so why not do it...as opposed to walking to Dining Area B. South campus you have Dining Area C and...which...is buffet and you can’t eat healthy there.”

Participants living off-campus also described how convenience influenced their dietary habits, particularly the time required for meal preparation. When asked about the types of foods he prepared, one participant stated:

“Well...let’s see...usually macaroni and cheese and ramen noodles. They are easy to make and filling I guess. Frozen pizzas, hotdogs and hamburgers...sandwiches. A lot of sandwiches and stuff like that.”

Another participant stated:

“...I’d love to go have a healthy meal but it would cost me \$10 for all the vegetables...cut them up would take an hour. I can heat this up and be done in 10 minutes.”

3.1.4. Social influences.

Various social influences were perceived as barriers to engaging in behaviors associated with optimal cardiovascular health. For example, participants discussed social pressure for men to focus on “getting bigger” through strength training rather than emphasizing aerobic activity for cardiovascular health. One participant stated:

“You feel everyone else is expecting out of you...eat meat, exercise hard, and get big. No one is whispering much about, you got to make sure your heart is alright, you know?”

Another participant stated:

“...a lot of guys are lifting weights to build muscle mass. A lot of guys probably struggle with some body image things too.”

Participants also discussed how peer influences promoted unhealthy behavior. One participant also described how his food intake was influenced by those with whom he dined:

“Everyone was eating a lot...and...uh...so...you really didn’t think there was anything wrong with it. Everyone around you goes up for three plates of food so why not you?”

3.1.5. Threats to health must be perceived as immediate before action is taken.

One of the biggest barriers to engaging in healthy lifestyle behaviors was choosing not to think about long-term behavioral consequences with respect to CVD. Participants felt that if a threat to health was not immediate, they would not address it. They also felt the risk of CVD did not feel immediate because similar-aged peers did not experience these events. For example, one participant stated:

“I guess you don’t really hear about young men having heart attacks and going to the hospital. You just deal with older people...we don’t think about it. When you get older your co-workers and your parents and other people you know start having problems and you start to think about it.”

Participants felt that healthcare providers should express a sense of urgency when encouraging CVD risk reducing behaviors. If a healthcare provider emphasized how current behaviors would lead to CVD in the future, participants would initially consider the recommendation, but ultimately not change. However, if the healthcare provider emphasized how the behavior could immediately

contribute to CVD the recommendation would be more meaningful and the behavior change more likely to be sustained. One participant remarked:

“It’s one of those things that if a doctor tells you then he has to imply the immediate risks to me. You know he’d basically have to lie to me and say you have to do it now...it’s going to be a problem now...to get me to actually do anything...they would have to see the immediate risks before they will do anything...or else they’d say ‘well...I’ll fix it later.’”

3.2. Perceptions about Modifiable and Non-Modifiable CVD Risk Factors

Participants discussed the importance of behavioral factors in preventing CVD, particularly being physically active and eating healthy. They indicated these behaviors were vital to promote and maintain good cardiovascular health.

However, they indicated they did not always engage in these healthy behaviors.

3.2.1. Diet and physical activity.

Participants spoke about the importance of diet and physical activity and described their own behaviors to promote cardiovascular health. Two participants echoed:

“Just try to stay away from fast food as much as possible. And making time for meals. Try to eat three meals...three healthy meals a day. Um...eat fruits and vegetables...stuff like that.”

“I like to get out on my bike...you know I feel like I accomplished something if I come home and I’m out of breath and sweating...I feel like I’ve done work and I feel like my body will thank me for that.”

Although the participants suggested that being physically active was important for good cardiovascular health, they spoke about how their activity consisted mostly of lifting weights instead of aerobic exercises. However, they perceived aerobic activities as more important for heart health. Despite the beneficial perception of aerobic activity, most participants stated they neglected aerobic activities.

3.2.2. Lifestyles of men increase risk.

Participants perceived that the lifestyles of men including fast food consumption and neglecting aerobic activity increased the risk for CVD. Participants perceived that men are less likely to prepare their own meals, be less conscious of the foods they eat, and less likely to engage in aerobic activity.

One participant stated:

“I think most girls will eat better than guys will. You know guys will get burgers and a pizza or something like that. Girls won’t exactly eat like that...they’ll eat smaller meals for the most part...They’ll get the vegetable wrap or whatever and we’ll be like I’ll get this or whatever because it’s easier to get or tastes better. So I think men are the higher risk.”

Another participant stated:

“...you see a lot more women at the gym...their risk might be less than men because they put so more attention on their health.”

3.2.3. Family history perceived as an important risk factor.

Participants perceived family history was an important factor related to their cardiovascular health. Participants felt if someone in their family had CVD,

they would have a greater risk for a similar problem in the future. However, they also indicated family history was not the sole factor influencing cardiovascular health. According to participants, lifestyle choices would determine the extent to which family history would affect the development of CVD. As one participant stated:

“Some people are predetermined...more likely to have a certain disease or a certain condition...but um...I think I could also say that most people with work could overcome that partially at least...I mean most of the time.”

Participants felt if their risk was greater due to a positive family history of CVD, they could overcome this risk by making healthier dietary choices and engaging in physical activity. Overall, these participants felt in control over whether or not they would develop CVD.

4. Discussion

We explored perceptions related to CVD risk in emerging adult males in college. Understanding perceptions related to CVD risk is critical to promoting cardiovascular health behaviors in this population. College students generally have a diet low in fruits and vegetables,^{13,30} consume fast food frequently,¹⁹ and many do not exercise regularly.¹⁷ Our study provides valuable insight on how emerging adult males in college perceive factors that are associated with these behaviors.

Participants perceived several barriers to consuming healthy foods while being in college: abundance of unhealthy foods on campus, time constraints, convenience, and social influences. These findings are consistent with other

qualitative studies exploring perceptions related to health behaviors among college students.^{9,31,32} In our study, lack of healthy food choices was not perceived as a barrier to healthy eating on campus suggesting that other factors are associated with healthy dietary habits in this population. College students have previously reported lacking the motivation to choose healthy food options even when they are available,²⁵ and data suggest that other factors such as cost, convenience, and taste are important factors influencing food choice³³—especially fast food.^{10,20} Despite having access to healthy foods on campus, our participants reported difficulty choosing healthier options because they were overshadowed by the abundance of unhealthier options. With fixed-price buffet dining, food costs would be the same for healthy and unhealthy options suggesting that factors other than cost and convenience, such as greater access to unhealthy food and taste, may more strongly influence poorer eating habits in this population. Colleges could promote healthier eating habits by reducing the amount of unhealthier food options and increasing the amount of tasty, healthier options.

Buffet-style dining on campus was perceived as a barrier to healthy eating habits. Participants felt overconsumption of unhealthy foods was associated with this type of environment, which is consistent with previous research.³¹ Wengreen and Moncur speculated that the association between eating breakfast and weight gain in their study could be due to all-you-can-eat campus dining.¹⁵ Alliot and colleagues found that healthy, normal-weight men aged 22-33 years consumed approximately 1,433 calories during a buffet-style lunch.³⁴ Kral and others found

that adolescent males consumed 44% and 133% more energy from food and beverages, respectively, during a lunch buffet compared to females.³⁵ Reducing the amount of high-calorie, low-nutrient foods and replacing them with lower calorie, nutrient-dense options may be one strategy to promote healthier eating in buffet-style settings. Colleges could also limit the number of buffet-style dining facilities in order to promote healthier eating and prevent weight gain while students are on campus.

Although data suggest that many college students are physically inactive,¹² physical activity was perceived as an important factor related to cardiovascular health among the participants in our study. However, many college students define health as the absence of disease and being free of psychological and physical problems,⁹ which may be a barrier to engaging in physical activity. Participants in our study also discussed that behavior change would not occur unless there was an immediate health threat. This finding is similar to what others have described in the literature. Davies and colleagues found that men in college are aware of having health needs but do not take action to address them.³⁶ Men in their study stated that they would not receive help unless in extreme physical or emotional pain. Healthcare providers are in a unique position to promote physical activity in this population by focusing on immediate health risks that are associated with sedentary lifestyles. Although healthcare professionals are less frequently consulted for health-related information compared to the Internet, family, and friends, students perceived information is most believable from medical staff and health educators.¹²

Participants in our study indicated that healthcare provider recommendations are valued and may be acted upon if presented in the context of an immediate cardiovascular health need. Participants also reported that time constraints and convenience were factors that influenced health behaviors such as engaging in physical activity, which is consistent with previous research.³¹ Internet- or email-based programs that emphasize easy ways to incorporate physical activity may be options to encourage physical activity on college campuses. Studies have shown that web-based programs are effective in increasing short-term physical activity,^{37,38} and data from work settings suggest that email-based programs are effective in increasing moderate and vigorous physical activity.³⁹ Programs that have worked in the workplace could be adapted to help college males overcome perceived barriers impacting their ability to engage in physical activity. These programs may be most effective if administered by healthcare professionals or medical educators since they are the most trusted source of health-related information by college students.

4.1. Limitations

Several limitations of this study should be noted. Although data saturation was achieved through 10 interviews, including students from diverse backgrounds may have revealed additional perceptions regarding cardiovascular risk that are racially or culturally specific. For example, previous qualitative research has explored factors related to hypertension among African American college students with findings suggesting that racial stereotypes and prejudice are major stressors in this population.²⁶ While we acknowledge the importance of

exploring perceptions related to CVD risk among ethnic and racial minorities, we did not pursue a diverse sample for this study as the intent was not to compare differences in perceptions across various racial and ethnic backgrounds. We felt that perceptions related to CVD risk would be more consistent in a smaller, more homogenous sample compared to a diverse one. Given that qualitative studies exploring perceptions specific to CVD risk are scarce among college students, future research in other samples is warranted. Another limitation is that the sample consisted primarily of freshmen and sophomores. The perceptions of college students who have had more time to adjust and respond to the college environment may be different from those entering college. The living arrangements of the participants may have also influenced their perceptions related to CVD risk. Brunt and colleagues found that students who live off-campus are more likely to be overweight or obese, consume alcohol, smoke cigarettes, and consume a lower variety of fruits and vegetables than those living on-campus.⁴⁰ Given these behavioral differences, perceptions related to CVD risk might also be different between these two groups of students. These differences should be considered for future studies exploring perceptions of CVD risk in this population.

5. Conclusions

This study provides evidence that emerging adult college males perceive that healthy lifestyle behaviors are crucial for achieving optimal cardiovascular health, but many barriers prohibit their ability and desire to engage in these behaviors. Future research and health promotion efforts should address barriers

to eating healthy and engaging in aerobic activity on college campuses. Efforts should also be directed toward helping students to perceive health issues as immediately concerning to promote engaging in risk-reducing behaviors.

CHAPTER THREE:

Regional Differences in Cardiovascular Disease Risk Factors among Emerging Adults in College

1. Introduction

The Appalachian region of the United States spans 13 states extending from southern New York to northern Alabama. Coronary heart disease mortality in Appalachia is significantly higher in rural compared to urban areas.¹ Rates of cardiovascular disease (CVD) mortality are particularly high in rural, Eastern Appalachian Kentucky.² Several individual sociodemographic and built environmental factors may be associated greater burden of CVD in this area including higher levels of poverty, lower education attainment,³ limited medical care resources,¹ difficulty traveling to grocery stores,⁴ and limited opportunities for engaging in physical activity.⁵⁻⁷ Many CVD risk factors are also prevalent among adults in rural, Eastern Appalachian Kentucky including smoking,⁸ physical inactivity,⁹ low fruit and vegetable consumption,⁹ and obesity.¹⁰

Broader neighborhood factors may also influence CVD behaviors and outcomes. Neighborhood poverty is associated with remaining obese during the transition from adolescence to young adulthood,¹¹ and living in a disadvantaged neighborhood is associated with a greater likelihood of developing coronary heart disease independent of individual-level factors.¹² Barker and colleagues found that living in distressed Appalachian counties was independently associated with a greater likelihood of developing diabetes¹³ and that diabetes is diagnosed

earlier among residents living in these areas.¹⁴ These findings suggest that the environment exerts multiple degrees of influence on CVD risk.

Environmental influences on CVD risk behaviors may be particularly strong in emerging adults. Emerging adulthood is the developmental period between 18-25 years of age¹⁵ during which high risk behaviors can form. Emerging adults are past the period of dependency in adolescence but have not taken on full responsibilities of adulthood.¹⁶ Evidence suggests that unhealthy behaviors worsen as emerging adults transition into adulthood.^{17,18} Emerging adults in college may engage in more unhealthy behaviors because they are less monitored by parents, have greater independence, and are in an environment associated with unhealthy behaviors. Many emerging adults in college do not consume the recommended amount of fruits and vegetables and many are physically inactive.¹⁹⁻²² As students continue through college, their aerobic activity declines¹⁹ and weight gain is common.^{19,21,23,24} Many of these modifiable risk factors significantly contribute to mortality²⁵ and are associated with CVD development.²⁶ Emerging adulthood is therefore a critical developmental period to examine cardiovascular risk factors, particularly among those attending college.

Because unhealthy CVD behaviors and obesity present during emerging adulthood persist into adulthood,^{17,18} the higher burden of CVD observed in rural, Eastern Appalachian Kentucky may be partially due to regional differences in risk factors among emerging adults. Despite the evidence regarding the high prevalence of CVD and risk factors among adults living in rural, Appalachian

Kentucky, no one has compared differences in CVD risk behaviors and obesity between healthy emerging adults in college living in rural, Appalachian Kentucky compared to those living in urban, non-Appalachian Kentucky. Therefore, the purpose of this study was to compare differences in CVD risk behaviors and obesity between emerging adults in college living in rural, Eastern Appalachian Kentucky and urban Fayette County, Kentucky. These two regions have contrasting levels of CVD risk factors and outcomes among older adults and differ widely with respect to economic and environmental factors associated with CVD. It was hypothesized that students living in rural, Eastern Appalachian Kentucky would have higher levels of CVD risk behaviors and obesity than those living in urban Fayette County, Kentucky. A greater understanding of regional differences in CVD risk behaviors and obesity in this population may assist researchers, healthcare providers, public health professionals, policy makers, and the community in developing targeted interventions to reduce CVD risk behaviors that lead to disparities in CVD outcomes.

2. Methods

2.1. Design, Setting, and Sample

A cross-sectional design was used to compare regional differences in CVD risk behaviors and obesity between emerging adults in college living in rural, Eastern Appalachian Kentucky and urban Fayette County, Kentucky. The eight rural, Eastern Appalachian counties where data were collected have some of the highest rates of poverty and unemployment in the nation with approximately 21-36%³ of the populations in poverty and 10-15% unemployed.²⁷

These counties are defined as “distressed” by the Appalachian Regional Commission indicating they rank economically in the bottom 10% of all counties nationwide.²⁸ Residents in these counties also have some of the worst overall health in the state²⁹ with rates of heart disease mortality significantly higher than the national average.³⁰ In contrast, urban Fayette County, Kentucky is among those with the lowest rates of poverty and unemployment in the state.^{3,27} The Kentucky Institute of Medicine ranked Fayette County as 6th best in the state for general health.²⁹

One hundred and eighteen students were recruited from a community college and a four-year institution in urban, central Kentucky and a community college in rural, Eastern Appalachian Kentucky. Students were eligible if they were 18-25 years of age, enrolled in college, and a lifetime resident of either rural, Eastern Appalachian Kentucky or urban Fayette County, Kentucky. Lifetime residency of these counties was a criterion to minimize residential self-selection bias, which suggests that people choose their residence based upon resources supporting their lifestyle preferences.³¹⁻³³ Students with a CVD-related diagnosis were excluded because they might be engaged in healthier lifestyle behaviors as part of their disease management. Pregnant students were excluded because pregnancy impacts measures of general and central obesity.

2.2. Measures

2.2.1. Fruit and Vegetable Consumption

Fruit and vegetable consumption was measured using questions from the Behavioral Risk Factor Surveillance System (BRFSS)³⁴ regarding the frequency

of consuming 100% pure fruit juices, fruit, cooked or canned beans, dark green vegetables, orange-colored vegetables, and other vegetables. The BRFSS questions regarding fruit and vegetable consumption are particularly useful for determining disparities in fruit and vegetable intake.³⁵ Participants had the option to list the daily, weekly, or monthly frequency of consumption of each item during the past 30 days. Fruits and vegetables consumed daily were multiplied by 30 and those consumed weekly were multiplied by four to compute a monthly total. Daily fruit and vegetable intake was calculated by summing the monthly consumption of each item and dividing by 30 days. Fruit and vegetable consumption was defined as the daily frequency of consuming individual fruits and vegetables as well as total fruits and vegetables.

2.2.2. Fast Food Consumption

Frequency of fast food consumption was measured using a behavioral questionnaire that included a question on how many times per month food is consumed at fast food restaurants.

2.2.3. Smoking

Smoking was self-reported from questions asking participants to indicate their smoking status, number of cigarettes smoked per day, and use of smokeless tobacco.

2.2.4. Physical Activity

Physical activity was measured by the International Physical Activity Questionnaire short form (IPAQ-SF), which was designed to be used by adults between the ages of 15-69.³⁶ The IPAQ-SF contains seven questions regarding

the frequency and time spent in vigorous and moderate intensity activity, walking, and sitting. Weekly time spent in vigorous physical activity was calculated by multiplying the self-reported number of days engaged in vigorous physical activity by the self-reported time spent engaged in vigorous physical activity on one of those days. Weekly time spent engaged in moderate physical activity and walking were calculated similarly. Physical inactivity was defined as the number of minutes per day that participants report sitting on an average weekday.

2.2.5. Overweight, Obesity, and Abdominal Obesity

Overweight and obesity were defined according to body mass index (BMI) categories. Participants were defined as underweight, normal weight, overweight, or obese class I-III according to standard BMI cut-points (<18.5, 18.5-24.9, 25-29.9, 30-34.99, 35-39.99, and $\geq 40\text{kg/m}^2$, respectively).³⁷ Body weight was measured using a portable, mechanical digital scale to the nearest 0.1lb and height was measured using a portable stadiometer to the nearest 0.1cm with participants wearing no shoes and light clothing.

Abdominal obesity was defined as waist circumference (WC) >102cm for men and >88cm for women and was measured according to clinical guidelines.³⁸ An anthropometric tape measure was placed in a horizontal plane around the abdomen starting at the upper lateral border of the right iliac crest at the mid axillary line. The tape was snug without compressing the skin. Measurements were taken at the end of normal expiration and to the nearest 0.1cm. Sagittal abdominal diameter (SAD) was obtained using Holtain-Kahn abdominal calipers while the participant was standing with arms folded across the chest. The non-

moveable arm of the caliper was placed at the small of the back and the moveable arm positioned at the umbilicus. The measurement was taken to the nearest 0.1cm at the end of normal expiration. Sagittal abdominal diameter allows for assessment of abdominal tissue because subcutaneous fat, which is typically located along the flanks, is not measured.³⁹ Measuring SAD with participants standing has been shown to be as valid as taking it supine.⁴⁰ There are no established SAD values defining high abdominal obesity.

Participants were placed into one of four CVD disease risk categories based upon BMI and WC as outlined in the National Heart Lung and Blood Institute's (NHLBI) obesity guidelines.³⁷ Increased risk was defined as overweight without abdominal obesity. High risk was defined as overweight with abdominal obesity or class I obese without abdominal obesity. Very high risk was defined as class I obese with abdominal obesity or class II obese regardless abdominal obesity. Extremely high risk was defined as class III obese regardless of abdominal obesity.

2.2.6. Other Variables of Interest

A standard, self-administered sociodemographic questionnaire was used to gather data on age, sex, race/ethnicity, household income, insurance status, having a primary care provider, and living arrangements.

2.3. Procedure

Institutional Review Board approval was obtained at each recruitment site prior to study initiation. Students were predominantly recruited on college campuses using recruitment tables staffed with study personnel. Flyers were also

sent to students at each site by email and were posted at high traffic locations. The Center for Clinical and Translational Sciences at the four-year college site also provided recruitment assistance through a clinical research opportunities database.

Students who were interested and eligible scheduled a meeting with the PI at a mutually agreed upon date and time to review the study, provide written informed consent, complete study questionnaires, and undergo a brief health examination where height, weight, and measures of abdominal obesity were assessed. Students were entered into two separate cash lottery drawings following completion of all study related activities. The “low cash lottery” consisted of 10 prizes of \$25. The “high cash lottery” consisted of 2 prizes of \$250. Due to additional funding received after study initiation, most students were also compensated \$10 for their participation.

2.4. Data Analysis

Sociodemographic characteristics were summarized using means with standard deviations or percentages as appropriate, and groups were compared using independent sample tests and chi-square. Independent sample t-tests, independent samples Mann-Whitney U tests, or chi-square tests of association were used to test the hypothesis that CVD risk behaviors and obesity would be greater in emerging adults living in rural, Eastern Appalachian Kentucky compared to urban Fayette County, Kentucky.

Mean adjusted daily activity was used because some participants provided unusable data on the IPAQ-SF by checking “Not Sure/Don’t Know” for

time spent in vigorous activity (n = 2, urban; n = 1 rural), moderate activity (n = 1 urban; n = 6 rural), walking (n = 3, urban; n = 6 rural), and time spent sitting (n = 5, urban; n = 14 rural). Mean adjusted data were also used for missing data among the rural group on time spent in moderate physical activity (n = 2) and walking (n = 1). The means of each activity according to each geographic area were used for unusable and missing data. Physical activity data from one participant in the rural Appalachian group were excluded from analyses due to providing an implausible value for days engaged in moderate physical activity. Fruit and vegetable data from four participants were excluded due to missing data (n = 1, urban; n = 2, rural) and implausible values (n = 1, rural). Data on frequency of fast food consumption were missing on two participants in the rural Appalachian group, and measures of obesity were unobtainable from one participant in this group.

Independent samples Mann-Whitney U tests were used to compare differences in fruit and vegetable consumption and physical activity due to these variables being non-normally distributed. Levene's test for equality of variances was used when comparing group means using independent sample t-tests. An alpha level of 0.05 was used to determine statistical significance for all analyses. All statistical analyses were performed using SPSS version 22.

3. Findings

3.1. Characteristics of Participants

Table 3.1 shows the characteristics of the sample. The mean age of the sample was approximately 20 years and 56% was female. The majority identified as Caucasian/White. Participants completed approximately 2 years of college with nearly 60% living with family. Fewer students currently had insurance coverage or a primary care provider and more reported lower household incomes compared to when they were growing up. The rural, Eastern Appalachian Kentucky group was approximately one year younger than the urban Fayette County, Kentucky group (referred hereafter to the rural Appalachian and urban groups, respectively) and completed nearly 1.5 more years of school. A greater percentage of the rural Appalachian group was Caucasian/White, lived with family, and reported lower current household incomes compared to those in the urban group. More students in the rural Appalachian group did not currently have medical insurance or a primary care provider.

3.2. Fruit and Vegetable Consumption

Table 3.2 shows differences in fruit and vegetable consumption between the groups. The urban group consumed orange and dark green colored vegetables more frequently compared to the rural Appalachian group. The urban group also consumed cooked or canned beans more frequently. There were no other differences in fruit and vegetable intake between the two groups.

3.3. Frequency of Fast Food Consumption

There were no significant differences between the rural Appalachian (n = 59) and urban (n = 57) groups in monthly frequency of fast food consumption (9.9 ± 8 vs. 7.84 ± 7.04 times per month, respectively, $p=0.145$).

3.4. Smoking

More than triple the number of students in the rural Appalachian group were current or recent smokers compared to those in the urban group (43% vs. 14%, $p=0.001$). One fifth of students in the rural Appalachian group reported using smokeless tobacco compared to no students in the urban group ($p<0.001$). Among current smokers, there were no differences in the average number of cigarettes or cigars smoked per day between the groups.

3.5. Physical Activity

Table 3.3 shows differences in physical activity behaviors between the two groups. The rural Appalachian group spent fewer days engaging in vigorous physical activity and spent fewer minutes engaging in weekly vigorous physical activity compared to the urban group. During the prior week, the rural Appalachian group walked fewer days per week and spent less total time walking per week than the urban group. There were no other group differences in physical activity behaviors.

3.6. Overweight, Obesity, and Abdominal Obesity

Table 3.4 shows differences in general and central obesity between the groups. The rural Appalachian group weighed more, had a higher BMI and SAD, more were obese, and a greater percentage were abdominally obese measured

by WC. More students in the rural Appalachian group had very high or extremely high risk for CVD according to NHLBI obesity risk categories.

4. Discussion

This was the first study to compare CVD risk behaviors and obesity between college students living in rural, Eastern Appalachian versus urban, non-Appalachian Kentucky. Findings from this study suggest that many CVD risk behaviors and obesity are more prevalent among emerging adults in college who are residents of rural, Eastern Appalachian Kentucky.

4.1. Fruit and Vegetable Consumption

An adequate consumption of fruits and vegetables is a key component of healthy eating and CVD prevention.⁴¹ Adults living in rural areas were previously reported to be less likely to consume five or more daily servings of fruits and vegetables compared to those in non-rural areas⁴² and describe access barriers to healthy eating.⁴³ In our study, however, total fruit and vegetable consumption did not differ between the two groups. In a recent Foundation for a Healthy Kentucky health issues poll, 74% of Eastern Kentucky residents perceived it was easy to purchase fruits and vegetables compared to 81% statewide.⁴⁴ Therefore, comparable access to fruits and vegetables may explain why total fruit and vegetable consumption did not differ between the groups. Grocery store access may also play a minimal role in whether emerging adults consume the recommended amounts of fruits and vegetables. Boone-Heinonen and colleagues reported that supermarket and grocery store availability were generally not associated with meeting fruit and vegetable recommendations

among young adults participating in the CARDIA study.⁴⁵ These findings suggest that effective interventions are needed to improve fruit and vegetable intake among emerging adults in college.

4.2. Frequency of Fast Food Consumption

Although researchers have reported that college students frequently consume fast food,⁴⁶⁻⁴⁸ our study was the first to compare frequency of fast food consumption in rural Appalachian versus urban non-Appalachian students. Our finding that the monthly frequency of fast food consumption was comparable between the groups was somewhat surprising given college students have described cost as an important factor influencing fast food consumption,⁴⁷ and more students in the rural Appalachian group reported lower household incomes. This would suggest that factors other than cost were related to fast food consumption. More convenient access to fast food restaurants in urban versus rural areas may be one explanation. However, a definitive explanation will require additional research in which reasons for students' food choices are explored.

4.3. Smoking

Approximately 17% of 18-24 year olds in the United States are current cigarette smokers.⁴⁹ Data from the present study suggest smoking is more prevalent among emerging adults in college living in rural, Eastern Appalachian Kentucky. This is consistent with other data showing that smoking is a significant problem in this region with smoking rates ranging from 28-41% among adults in the rural Appalachian recruitment counties compared to 16% in urban Fayette County⁸ and approximately 18% nationally.⁴⁹ The finding of significantly greater

smoking among the rural Appalachian group may be due to high poverty levels in the region, as smoking rates are generally higher among those living below the poverty level.⁴⁹ Our findings highlight the need for effective smoking cessation interventions among college students living in rural Appalachian Kentucky.

4.4. Physical Activity

Geographic disparities in physical inactivity are noted in Kentucky with rates of physical inactivity among adults being higher in rural, Eastern Appalachian Kentucky compared to the rest of the state. Further, Fayette County has the lowest rate of physical inactivity among all Kentucky counties.⁵⁰ Although data from this study suggest that time spent sitting was similar for both groups, the rural Appalachian group spent less time engaging in vigorous physical activity and walking compared to the urban group. Children and adults from rural Appalachian Kentucky have reported multiple barriers to engaging in physical activity such as poor access to recreation facilities, financial constraints, and time commitments.^{7,51,52} Residents from this region also indicate their environments are less safe compared to adults living in the remainder of the state.⁴⁴ Differences in activity between the two groups might also be due to the characteristics of the college campuses where students were recruited. Students recruited from urban Fayette County attended colleges with larger campuses situated near downtown dining, shopping, and recreation areas that are within walking distance. Those who attended college from rural, Eastern Appalachian Kentucky did not have similar opportunities within walking distance.

4.5. Overweight, Obesity, and Abdominal Obesity

General⁵³ and abdominal obesity⁵⁴ are strong CVD risk factors, and data suggest that obesity rates are high among adult residents of rural, Eastern Appalachian Kentucky.¹⁰ Data from our study suggest that the prevalence of obesity is higher among emerging adults in college from rural, Eastern Appalachian Kentucky compared to those from urban Fayette County. Nearly 20% of students in the rural Appalachian group were classified as class III obese with a BMI greater than 40kg/m². More students in the rural Appalachian group also had abdominal obesity. These findings are somewhat surprising given that there were no differences between the two groups on frequency of monthly fast food consumption, total fruit and vegetable consumption, and amount of time engaged in sedentary activity. However, less time spent in vigorous physical activity and walking may partially explain the significantly higher general and central obesity in the rural Appalachian group. Among younger adults (aged 18-30 years) participating in the CARDIA study, Gordon-Larsen and colleagues found that those who walked more gained less weight over 15 years.⁵⁵ Other unmeasured dietary factors may also have contributed to the obesity differences observed between the groups. Evidence suggests that increases in the frequency of eating and drinking occasions and portion sizes are the largest factors associated with total energy intake.⁵⁶ A more comprehensive dietary assessment in emerging adults from rural Appalachia is needed to understand the mechanisms associated with the greater obesity observed in these areas.

4.6. Limitations

Several limitations to this study should be noted. First, only emerging adults who were attending college were recruited to participate. Differences in CVD risk factors may exist between emerging adults who attend college versus those who do not attend college. Huh and colleagues found that emerging adults who did not attend college, moved out of parents' homes, and obtained employment had a greater risk of increasing cigarette use compared to those who attended college and were either starting a family or being in an uncommitted relationship.⁵⁷ Given these findings, it is possible that other CVD risk factors may differ between students who attend college compared to those who do not attend. Second, full-time versus part-time status was not evaluated in this study, and unhealthy behaviors may differ according to student status. Pelletier and Laska found that part-time college students were more likely than full-time students to purchase food on campus, which was associated with a higher intake of added sugar and fat.⁴⁸ Third, although the fruit and vegetable questions of this study are comparable with large epidemiological studies,^{58,59} they only consider the frequency of consumption rather than serving sizes. Similarly, the assessment of fast-food intake used did not account for the quality or quantity of food consumed at fast food restaurants. A more comprehensive dietary assessment is needed to further our understanding of regional differences in dietary intake among emerging adults in college. Fourth, means-adjusted data were used for the average time spent engaging in vigorous and moderate activity, walking, and sitting when participants responded "Not Sure/Don't Know"

for those questions on the IPAQ-SF. However, the findings remained essentially unchanged when excluding those participants from the analysis (data not shown). More objective measures of physical activity are needed in future studies when examining activity behaviors among emerging adults in college.

5. Conclusions

Emerging adults attending college from rural, Eastern Appalachia Kentucky were at greater risk for CVD due to having more unhealthy behaviors and higher prevalence of obesity compared to students from urban Fayette County, Kentucky. Greater differences in these CVD risk behaviors and obesity may contribute to the higher rates of CVD observed in rural, Eastern Appalachia Kentucky. Interventions to promote healthy lifestyle behaviors are needed in emerging adults in college who are residents of this region.

Table 3.1. Sample Characteristics (n=118)

Variable	Rural Appalachian n = 61	Urban Fayette Co. n = 57	p-value
Age	19.7 ± 1.7	20.8 ± 1.8	0.001
Female	51%	61%	0.270
Caucasian/White	98%	72%	0.001
African American	0%	19%	
Education (yrs)	13.4± 1.1	14.8 ± 1.6	<0.001
Living with family	79%	35%	<0.001
Living with friends	2%	35%	
Living in dormitory	0%	14%	
Had Insurance			
Growing Up	92%	97%	0.281
Currently Has			
Insurance‡	50%	88%	<0.001
Had Primary Care			
Provider Growing Up	90%	91%	0.843
Currently Has Primary			
Care Provider	56%	77%	0.014
Household Income			
Growing Up†			
<\$30,000	60%	12%	
\$30,000-\$60,000	23%	25%	<0.001
>\$60,000	17%	63%	

Table 3.1 (continued)

Current Household

Income‡

<\$30,000	68%	45%	
\$30,000-\$60,000	18%	21%	0.016
>\$60,000	13%	34%	

‡ Rural Appalachian: n = 60; Urban Fayette Co.: n = 56

† Rural Appalachian: n = 60

Table 3.2. Daily Frequency of Fruit and Vegetable Consumption

Variable	Rural Appalachian Mdn (IQR) n = 58	Urban Fayette Co. Mdn (IQR) n = 56	p-value
Cooked or Canned Beans	0.07 (0-0.27)	0.13 (0.04-0.27)	0.019
Dark Green Vegetables	0.13 (0-0.53)	0.4 (0.22-0.67)	0.002
Orange Colored Vegetables	0.07 (0-0.22)	0.15 (0.07-0.27)	<0.001
Other Vegetables	0.4 (0.16-1)	0.42 (0.25-0.98)	0.838
Total Fruit	1.03 (0.39-2.07)	1 (0.53-1.81)	0.721
Total Vegetables	1.23 (0.4-2.25)	1.33 (0.89-1.98)	0.458
Total Fruits and Vegetables	2.52 (1.03-4.9)	2.13 (1.6-3.8)	0.946
Vegetables <2.5 per day	78%	80%	0.717
Fruit <2 per day	69%	77%	0.348

Mdn=Median; IQR=Interquartile range

Table 3.3. Physical Activity

Variable	Rural Appalachian Mdn (IQR) n = 60	Urban Fayette Co. Mdn (IQR) n = 57	p-value
# Days VPA Past Week	0.5 (0-3)	3 (0.5-4)	0.003
Time VPA One Day (min)	15 (0-105)	60 (15-120)	0.070
VPA Week Total (min)	26 (0-300)	180 (22.5-352.2)	0.026
# Days MPA Past Week	2 (0-4)	2 (1-3.25)	0.572
Time MPA One Day (min)	60 (0-120)	30 (15-60)	0.191
MPA Week Total (min)	178.2 (0-360)	90 (25-195)	0.233
Days Walking	3 (2-7)	6 (5-7)	<0.001
Time Walking One Day (min)	60 (10.5-113.9)	45 (30-89.1)	0.659
Weekly Walking (min)	157.5 (30-659.6)	245 (150-567.4)	0.036
Time Sitting Week Day (min)	428.7 (300-480)	360 (255-480)	0.216

Mdn=Median; IQR=Interquartile range; VPA=Vigorous physical activity;
MPA=Moderate physical activity

Table 3.4. Indices of Obesity

Variable	Rural Appalachian n = 60	Urban Fayette Co. n = 57	p-value
Weight (lbs)	180.82 ± 65.25	151.91 ± 28.37	0.002
Body Mass Index (kg/m ²)	28.91 ± 9.51	24.03 ± 3.28	<0.001
Underweight	5%	0%	
Normal Weight	42%	72%	
Overweight	20%	21%	
Class I Obese	7%	7%	<0.001
Class II Obese	8%	0%	
Class III Obese	18%	0%	
Waist Circumference (cm)	90.14 ± 20.58	78.42 ± 9.26	<0.001
High WC	33%	3%	<0.001
Low WC	67%	97%	
NHLBI Disease Risk			
Increased	18%	21%	
High	3%	4%	
Very High	13%	4%	0.002
Extremely High	18%	0%	
Sagittal Abdominal Diameter (cm)	24.08 ± 6.84	19.89 ± 2.97	<0.001

WC=Waist circumference; NHLBI=National Heart Lung and Blood Institute

CHAPTER FOUR:

A Comparison of General versus Abdominal Obesity in Predicting Blood Pressure among College Students

1. Introduction

Hypertension is a major public health concern impacting approximately 78 million adults in the United States¹ and is a significant risk factor for cardiovascular diseases (CVD) including heart disease,^{2,3} stroke,³ and heart failure.⁴ Among those diagnosed with hypertension but no other CVD, nearly 30% are unaware of having the condition.¹

Although the prevalence of hypertension increases with age,¹ it is also common among young adults. Data from 1999-2008 National Health and Nutrition Examination Surveys (NHANES) indicate that 14% of those aged 12-19 years have prehypertension or hypertension.⁵ Other data suggest nearly 7% of young adults aged 18-39 years are diagnosed with hypertension.¹ However, the prevalence of hypertension may be higher due to underdiagnosis among younger adults. In the primary care setting, as many as 44% of those aged 18-25 years who meet hypertension criteria are not being timely diagnosed.⁶ Because hypertension in young adulthood is independently associated with CVD and all-cause mortality later in adulthood,⁷ it is important to determine factors associated with blood pressure among high-risk young adults, such as those attending college, so that appropriate interventions can be developed to reduce hypertension risk.

College students engage in multiple unhealthy behaviors associated with elevated blood pressure. In general, college students have diets low in fruits and vegetables^{8,9} and many are physically inactive.⁸⁻¹⁰ Weight gain is also common among college students,^{11,12} with body fat increasing from their freshman to junior year.¹³ A significant number of college students are overweight or obese¹⁰ and have high levels of abdominal obesity.^{14,15}

In addition to engaging in unhealthy behaviors associated with hypertension, college students also suffer from high levels of psychological distress,^{9,16} which is associated with weight gain.¹² Depressive symptoms and anxiety are also independently associated with hypertension among adults.^{17,18}

Numerous studies have provided evidence that overweight and obesity are risk factors for hypertension in adults,¹⁹⁻²³ adolescents,^{5,24-26} and children.^{24,27,28} Data from the Framingham Heart Study suggest that a 5% weight gain increases the odds of developing hypertension by 20-30%.²⁹ Other data indicate that each one-unit increase in body mass index (BMI), a general measure of obesity, independently increases the risk for incident hypertension by 8%.³⁰

The location of body fat may be an important consideration in the risk of hypertension associated with weight gain. Greater abdominal obesity is associated with pre-hypertension and hypertension in youth,^{31,32} and even a moderate elevation in abdominal obesity is associated with hypertension in adults.³³ Waist circumference (WC) and sagittal abdominal diameter (SAD) are two simple anthropometric measures of abdominal obesity³⁴ that may be better

predictors of risk than BMI. There is some evidence that SAD may be a better predictor of hypertension risk than WC^{35,36} because it minimizes inclusion of subcutaneous fat in assessing abdominal obesity. However, additional studies are needed to determine whether SAD is a better predictor of hypertension risk in young adults.³⁷

Therefore, the purpose of this study was to compare measures of general and abdominal obesity in independently predicting blood pressure in a sample of college students in Kentucky controlling for non-modifiable and modifiable hypertension risk factors.

2. Methods

2.1. Design, Setting, and Sample

A cross-sectional design was used to compare measures of general and abdominal obesity in predicting blood pressure in a convenience sample of 116 college students in Kentucky. Students were recruited from a community college and four-year university in urban, central Kentucky and a community college in rural, Eastern Appalachian Kentucky. Students were eligible if they were 18-25 years of age and enrolled in college. Students with a cardiovascular-related diagnosis including hypertension, hyperlipidemia, and diabetes were excluded because they may have been engaged in healthier lifestyle behaviors for disease management. Pregnant students were excluded because pregnancy impacts measures of abdominal obesity and blood pressure.

2.2. Predictors

2.2.1. Body Mass Index

Participants were defined as underweight, normal weight, overweight, or obese class I-III according to standard BMI cut-points (<18.5, 18.5-24.9, 25-29.9, 30-34.9, 35-39.9, and $\geq 40 \text{kg/m}^2$, respectively).³⁸ Body weight was measured using a portable, mechanical digital scale to the nearest 0.1lb, and height was measured using a portable stadiometer to the nearest 0.1cm with participants wearing no shoes and light clothing.

2.2.2. Waist Circumference

Waist circumference was measured according to procedures outlined in the National Institutes of Health, National Heart, Lung, and Blood Institute's *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*.³⁹ An anthropometric tape measure was placed in a horizontal plane around the abdomen starting at the upper lateral border of the right iliac crest at the mid axillary line. The tape was snug but did not compress the skin. Measurements were taken at the end of normal expiration and to the nearest 0.1cm. Abdominal obesity was defined as having a WC measurement greater than 102cm for men and greater than 88cm for women.³⁸

2.2.3. Sagittal Abdominal Diameter

Sagittal abdominal diameter was obtained using Holtain-Kahn abdominal calipers while the participant was standing with arms folded across the chest. The non-moveable arm of the caliper was placed at the small of the back and the moveable arm moved to the umbilicus. The measurement was taken to the

nearest 0.1cm at the end of normal expiration. Sagittal abdominal diameter allows for assessment of visceral abdominal tissue because subcutaneous fat typically located along the flanks is not measured.⁴⁰ Measuring SAD with participants standing has been shown to be as valid as taking it supine.³⁴

2.3. Covariates

Physical inactivity,⁴¹ fruit and vegetable consumption,⁴² smoking,⁴³ depressive symptoms,⁴⁴ anxiety,⁴⁵ and parental history of hypertension⁴⁶ were included as covariates because of their association with elevated blood pressure.

2.3.1. Physical Inactivity

Physical inactivity was measured by the International Physical Activity Questionnaire short form (IPAQ-SF). This questionnaire was designed for adults between the ages of 15-69⁴⁷ and contains seven questions regarding the frequency and time spent in vigorous intensity activity, moderate intensity activity, walking, and sitting. For this study, physical inactivity was defined as the number of self-reported minutes participants sat on a typical weekday.

2.3.2. Fruit and Vegetable Consumption

Fruit and vegetable intake was measured using questions on a behavioral questionnaire from the Behavioral Risk Factor Surveillance System (BRFSS)⁴⁸ regarding the consumption of 100% pure fruit juices, fruit, cooked or canned beans, dark green vegetables, orange-colored vegetables, and other vegetables. The BRFSS questions regarding fruit and vegetable correlate moderately with food-frequency questionnaires and 24-hour recalls.⁴⁹ Participants were given the option to list the frequency of consuming each item on either a daily, weekly, or

monthly basis during the past 30 days. Fruits and vegetables consumed daily were multiplied by 30 and those consumed weekly by 4 to calculate a monthly total. Daily total fruit and vegetable intake was calculated by summing the monthly consumption of each item and dividing the total by 30 days.

2.3.3. Smoking

Smoking was measured by self-report of smoking status. Smoking status was dichotomized to never/former smoker and current/recent smoker. Participants who had not smoked in over a year were deemed former smokers, and those who smoked within the past year were recent smokers.

2.3.4. Depressive Symptoms

Depressive symptoms were measured using the nine item Patient Health Questionnaire (PHQ-9) that assessed the frequency of depressive symptoms over the past two weeks ranging from 0 (not at all) to 3 (nearly every day).⁵⁰ Scores on the PHQ-9 range from 0-27. A score of 5-9 represents minimal symptoms; 10-14 mild; 15-19 moderately severe; and ≥ 20 severe. Internal consistency reliability has been shown to be high, with Cronbach's alpha ranging from 0.79-0.89 among individuals in primary care.^{50,51} In this study, Cronbach's alpha was 0.69.

2.3.5. Anxiety

Anxiety was measured using the 6-item subscale of the Brief Symptom Inventory (BSI). Each item on the BSI is rated on a 5-point scale of distress ranging from 0 (not at all) to 4 (extremely). Item scores were summed and the mean was calculated with higher scores indicating a higher degree of anxiety.

The BSI anxiety subscale has been shown to have a high internal consistency reliability with a Cronbach's alpha of 0.81 in a sample of outpatient adults.⁵² In this study, the Cronbach's alpha was 0.719.

2.3.6. Parental History of Hypertension

Parental history of hypertension was assessed using a family history of heart disease and diabetes specific questionnaire. Participants were asked to indicate whether their biological mother or father had been diagnosed with hypertension. For this analysis, three categories of parental history of hypertension were created. A positive family history of hypertension was defined as either a maternal or paternal history of hypertension. A negative parental history of hypertension was defined as neither parent having hypertension. Parental history of hypertension among the eight participants who were adopted or unaware of their family history was defined as unknown.

2.4. Blood Pressure

Blood pressure was measured in the participant's right arm (supported at the heart level) in a quiet setting after the participant had been seated quietly for at least five minutes in a chair and with feet on the floor.⁵³ The auscultatory method of blood pressure measurement was used with an aneroid sphygmomanometer placed over the brachial artery.⁵⁴ Three blood pressure measurements were obtained, each after one minute of the previous reading. The average of the three readings was used for data analysis. Blood pressures consistent with hypertension were defined as systolic blood pressure (SBP) ≥ 140 mmHg or a diastolic blood pressure (DBP) ≥ 90 mmHg.⁵⁵

2.5. Other Variables of Interest

A standard self-administered sociodemographic questionnaire was used to gather data on age, sex, race/ethnicity, and current household income.

2.6. Procedure

Institutional Review Board approval was obtained at all study sites. Students were recruited using recruitment tables on college campuses, flyers placed at high-traffic locations, and through email invitation. The Center for Clinical and Translational Science at the primary study site also provided recruitment assistance through a research opportunities database.

Students interested in the study contacted the PI for additional information and to determine eligibility criteria. Those who were interested and eligible met the PI at a mutually agreed upon location to provide written informed consent following an overview of the study's purpose and procedures. After providing written informed consent, students completed self-administered questionnaires and then underwent a brief health examination to obtain measures of obesity and blood pressure.

2.7. Data Analysis

Data from 116 participants were used for this analysis. Because 19 participants provided unusable information on the IPAQ-SF questionnaire (i.e., checking "Not Sure/Don't Know" for time spent sitting), those data were means adjusted according to the geographic location where participants were recruited. Four participants had a missing value on the PHQ-9; total scores for these participants were computed from the remaining completed responses. Means

adjusted fruit and vegetable intake was computed for three participants who provided incomplete data.

Variables were summarized using means with standard deviations or percentages as appropriate. Three separate hierarchal multivariable linear regressions were run for BMI, WC, and SAD as predictors of SBP and DBP due to strong intercorrelations (Pearson's $r \geq 0.94$ among all indices of obesity). In the first step, sex, physical inactivity, fruit and vegetable intake, smoking status, depressive symptoms, anxiety, and parental history of hypertension were entered as covariates. In the second step, BMI was entered as the measure of obesity in the first model, WC was entered in the second model, and SAD was entered in the third model. Given evidence suggesting abdominal obesity predicts hypertension independent of BMI,⁵⁶ four additional hierarchal multivariable linear regressions were conducted including covariates in the first step, BMI in the second step, and each measure of abdominal obesity in separate models in the third step. An alpha level of 0.05 was used to determine statistical significance. Variance inflation factors were examined to determine the presence of multicollinearity. Residual histograms and normal P-P plots were examined to determine normality of residuals. A plot of standardized residuals and predicted values was examined to determine homoscedasticity. Multicollinearity was absent in the first six models in which BMI, WC, and SAD were analyzed separately. In the four models that included measures of general and abdominal obesity together, multicollinearity was present with variance inflation factors greater than 10 for BMI, WC, and SAD. Heteroscedasticity was absent in all models, and

residuals were normally distributed. All statistical analyses were performed using SPSS version 22.

3. Results

3.1. Sample Characteristics

Table 4.1 is the sample characteristics. The average age of the sample was approximately 20 years, 85% were white, and a slight majority was female. More than half the sample lived with family members and approximately one fifth lived with friends. Nearly 60% reported a current household income less than \$30,000, and approximately one-fourth reported an income greater than \$60,000. On average, the sample consumed fruits and vegetables three times per day. Approximately 7 hours was spent being sedentary on a typical weekday. Roughly a fourth of the sample currently or recently smoked. On average, the sample was overweight with more than a third overweight or obese. Nineteen percent of the sample had elevated WC. Although the average blood pressure was normotensive, 14% had hypertension based upon measures taken at a single sitting.

3.2. Predictors of Systolic Blood Pressure

The regression models are summarized in Table 4.2. Being female was predictive of lower SBP in all models, and covariates explained approximately 16% of the variance in SBP. In Model 1, BMI was a significant predictor explaining roughly 22% additional variance in SBP. In Model 2 WC explained an additional 27% of the variance in SBP, while in Model 3 SAD explained an additional 22% of the variance.

3.3. Predictors of Diastolic Blood Pressure

Being female was predictive of lower DBP in Model 1 containing BMI (Table 4.3), and covariates explained nearly 14% of the variance in DBP. Higher anxiety was predictive of lower DBP in all models. In Model 1, BMI was a significant predictor explaining roughly 27% additional variance in DBP. In Models 2 and 3, WC explained an additional 29% of the variance in DBP and SAD explained an additional 28% of the variance.

3.4. Independent Effects of General and Abdominal Obesity on Blood Pressure

Waist circumference, but not SAD, was an independent predictor of SBP and DBP controlling for BMI (Table 4.4). Body mass index did not predict blood pressure independent of WC and SAD.

4. Discussion

Findings from this study suggest that WC as a measure of abdominal obesity is a marginally better predictor of SBP in college students than BMI as a general measure of obesity and SAD as a measure of abdominal obesity. All three measures were comparable predictors of DBP. Findings also suggest that WC predicts blood pressure independently of BMI.

Although there has been interest in determining which simple measure of body fat, BMI or WC, is the best predictor of blood pressure among children and adolescents, few researchers have evaluated these measures in college students. Our findings are in agreement with previous research indicating that

both BMI and WC are positively associated with hypertension among adolescents.^{57,58} However, we found that WC explained approximately 5% more variance in SBP than BMI and thus may be better in identifying risk for hypertension in college students. The usefulness of WC to identify risk for hypertension in this population is supported by Dalleck and Kjelland⁵⁹ who found that WC, but not BMI, was an independent predictor of SBP controlling for physical activity in college students. The lack of an association between BMI and SBP in their study may be due to their sample being normal weight and having less variability in blood pressure compared to our study. Collectively, these findings suggest that WC may be more clinically useful than BMI in identifying college students at risk for hypertension.

In a combined model, WC predicted SBP and DBP independent of BMI. However, BMI did not predict blood pressure independent of WC. This finding differs from others who found associations between BMI and systolic and diastolic blood pressure in children and adolescents independent of WC.^{58,60} Among adults, however, evidence suggests that WC is associated with blood pressure and hypertension independent of BMI.^{61,62} Differences in findings across populations may be due to age-related changes in body composition impacting the ability of WC to predict blood pressure independent of BMI.

Clinical obesity guidelines recommend using both WC and BMI measures to stratify risk for CVD, including hypertension.³⁹ Among people who are normal weight, overweight, and obese, those having a high WC are at greater risk for hypertension compared to those with a low WC.⁶¹ Zhang and colleagues have

demonstrated that grouping children and adolescents according to combinations of WC and BMI increases the ability to identify risk for hypertension compared to using BMI alone.^{63,64} Although this approach is supported in clinical guidelines, it is of limited utility in predicting risk with increasing degrees of obesity.³⁸ Grouping participants according to WC and BMI categories was not feasible in our study due to only one participant being normal weight or overweight and having a high WC. Additionally, Janssen and colleagues found that BMI did not increase the ability to predict health risk independent of WC when both were analyzed continuously and concluded that health risks for a given WC are similar regardless of BMI.⁶⁵ Future research is needed to determine how creating risk categories by combining WC and BMI performs in predicting blood pressure among high-risk young adults such as college students.

Evidence suggests that visceral abdominal fat, rather than subcutaneous abdominal fat, is the component of abdominal obesity associated with hypertension.⁶⁶ When taken in the supine position, SAD may be a better measure of visceral abdominal fat than WC because subcutaneous fat drifts to the sides and is not measured.³⁵ However, Clasey and colleagues demonstrated that measuring SAD in the standing position is more strongly associated with visceral abdominal fat than the supine position.³⁴ Our findings, however, suggest that WC was a stronger independent predictor of SBP than SAD in college students. Previous research has provided mixed results regarding associations among WC, SAD, and blood pressure with some evidence suggesting that SAD is slightly more correlated with blood pressure than WC in adults.^{35,37} Other

evidence, however, suggests that WC is more highly correlated with blood pressure compared to SAD.⁶² In our study, WC may have been a better predictor of SBP than SAD due to gender differences in the correlation between anthropometric and CT measures of visceral abdominal fat. Evidence suggests that SAD is more strongly correlated with visceral abdominal fat than WC in women but not men.³⁴ Furthermore, because blood pressure is generally higher among younger men than women,^{46,67} our finding that WC was a better predictor of SBP than SAD may be due to gender differences in measuring visceral abdominal obesity using simple anthropometric techniques and blood pressure. Given these findings, the more familiar WC may remain a more clinically appropriate measure of abdominal obesity for evaluating younger adults at risk for elevated blood pressure. However, additional research regarding the use of SAD in assessing cardiovascular risk in younger populations is needed.³⁷

4.1. Limitations

Several limitations to this study should be noted. First, this was a cross-sectional study limiting our ability to draw temporal or causal inferences regarding the relationship between measures of obesity and blood pressure. Second, our findings are not generalizable to minority populations due to 85% of our sample being White. Future research should include diverse populations to further understand the relationship between body fat distribution and blood pressure among emerging adults in college. Third, the small sample size may have limited our ability to detect independent associations between obesity

measures and blood pressure in models where BMI and measures of abdominal obesity were analyzed together.

5. Conclusions

Waist circumference was a marginally better predictor of SBP in college students compared to SAD and BMI. Waist circumference was also a predictor of blood pressure independent of BMI. These findings suggest that the easily obtainable WC, as a simple anthropometric measure of abdominal obesity, could be used in evaluating hypertension risk among college students.

Table 4.1. Sample Characteristics (n=116)

Variable	Mean (\pm SD) or Percent*
Age	20.3 \pm 1.8
Sex (Female)	56%
Race	
Caucasian/White	85%
African American/Black	10%
Current Household Income†	
<\$30,000	56%
\$30,000-\$60,000	20%
>\$60,000	24%
Living Arrangements	
With Family	58%
With Spouse	10%
With Friends	18%
College Dormitory	7%
Daily Fruit and Vegetable Intake	3 \pm 2.1
Sedentary Activity (min)	419.9 \pm 221.1
BSI-Anxiety	2.9 \pm 3.9
PHQ-9	5.3 \pm 4.4
Parental History of HTN	
Yes	60%
No	33%
Unknown	7%
Smoking	
Never/Former	72%
Recent/Current	28%

Table 4.1. (continued)

BMI (kg/m ²)	26.5 ± 7.6
Underweight	3%
Normal Weight	57%
Overweight	21%
Class I Obese	6%
Class II Obese	4%
Class III Obese	10%
WC (cm)	84.3 ± 17.1
High WC	19%
SAD	22 ± 5.7
Systolic Blood Pressure (mmHg)	117.8 ± 14.9
Diastolic Blood Pressure (mmHg)	76.5 ± 10.6
Hypertension	14%
Systolic ≥140mmHg	9%
Diastolic ≥90mmHg	10%

BSI=Brief Symptom Inventory; PHQ=Patient Health Questionnaire;
HTN=Hypertension; BMI=Body Mass Index; WC=Waist Circumference;
SAD=Sagittal Abdominal Diameter

*Percentages may not add to 100% due to rounding

† n = 114

Table 4.2. Predictors of Systolic Blood Pressure (n=116)

Variable	Model 1 β	Model 2 β	Model 3 β
Step 1			
Sex	-0.298*	-0.194**	-0.228*
Parental History of HTN	0.057	0.067	0.062
Smoking	-0.069	-0.081	-0.066
Daily FV Intake	0.032	0.038	0.044
Sedentary Activity (min)	-0.101	-0.124	-0.122
Depressive Symptoms	0.036	0.017	0.017
Anxiety	-0.102	-0.103	-0.102
Step 1 Adjusted R ²	0.156	0.156	0.156
Step 2			
BMI	0.496*	-----	-----
WC	-----	0.570*	-----
SAD	-----	-----	0.520*
Step 2 Adjusted R ²	0.379	0.424	0.378
ΔR^2	0.223	0.268	0.222

HTN=Hypertension; BMI=Body Mass Index; WC=Waist Circumference;
SAD=Sagittal Abdominal Diameter

Standardized beta coefficients shown for Step 2

*p<0.01; **p<0.05

Table 4.3. Predictors of Diastolic Blood Pressure (n=116)

Variable	Model 1	Model 2	Model 3
	β	β	β
Step 1			
Sex	-0.214*	-0.111	-0.132
Parental History of HTN	0.093	0.105	0.099
Smoking	-0.085	-0.099	-0.079
Daily FV Intake	0.037	0.045	0.050
Sedentary Activity (min)	-0.053	-0.076	-0.077
Depressive Symptoms	0.051	0.040	0.024
Anxiety	-0.192**	-0.198**	-0.189**
Step 1 Adjusted R ²	0.137	0.137	0.137
Step 2			
BMI	0.542*	-----	-----
WC	-----	0.594*	-----
SAD	-----	-----	0.586*
Step 2 Adjusted R ²	0.405	0.428	0.421
ΔR^2	0.268	0.291	0.284

HTN=Hypertension; FV=Fruits and Vegetables; BMI=Body Mass Index; WC=Waist Circumference; SAD=Sagittal Abdominal Diameter

Standardized beta coefficients shown for Step 2

*p<0.01; **p<0.05

Table 4.4. Predictive Ability of Abdominal Obesity Controlling for Body Mass Index (n=116)

Variable	SBP	SBP	DBP	DBP
	Model 1	Model 2	Model 3	Model 4
	β	β	β	β
Step 1				
Sex	-0.162	-0.261*	-0.119	-0.149
Parental History of HTN	0.072	0.059	0.104	0.097
Smoking	-0.088	-0.066	-0.097	-0.079
Daily FV Intake	0.042	0.037	0.044	0.046
Sedentary Activity (min)	-0.132	-0.112	-0.074	-0.071
Depressive Symptoms	0.020	0.022	0.040	0.026
Anxiety	-0.108	-0.100	-0.196**	-0.188**
Step 1 Adjusted R ²	0.156	0.156	0.137	0.137
Step 2				
BMI	-0.207	0.265	0.052	0.136
Step 2 Adjusted R ²	0.379	0.379	0.405	0.405
Step 2 ΔR^2	0.223	0.223	0.268	0.268
Step 3				
WC	0.777*	-----	0.542**	-----
SAD	-----	0.256	-----	0.450
Step 3 Adjusted R ²	0.422	0.379	0.423	0.417
Step 3 ΔR^2	0.043	0	0.018	0.012

HTN=Hypertension; FV=Fruits and Vegetables; BMI=Body Mass Index; WC=Waist Circumference; SAD=Sagittal Abdominal Diameter; SBP=Systolic Blood Pressure; DBP=Diastolic Blood Pressure

Standardized beta coefficients shown for Step 3

*p<0.01; **p<0.05

CHAPTER FIVE:

Discussion and Conclusions

1. Background and Purpose

The purpose of this dissertation was to examine CVD risk factors in emerging adults in college. This population is gaining independence and establishing CVD risk behaviors that may extend into adulthood. Three data-based manuscripts focused on CVD risk factors in this population were developed: 1) a qualitative descriptive study to examine perceptions related to CVD risk in college males, 2) a comparison of CVD risk behaviors and obesity between emerging adults in college living in rural, Eastern Appalachian Kentucky and urban non-Appalachian Kentucky, and 3) a comparison of general and abdominal obesity in predicting blood pressure in college students.

Cardiovascular disease risk factors in young adulthood are associated with both short and long-term CVD outcomes. Although the 10-year risk for coronary heart disease is less than 10% for nearly all those aged 20-29 years,¹ subclinical atherosclerosis is greater among those with high compared to low lifetime risk for CVD.² Evidence suggests CVD risk behaviors and risk factors present in adolescence and young adulthood often persist with age,³⁻⁵ therefore increasing CVD risk. Given this evidence, it's crucial to study populations at high risk for developing CVD risk behaviors such as college students and residents of rural, Eastern Appalachian Kentucky.

The purpose of this chapter is to synthesize findings from the dissertation and discuss how it advances the state of the science on CVD risk in college

students and those living in rural, Eastern Appalachian Kentucky.

Recommendations for future research and implications for clinical care are also discussed.

2. Summary of Findings

Chapter Two was a qualitative descriptive study examining perceptions related to CVD risk in a sample of 10 college males. Students discussed many environmental barriers to engaging in CVD health-promoting behaviors and emphasized the importance of a healthy diet and physical activity in preventing CVD. Students also emphasized that the absence of an immediate health threat was a barrier to engaging in healthy lifestyle behaviors, and healthcare professionals could promote behavior change by focusing on immediate health consequences of behaviors.

Chapter Three was a cross-sectional study comparing CVD risk behaviors and obesity between 61 college students living in rural, Eastern Appalachian Kentucky and 57 living in urban, non-Appalachian Kentucky. Findings demonstrated that more students from rural, Eastern Appalachian Kentucky smoked, had greater general and abdominal obesity, were less physically active, and consumed orange and green colored vegetables and beans less frequently compared to those from urban, non-Appalachian Kentucky. These findings suggested that students from rural, Eastern Appalachian Kentucky were at higher risk for CVD due to more CVD risk behaviors and greater obesity.

Chapter Four was a comparison of general vs. abdominal obesity in predicting blood pressure in a sample of 116 college students. Although all

measures of general and abdominal obesity predicted blood pressure, waist circumference was the strongest predictor explaining the most variance in systolic blood pressure. Abdominal obesity, measured by waist circumference, also predicted blood pressure independent of general obesity measured by body mass index.

3. Impact of Dissertation on the State of the Science

College students engage in numerous CVD risk behaviors and have other CVD risk factors including hypertension.⁶⁻⁹ The results of this dissertation expand our understanding of CVD risk in college students in the following ways: 1) identified that students perceived the college environment as a barrier to engaging in CVD health-promoting behaviors, 2) identified that the absence of an immediate threat to cardiovascular health was a perceived barrier to engaging in behavior change, 3) demonstrated that many CVD risk behaviors and obesity were more common in students from rural, Eastern Appalachian Kentucky compared to urban, Fayette County, and 4) demonstrated that waist circumference was the best simple anthropometric measure of obesity in predicting blood pressure in college students.

In Chapter Two, students perceived that the college environment was a barrier to engaging in healthy behaviors associated with reduced CVD risk. Although this finding was consistent with previous qualitative studies exploring factors associated with weight-related behaviors in this population, this was the first study in which this finding emerged in the context of perceptions specific to cardiovascular risk. Students also perceived that changing unhealthy behaviors

would not occur unless there was an immediate threat to their cardiovascular health.

The strong emphasis on the perceived importance of environment on cardiovascular risk discovered in Chapter Two led to the development of the study in Chapter Three to examine whether healthy students living in the low socioeconomic, resource-deprived environment of rural, Eastern Appalachian Kentucky had more CVD risk behaviors and obesity compared to students living in more resource-rich urban Fayette County, Kentucky. Because college students ignore long-term consequences of their behavior and many risk factors extend into adulthood,^{3,4} regional differences in CVD risk factors in this population may partially explain the high burden of CVD in rural Appalachian Kentucky. Previous research on the cardiovascular health of people from rural, Eastern Appalachian Kentucky has predominantly included middle and older aged adults or children. This was the first study to compare CVD risk behaviors and obesity among emerging adults in college living in rural Appalachian vs. urban non-Appalachian regions. Findings from this study suggest that many CVD risk behaviors and obesity were greater in college students living in rural Appalachian counties in Kentucky, thus being at higher risk for future CVD than those living in urban Fayette County.

There is growing recognition of abdominal obesity as a CVD risk factor. Although WC has been widely used in research on CVD risk, few studies have used this measure in college students. Sagittal abdominal diameter, another measure of abdominal obesity, has never been used in college students. Chapter

Three of this dissertation therefore advances our understanding of the prevalence and magnitude of abdominal obesity among emerging adults in college by using these two measures of abdominal obesity. Further, although researchers have previously used WC as a measure of abdominal obesity to determine the prevalence of metabolic syndrome among college students, Chapter Four demonstrates the importance of using WC to assess CVD risk due to it being the best simple measure of obesity predicting systolic blood pressure in this population.

4. Recommendations for Clinical Practice and Research

Findings from Chapter Two suggest that healthcare professionals can play a significant role in promoting cardiovascular health behaviors among emerging adults in college by emphasizing immediate consequences of unhealthy behaviors. Data suggest that healthcare providers and health educators are the most trustworthy sources of health-related information for college students.¹⁰ Many students are also interested in receiving information about physical activity and nutrition.¹¹ These findings suggest that, despite high rates of physical inactivity and unhealthy diets, many college students are interested in improving these behaviors, which would reduce CVD risk. Clinicians and health researchers are therefore in a unique position to promote healthy behaviors in this population by focusing on the short-term effects of behaviors on CVD risk.

Emerging adults from rural, Eastern Appalachian Kentucky had significantly greater general and abdominal obesity and more were obese compared to those from urban Fayette County. These results can be used to

emphasize the importance of healthcare providers addressing obesity in rural Appalachia, which is often neglected. Holt and colleagues reported that approximately 70% of physicians discussed diet and physical activity with parents of overweight or obese children, but only 19% indicated they provided resources to promote change.¹² More than 90% of physicians also reported not routinely assessing children's BMI and WC.

In addition to behavioral interventions, changes in the college environment are needed to overcome barriers associated with weight-gain behaviors. Data from numerous studies suggest students perceive that colleges promote unhealthy dietary behaviors due to a greater availability of unhealthy compared to healthy foods.¹³⁻¹⁵ It is critical that college administrators take appropriate action to improve the college environment as part of obesity prevention efforts.

Findings from Chapter Three indicate that the majority of emerging adults in college did not meet recommendations for fruit and vegetable intake and many are physically inactive. Although fruit and vegetable consumption and physical activity are associated with favorable changes in BMI and adiposity among health professions graduate students,¹⁶ facilitating behavior change in college students remains challenging. Future research should build upon existing studies that have attempted to promote behavior change in this population. Several interventions to promote behavior change in college students have been developed and described in the literature. One strategy to promote obesity prevention behaviors is for colleges to offer formal coursework that incorporates desired behavioral changes such as the TIGER study where sedentary students

enrolled in an exercise program that included educational content.¹⁷ However, the adherence rate was 20% for the 30-week study period. Greene and colleagues demonstrated 84% adherence of students in a treatment group completing an online 10-week dietary and physical activity curriculum. Although this curriculum was effective in increasing fruit and vegetable intake and total activity among a large sample of college students at eight institutions, BMI also increased.¹⁸ Future research is needed to determine the most effective interventions to promote behavior change in this population to reduce CVD risk.

The high rates of smoking among emerging adults in college from rural, Eastern Appalachian Kentucky indicate the need for effective, evidence-based smoking cessation interventions to reduce their risk for CVD. Phone-based interventions may be one strategy to promote smoking cessation in this limited-resource area. Whittaker and colleagues pooled results from five studies using phone-based interventions to promote smoking cessation and found this method was effective in achieving long-term smoking abstinence.¹⁹ Changes in the college environment are also needed to successfully achieve smoking cessation. College students participating in focus groups emphasized that social and environmental factors are influential in quitting.²⁰ Therefore, it's critical that colleges promote an environment where smoking cessation can be successful. Future research should consider social and environmental factors when designing and testing smoking cessation interventions.

Emerging adults in college living in rural, Eastern Appalachian Kentucky engaged in more unhealthy behaviors and more were obese than those in urban

Fayette County. Although the built environment of rural Appalachian Kentucky has been well characterized and residents describe barriers to healthy eating and engaging in physical activity,²¹⁻²³ future research is needed to better understand how the environment impacts obesity-related behaviors in emerging adults in college.²⁴ Quantitative data using Geographic Information Systems (GIS) mapping suggest that greater access to fast food restaurants was associated with greater fast food consumption among younger adults with lower incomes; however, grocery store access was unrelated fruit and vegetable intake in this population.²⁵ Additional studies using GIS mapping could provide additional insight on how the built environment influences CVD risk behaviors among emerging adults in college, particularly those in high-risk environments such as those living in rural, Eastern Appalachian Kentucky. A better understanding of how the built environment impacts health behaviors in this population may lead to developmentally appropriate interventions to reduce CVD risk.

5. Limitations

Although this dissertation has filled several important gaps regarding the understanding of CVD risk among emerging adults in college, several limitations should be noted. In Chapter Two, perceptions related to cardiovascular risk were explored in Caucasian emerging adult males in college. Including a larger, more diverse sample could have revealed additional perceptions regarding cardiovascular risk that are unique to certain racial and ethnic minorities. Similarly, the findings from Chapters Three and Four cannot be generalized due to the samples being predominantly Caucasian. In Chapter Three, behaviors of

smoking, physical activity, fruit and vegetable intake, and fast-food consumption were measured using self-report. The validity of the findings reported in this study could have been improved through the use of objective measures of these behaviors. Finally, self-selection bias could have impacted the findings reported in each chapter due to healthier students or those interested in health being more likely to participate in these studies.

6. Summary

This dissertation has demonstrated that emerging adulthood is an important time to examine cardiovascular health because risk factors present during this period often persist further into adulthood. Emerging adults in college are particularly at high risk for developing unhealthy behaviors due to numerous perceived barriers to engaging in health lifestyle behaviors during this period. The studies in this dissertation have demonstrated that emerging adults in college have numerous CVD risk factors, particularly those living in rural, Eastern Appalachian Kentucky. Findings also suggest that abdominal obesity is prevalent among college students and is predictive of blood pressure. Future research to reduce CVD risk through behavior change is needed in this population.

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4. Chapter Four

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5. Chapter Five

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Vita

Demetrius A. Abshire

Education

Institution	Degree	Date Conferred	Field of Study
University of Kentucky	BSN	2006, May	Nursing
University of Kentucky	MSN	2009, May	Nursing

Professional Experience

Dates	Institution and Location	Academic Position
August, 2011-present	University of Kentucky College of Nursing, Lexington, KY	Research Assistant (25%)
July, 2011-present	University of Kentucky College of Nursing, Lexington, KY	Lecturer (50%)
August, 2009 – June, 2011	University of Kentucky College of Nursing, Lexington, KY	Lecturer (75%)
August, 2007 - August, 2009	University of Kentucky College of Nursing, Lexington, KY	Pre-Doctoral Fellow RICH Heart Program
July, 2005 - September, 2005	University of Kentucky College of Nursing, Lexington, KY	Temporary Tech

Dates	Institution and Location	Clinical Position
June, 2006 - June, 2008	Cardinal Hill Rehabilitation Hospital, Stroke Unit, Lexington, KY	Staff Nurse

Dates	Institution and Location	Clinical Position
June, 2006 - July, 2007	University of Kentucky Chandler Medical Center, Neuro-Surgical Intensive Care Unit, Lexington, KY	Staff Nurse

June, 2004 - June, 2006 Cardinal Hill Nurse Extern
Rehabilitation Hospital,
Stroke Unit, Lexington,
KY

Awards and Honors

2014 Featured as an Emerging Leader in the Graduate Nursing Student Academy's February 2014 Bulletin

2013 Semi-finalist for a Tylenol Future Care Scholarship

2013 Secondary recipient of a Student Government Association Graduate Excellence Scholarship

2013 Phi Kappa Phi Love of Learning Award

2013 University of Kentucky College of Nursing Sima Rinku Maiti Memorial Scholarship

2012 Delta Psi Research Award

2012 SAHA Award for Cardiovascular Research and Education: Nursing Student with UK HealthCare Award

2012 Post-Doctoral Grant, European Society of Cardiology Council on Cardiovascular Nursing

2009 Lyman T. Johnson Odyssey Award, Student Government Association

2008 Lyman T. Johnson Academic Fellowship

2007 Lyman T. Johnson Academic Fellowship

2006 Graduated Magna Cum Laude, University of Kentucky

2006 Faculty Award, University of Kentucky College of Nursing

2006 Second place award in Oswald Research and Creativity Program, Category: Biological Sciences

2005 First place award for undergraduate presentation in College of Nursing's Student Scholarship Showcase

2005 SAHA Foundation for Cardiovascular Research and Education Scholarship

Publications (*indicates data-based)

Journal Articles

*Welsh, D., Lennie, T.A., Marcinek, R., Biddle, M.J., **Abshire, D.**, Bentley, B., & Moser, D.K. (2012). Low-sodium diet self-management intervention in heart failure: Pilot study results. *European Journal of Cardiovascular Nursing*. Advance online publication. doi: 10.1177/1474515111435604

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