Stress, Coping, and Disease Awareness with Metabolic Disease Risk: A Longitudinal Cohort Study

Chelsea Anestal
University of Central Florida

STRESS, COPING, AND DISEASE AWARENESS WITH METABOLIC DISEASE RISK: A LONGITUDINAL COHORT STUDY

by

CHELSEA ANESTAL

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Thesis Chair: Keith Brazendale, Ph.D.

ABSTRACT

College students undergo stressors (e.g., potential financial strain, changes in workload or location), which may precipitate metabolic syndrome (MetS) risk associated with obesity and high blood pressure. Concerning rises in young adult obesity and type 2 diabetes, prompt study into MetS risk factor prevalence and awareness in youthful populations transitioning to new environments, such as college. This study assessed perceived stress, coping resources, and disease awareness differences in the first time on campus and final-year students associated with MetS risk factors (elevated body mass index (BMI) and blood pressure). We hypothesized lower stress perception, lower weight gain and blood pressure, higher MetS knowledge, and more positive coping strategies in final-year students. We conducted a longitudinal cohort study of 43 undergraduates with a baseline assessment in September (T0) and a follow-up in December (T1). BMI and blood pressure were measured at each visit and compared to baseline predictors of MetS knowledge, perceived stress, and coping resources. Though trends in MetS knowledge, perceived stress, and coping scores followed those in our hypothesis, only differences in weight and BMI change were statistically significant. The mixed-effects regression analysis did not find any statistically significant trends. First-time on-campus students gained an average of 1.736 kg, and their average BMI increased by 0.485 kg/m^2. Conversely, final year students lost 0.313 kg, and their average BMI decreased by 0.210 kg/m^2. Information on blood pressure was inconclusive. The average increase in weight/BMI in first-time on-campus students compared to final-year students highlights the need to provide education and resources to protect against metabolic syndrome risk in young adults. Trends in final year student clinical outcomes and their predictors illustrate how education may be a protective factor against MetS risk.

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INTRODUCTION

Metabolic syndrome (MetS) is characterized by concurrent obesity, hypertension, hyperglycemia/insulin resistance, and elevated cholesterol or fats (dyslipidemia).[1] Revised definitions of MetS help identify risk factors that may predispose an individual to chronic conditions such as diabetes, cancer, stroke, and coronary heart disease (the leading cause of death in America). The National Institutes of Health guidelines describe how MetS is diagnosed in individuals who have three or more of the following traits: (1) large waist at >=35 inches for women and >=40 inches for men, (2) increased blood pressure at 130/85 mmHg or higher, (3) elevated fasting blood glucose (FBG) at 100 mg/dL or more, and (4) high triglyceride levels (TAGs) at 150 mg/dL or higher and reduced HDL cholesterol at >40 mg/dL in men and > 50 mg/dL in females. [2] These cardiometabolic factors have been closely monitored in the general U.S. population over the years.

In the United States, current statistics indicate that obesity levels in the U.S. adult population remain elevated. Between 2017 – and 2019, the U.S. Centers for Disease Control and Prevention (CDC) reported obesity rates among individuals 18-24 years of age to be 18.9%, which doubles for older adults. Further, the Midwestern (33.9%) and the Southern (33.3%) states had the highest rates of obesity, with a completed college education (e.g., individuals who have completed a four-year degree) being a protective factor against obesity.[3] There has been an apparent steady rise in the rates of obesity in pediatric and adult populations for the past two decades. Likewise, and equally alarming, statistics from the CDC on high blood pressure show that only 24% of U.S. adults have hypertension under control, and 45% have Stage 2 hypertension, >=140/>=90 mmHg.[4] This means three-quarters of the U.S. population face difficulty managing their blood pressure, and almost half are struggling with one of the worst forms of hypertension. In 2017-2018, adults aged 18-44 with hypertension comprised 13.1% of those with hypertension. Those between 45 and 64 years of age made up 46.8% of individuals with hypertension. Individuals with less than a high school diploma represent 12.4% of the hypertensive population. Individuals with high school degrees and some college education represent 62.3% of the hypertensive population. College graduates represent 25.3 % of the hypertensive population.[5] Questions may arise on why those who have or did not complete college have one of the highest percentages of hypertension at 62.3%. A national survey by the National Cholesterol Education Program Adult Treatment Panel III reported that insulin resistance affects about 24% of the adult population older than 20. Of concern, there is a rapid rise in obesity and type 2 diabetes in youthful populations.[6] This may indicate that issues with hyperglycemia start earlier in life and progress into adulthood. The current statistics on dyslipidemia – characterized by abnormal levels of lipids (e.g., high cholesterol and high triglycerides) – in the U.S. adult population indicate elevations. According to the American Heart Association (2020), 38.2% of adults older than 20 had total cholesterol over 200 mg/dL, 11.7% had a total cholesterol >=240 mg/dL, and 19.2% had HDL-C <40 mg/dL.[7] Overall, the cardiometabolic state of the adult U.S. population is an area of great concern.

One population that may display risk factors associated with MetS (e.g., high blood pressure and weight gain) are college students. High hypertension levels are indicated in those without a complete college education, and weight gain is rising in these populations. These MetS risk factors in this population may be linked to stress. A 2020 study illustrated that the prevalence of mild to severe stress in college students is approximately 34.5% of the population.[8]

College students in the U.S. may be at risk due to increased stress from life-changing events, including transitioning from high school to college or transferring from another institution to their current university. According to a 2018 study, college stressors included: (1) social activity changes, (2) working with unfamiliar people, (3) sleeping habit changes, (4) increased class workload, (5) attaining lower than anticipated grades and unfamiliar situations, and (5) changes in their living environment.[9] The stressors of the general college environment (e.g., exams, new living conditions, potential financial hardships, etc.) and likely ineffective or a possible lack of coping skills common in adolescent-to-young adult populations as they learn to navigate new obstacles in the real world may increase their susceptibility to conditions related to MetS.

In the college environment, many students, for the first time, learn to be masters of their own time, schedules, and welfare. Many opt for on-campus or off-campus housing away from their parent's homes, which necessitates them to balance school and other essential obligations such as housing payments, food preparation and purchases, transportation, and overall finances. Typically, "leaving the nest" means newfound autonomy to structure their day-to-day schedule, including bed/wake times, meals, and organizing class schedules through credit hour requirements.

Institutions tend to anticipate the needs of their students and provide opportunities for stress management and coping skills training early on during entering orientations. Large universities provide students with information on counseling services that may be peer-led or faculty-led to help students transition. Small or large university organizations also focus on assisting students in finding a place to belong away from home. Whether students use these resources frequently or quickly recognize them depends on the student population, particularly the institutions' values. Specific colleges within larger universities focus on wellness more than others. For instance, having positive coping strategies and management of overall wellness is crucial to Health Science and related programs. Students from these programs will need to use these strategies to maintain balance and help their future patients or clients in the professional world. A general understanding of wellness seems to be anticipated for students within these majors.

A few studies have explored college students' awareness of MetS and related diseases by comparing majors, college standing, and weight status.[10] In one study, Health Science majors displayed higher knowledge of MetS and associated conditions and ways to manage and prevent it. It was also clear that the typical college student has some basic understanding of many metabolic disorders and ways to manage them. However, knowing about these diseases and how to prevent them does not always translate into behaviors (e.g., activity, diet, sleep) that can reduce MetS risk factors, such as excess weight gain. More importantly, there is a notable gap in the literature of longitudinal studies that assess college students' awareness of MetS and related diseases with their coping strategies and MetS risk during critical times in their academic careers.

Thus, this study examines the association between MetS awareness, perceived stress, and coping resources against MetS risk factor prevalence in college students. Specifically, this study will compare whether this relationship differs between incoming and upper-level students. The findings of this study can help inform future interventions by indicating barriers to behavior change that predispose individuals to MetS.

LITERATURE REVIEW

Overview

Current research has reported associations between early signs of MetS in college students to knowledge of prevention,[10-15] coping resources, [16-18] and stress.[19-23] Experts in health science, nutrition, diabetology, and neuroendocrinology fields cover a wide range of topics about college students' knowledge on MetS, [10-12] MetS prevention mechanisms in young adults or college-age students,[13-15] coping and obesity in college students, [16-18] stress and obesity in college students, [19-23] and the influence that daily *'structure'* may have on weight gain in populations. [24-27] These topics provide insight into college students' health, college students' knowledge of health, and how that relates to risk factors associated with MetS and weight status. However, further research adopting alternate approaches – such as longitudinal research – is needed to establish a degree of temporality. The following sections will examine some of the pertinent literature centered on college students' MetS knowledge, prevention and coping practices, the relationship between stress and obesity, and other conceptual and theoretical models relevant to the research question.

College Students' Knowledge of MetS

Previous research has focused on college students and their knowledge of MetS, specifically, their ability to demonstrate awareness and understanding of factors related to MetS, [10] their level of nutritional knowledge and its relation to eating practices, [11] and their ability to accurately predict the severity of the main cardiometabolic risks (e.g., high blood pressure, obesity, and cardiovascular disease). [12] A cross-sectional study by Yahia et al. assessed students' level of awareness and knowledge relevant to MetS.[10] The sample consisted of 243 students (71.6% female,89% white, Year 1 through Year 5 students). The group collected anthropometric measures on height, weight, waist circumference, percentage of body fat, and visceral fat scores and administered a 90-question survey on MetS knowledge. The average body mass index (BMI) was 24.4 +/- 4.4, percent body fat was 23.9% +/- 8.6, the mean visceral fat score was 2.4 +/- 2.8, and waist circumference (cm) 8.6+/- 11.0. The study found that students were more knowledgeable about atherosclerosis and stroke conditions versus adiposity and cholesterol. Students being more familiar with atherosclerosis and stroke makes sense as stroke (ischemia to brain tissue), and atherosclerosis of coronary arteries are common injuries to the adult population. Other notable findings were that the students majoring in Health Science scored higher on knowledge scores, fifth-year students scored higher than first-year students, and female participants appeared to understand MetS better than male participants. These researchers also found that using family history as a perceived threat may not be practical from a clinical prevention standpoint. Health education may assume basic knowledge about various conditions related to MetS. Strengths of this study included a large sample size, but the investigation still lacked generalizability due to having a predominantly female, affluent, and white population majoring in similar subjects. Further limitations included the cross-sectional nature (i.e., limits temporality) and the self-report nature of some measures, including their demographic responses and covariates, which subjects the study to reporting bias.

Another research question in this same sample of students explored whether increased nutritional knowledge was associated with reduced unhealthy fat consumption.[11] They used an online questionnaire to obtain additional information, including a block dietary fat screener (self-reported intake) and questions related to general nutritional knowledge. The authors reported that female participants had a greater level of nutrition knowledge than male participants, and a higher level of nutritional expertise negatively correlated with fat and cholesterol intake. This study may inform future nutrition education intervention studies aiming to assess the efficacy of nutrition knowledge on fat consumption patterns among college students. Similar to their previous study, this study was limited by the homogenous nature of the sample, limiting generalizability (i.e., mainly female population and individuals already interested in health), the study design (i.e., cross-sectional), and the reliance on self-report measures.

Another cross-sectional study performed by Merianos et al. assessed the perceived severity of the three interrelated cardiometabolic risks; high blood pressure, obesity, and CVD.[12] In this large study of 1,361 college students (64.2% female,69.6% Non-Hispanic White, 4.5% African American, 20.8% Hispanic, and 5.1% Asian/Pacific Islander) completed an internet-based questionnaire self-report BMI, cigarette smoking, and demographics. Approximately 20.4%, 13.3%, and 66.4% of the sample were overweight, obese, and normal weight, respectively. This study demonstrated that the severity perception on average was high for high blood pressure, obesity, and cardiovascular disease. Individuals identified as female and non-smokers reported higher severity perceptions in all three. Individuals identified as Hispanics and Asian/Pacific Islanders compared to Non-Hispanic Whites had an overall lower perceived severity about all three. Overweight and obese students reported higher severity perceptions about obesity only. The investigators concluded that most students recognize weight-related severity but underestimated high blood pressure severity. Minimizing the seriousness of high blood pressure is of particular concern as high blood pressure is known as the "silent killer" in the U.S. adult population, has been rapidly increasing among adults in the U.S., and has begun to spread to the pediatric population, too.[5] Although this study had a large, diverse sample, results must be interpreted with caution as all measures (including anthropometry) were captured via self-report.

Overall, most students are somewhat knowledgeable of conditions relevant to MetS, nutritional knowledge, and severity of cardiometabolic risks. However, they may underestimate the major cardiometabolic risk factors, especially hypertension.

MetS Prevention Mechanisms in Young Adults/College Age Students

Nutrition, diabetes, and neuroendocrine experts have examined college students' MetS prevention mechanisms, such as physical fitness activities,[13] healthy eating behaviors,[14] and the presence or absence of unhealthy weight loss practices.[15] The majority of the studies agree that prevention against MetS involves multifactorial/interdisciplinary interventions incorporating cultural aspects, mental willpower and capacity, knowledge, and reduction of barriers present in the individual's environment.

A cross-sectional study by McEligot et al. examined the associations between physical fitness and behavioral factors with obesity in a multiethnic student population.[13] The sample consisted of 3,906 college students (Females 56.2%, 37.2% Non-Hispanic White, 36.8% Hispanic, 26% Asian). Anthropometry and fitness were measured through manual resting blood pressure measurements, standard height and weight measures, body composition measures through BMI and body fat skinfold tests, flexibility through the sit and reach box test, and muscle strength through a handgrip gyranometer. Participant lung function was measured using a spirometer. Cardiovascular/aerobic fitness was also measured using a stationary cycle and heart rate monitor. Participants total fitness score ranged from 11 at the lowest to 62 at the highest. The results demonstrated that Hispanic participants had higher fat scores than non-Hispanic White and Asian college student participants. Significant differences were in BMI, total fitness, % body fat and relative VO_2 max. Non-Hispanic Whites appeared to have a higher relative VO_2 max than Hispanics and Asians. VO_2 max was significantly inversely associated with obesity, adjusting for gender, age, blood pressure, stress, smoking, and race/ethnicity. The fitness parameters (e.g., flexibility and muscle strength), blood pressure, and stress were positively associated with obesity. Overall, the authors concluded that obesity disparities persist and that physical fitness and stress management interventions should be targeted toward Hispanic and Non-Hispanic White college students to help curb the onset of obesity. Although this study had the strength of a large sample size and several validated measures, it still had limitations. For example, it lacked dietary data, and the sample size was from one university, which may not represent the entire college population. The cross-sectional design of this study does not allow for causal inferences. There is a gap in addressing causality through capturing prevention mechanisms, steps taken by individuals to help manage weight-related factors such as stress, and how this relates to changes in weight. Thus, future studies may adopt a longitudinal approach to provide further information on this relationship.

Research has also incorporated an ecological model of the enablers and barriers to healthy behaviors in the college student population. Another cross-sectional study by Sogari et al. analyzed factors (barriers/enablers) students perceived influenced their healthy eating behaviors.[14] The sample consisted of 35 participants (66% female, 80% white, 11% Asian – excluding South Asian, 6% African American, and 3% South Asian). The average BMI was 23.2 (+/-SD 4.5). Across all groups, reported individual barriers were a sedentary lifestyle, unhealthy food choices, too convenient food, mood and stress, and food prices. Following individual barriers, participants also stated there were barriers at the social level, including parents, friends, and lack of a food culture. The environment (i.e., university dining services) and high-calorie food were the lowest barriers. Reported enablers were mainly individual, including a healthy lifestyle, food knowledge/education, meal planning, food preparation, physical activity, and portion awareness. Individuals discussed environmental enablers to healthy eating, such as dining services. Overall, it seems individual-level factors (conscious or subconscious choice/factors) may be the most vital determinant in enabling or hampering healthy eating behaviors which protect against obesity and other factors in MetS. The authors found that the ecological model applied to university communities provides insight into how and why students make confident food choices and support staying healthy. This sample size was small and not as representative as some of the other cross-sectional studies reviewed. Still, intrinsic factors determine healthy behaviors among a healthy population. It is worth noting that this study may have been subjected to selection bias for students interested in health. Thus, future studies require a more representative sample of college students to explore enablers and barriers deeply.

Other research has assessed unhealthy weight loss practices in college students. Individuals may attempt to prevent excess weight gain because they understand that this may lead to adverse health outcomes or fear judgment for weight or current weight status changes. Even if harmful weight loss practices may prevent obesity and partially MetS, many of these practices involve subjecting one's body to extreme nutrient deficiencies and sometimes subsequent binge episodes. These practices may have long-term effects, such as erosion of esophageal and pharyngeal mucosa in bulimia nervosa [28] or eventual skin and bone appearance for successful anorexic practices, leading to detrimental, and at times permanent, alterations to physical and mental status.

A cross-sectional study orchestrated by Davila et al. discerned whether unhealthy weight-loss practices in college women are associated with overweight or obese status or depression.[15] The sample consisted of 404 college students (70% female, 42% white, 4.2% Black/African American, 25% Asian, 2.7% Pacific Islander, 1.5% American Indian, 31% Hispanic, and 24.8% Other). Individuals in this sample were mostly overweight or obese – 66% overweight and 32.9% obese. The investigators used the Center of Epidemiologic Studies Depression short form to obtain self-reported information on weight loss practices (unhealthy), gender, and depression. 29% reported more than one harmful weight loss behavior in both males and females. These unhealthy weight loss behaviors included fasting and purging over the last 30 days. These behaviors were associated with depression after adjusting for confounders. The authors concluded that both sexes are equally likely to use unhealthy weight loss practices and that depressive symptoms may heighten the risk of adopting these practices. However, due to the study's cross-sectional nature, the authors cannot discern if harmful weight loss practices may lead to depression or if depression can lead to unhealthy weight loss practices. One may establish plausible pathways for both alternatives. For example, chronic negative dietary intake may alter an individual's neuroendocrine processes, moods, and even entire brain chemistry.[29] Individuals who are chronically depressed may also have difficulty caring for themselves, leading to unhealthy eating practices.

Though many of these studies may not fully generalize to the entire college population, many students have somewhat of an understanding of ways to prevent obesity. Their prevention practices may be affected by environmental or individual circumstances, as seen in the ecological model and depressive symptoms. Many students seem to understand somewhat physical fitness and eating may affect weight status. They also seem to have either inconsistent or dangerous measures of being involved in these practices. It may be essential to understand the current prevalence of different weight-management methods and potentially inform interventions on preventing students from engaging in unhealthy and inconsistent behaviors.

Coping and Obesity in College Students

Ineffective coping mechanisms appear to be linked with obesity and other metabolic disorders. Previous research has explored this in terms of executive function traits and weight-related behaviors,[16] negative coping mechanisms related to social support,[17] and perceived stress and coping resources related to emotional eating. [18]

A cross-sectional study by Byrd-Bredbenner and Eck attempted to understand the association between executive function traits, particularly anxiety, and weight-related behavior to inform strategies for improving obesity prevention programs. The sample consisted of 406 college students. Through an online survey, they retrieved information on sociodemographic factors, BMI, physical activity, sleep duration, sleep quality, fruit/vegetable consumption, emotional eating, food addiction, intuitive eating, distracting eating, adventurous eating, dichotomous eating, executive function, and anxiety. Participants were split into Executive Function Clusters. Cluster 1 had lower cognitive self-control and flexibility and moderate concentration. Those in Cluster 2 had the lowest concentration, moderate self-control, and flexibility. Participants in Cluster 3 had the highest scores in all executive functions. Cluster 3 participants had fewer days of poor mental health monthly than Clusters 1 and 2. The researchers found that weight-related behaviors tended to be significantly better in Cluster 3, which had higher physical activity levels, better sleep quality, and ate more fruits/vegetables daily. Overall, the investigators concluded that cognitive self-control is inversely linked with higher BMI. This finding aligns with the Merianos et al. study that illustrated that individual factors act as enablers and barriers to behavior change.

In a longitudinal study, Darling and colleagues assessed negative coping techniques by examining whether social support moderates the relationship between stress eating and BMI change in freshman college students.[17] The sample consisted of seventy individuals (72.9% were female, 64.3% Caucasian, 100% freshman (year 1 of university), 38.6% overweight/obese). The investigators obtained social support and stress information through the multidimensional scale of perceived social support (MSPSS) and the Perceived Stress and Eating Questionnaire (PSEQ). These measures found that individuals gained on average 4.55 pounds over their freshman year for both sexes. Individuals with higher BMIs reported lower levels of social support. Individuals with higher social support demonstrated a weaker relationship between stressful times and weight gain. Males with high levels of support significantly decreased the strength of the relationship between stress eating and change in BMI over their freshman year. Overall, the authors concluded that males with social backing illustrate a moderate relationship between stress eating and BMI. Social support serves as a buffer against the impact of stress eating on weight gain during freshman year. Though it had the value of a longitudinal format to provide an environment for causal inferences on stress eating, social support, and weight gain, and it had a mixture of objective and subjective measures, there were some limitations. The limitations to this study include lack of previous research on gender differences, limitation to freshmen, and a single formant methodology for the data. The authors stress the need for a multiple formant method to comprehend the complex relationship between social support and weight gain in college, primarily as aspects of social support may be related to adverse health outcomes (e.g., weight gain). The gap in research appears to be the need to extend measures to another class of individuals and draw comparisons between new students and students in different stages of their college career, as both groups of students face differing circumstances.

In 2015, a cross-sectional study by Wilson et al. examined perceived stress and coping resources as predictors of emotional eating during the transition to college and explored whether BMI moderates emotional eating-stress relationships.[18] The sample consisted of 98 students (73% female, 65% Caucasian, 21% African American, 10% biracial, 100% college freshman, 40% overweight/obese). For the psychosocial measures on stress, coping resources, and emotional eating, the Perceived Stress Scale (PSS), Eating and Appraisal Due to Emotions and Stress (EADES), and Emotional Eating Scale (EES) were used, respectively. The investigators found that individuals with better coping resources had lower levels of emotional eating. Overall, the authors concluded that limited coping skills increase emotional eating in young adults' transition to college. An individual's perceived stress may increase the risk for emotional eating among normal weight and overweight young adults. The authors noted that the possibility of using stress induction paradigms by combining perceived stress and objective physiological stress response (cortisol) measures might be an avenue for future research.

A focus on the types of coping mechanisms concerning weight changes illustrates that college students tend to have gaps in their knowledge and practice of effective coping strategies, especially individuals who are overweight and obese. Future research is needed to determine stressors and coping mechanisms of transitioning college students and how these may differ from more senior college students, to understand better and inform health-related intervention strategies.

Stress and Obesity in College Students

Several studies have explored the relationship between stress and obesity. Specific to college students, the association has been examined within the context of distress and social contextual factors concerning weight gain, [19] interrelationships among insomnia, stress, anxiety, and metabolic risk factors,[20] sleep, food security, physical activity, and eating behaviors associated with weight gain,[21] anxiety-related to visceral fat storage,[30] adverse childhood experiences and stress mediation, [22] and the relationship between stress, weight-related risk behaviors, and weight status. [23]

A cross-sectional study by Cheng et al. examined psychological distress and social contextual factors as key determinants of obesity.[19] The sample consisted of 2,932 students (64% female, 33.8% non-Hispanic white, 69.1% juniors and seniors, ~30% overweight or obese). Distress was captured via the PSS and Affect Balance Scale (ABS), social context factors, and individual-level factors/covariates were also recorded via an in-class survey. The social factors explored included living arrangements, extracurricular sports, social organizations, and 'Greek life.' Individual-level factors/covariates included financial strain, grade point average, employment, course credits, and race/ethnicity. The investigators found that distress in sophomores increased the odds of obesity, Greek life decreased the odds of obesity, distress was not associated with obesity, and financial strain was associated with obesity. In addition, gender patterns in obesity risk illustrated protective effects among women. The authors concluded that to address rising rates of obesity among college populations. An effective strategy may be enhancing psychological well-being and creating gender and context-specific interventions. Although this study had a large sample size, this study was not without limitations, such as the cross-sectional study design and self-report measures for weight status (e.g., BMI). In addition, other risk factors for obesity and psychological distress were not addressed, such as substance abuse.

Another study by Hsu and Chang examined the interrelationships among insomnia, stress, anxiety, and metabolic risk factors.[20] A sample of 124 college students had their fasting blood glucose, insulin, total cholesterol, triglycerides, high-density lipoprotein, and low-density lipoproteins measured. The researchers obtained self-reported measures on insomnia, stressful life events, and anxiety through a questionnaire. The investigators found that insomnia was positively associated with stress and anxiety. The authors concluded that reducing stress/anxiety in college students with insomnia may positively influence cardiovascular health. In a study focusing on sleep, Richards and Specker examined the associations of sleep quality/quantity, stress, food security, and physical activity with eating behaviors associated with college weight status through a cross-sectional study.[21] The sample consisted of 153 college students. The investigators obtained information on emotional eating, uncontrolled eating, and cognitive restraint from the Three-Factor Eating Questionnaire (revised). They found that higher emotional eating was associated with higher stress levels in the female population, and higher uncontrolled eating scores were associated with higher perceived stress. Lastly, individuals with higher cognitive restraint tended to have paternal education and reported using relaxation methods. The authors concluded that interventions to help reduce stress and improve sleep might improve eating behaviors. However, this study lacked temporality due to its cross-sectional nature and had a relatively small sample size. Another study explored stress, weight-related and risky behaviors (e.g., eating behaviors, physical activity, sedentary behavior, sleep cigarette smoking, and binge drinking), and weight status in a cross-sectional study.[23] The sample contained 411 college students (67.6% female 47%

overweight or obese) who completed a survey for behavioral and psychosocial correlates, predictors of obesity among young adults – eating and activity patterns, tobacco, and alcohol use, sleep, and stress (through the Cohen Perceived Stress Scale). The participants' self-reported demographics (e.g., age, sex, race), socioeconomic status, weekly work hours, relationship status, and presence of children at home. The investigators found that normal-weight individuals were more likely to engage in significant breakfast and dinner skipping than their overweight or obese counterparts. At the same time, lunch skipping was significant in normal weight, overweight, and obese individuals. Stress was positively associated with eating within an hour of bedtime in normal weight individuals. Participants with higher stress levels were also more likely to be smokers, individuals with financial strain, and more likely to be obese. Overall, the authors conclude that a differential response to stress by weight status was present. Studies have reported an association between other psychosocial outcomes in college students – such as anxiety – and visceral fat storage. One small study of 27 students (41% female) found a statistically significant positive correlation between visceral fat storage and anxiety levels.[30] Although the sample size was small, this study incorporated robust measures of the variables and provided preliminary evidence of the relationship between mental and physical health in college students.

Studies have also explored past childhood experiences and mental health status. One longitudinal study determined whether bad childhood experiences predicted mental health issues in college students and if current stress levels mediate the relationship.[22] The sample consisted of 239 college students (77% female, 76% white, 34% freshman, 28% sophomores, 24% juniors, and 15% seniors). The Early Adverse Experiences Questionnaire was administered, and students reported childhood family income. The Life Events Scale for Students was used to obtain information on stressors, and the Patient Health Questionnaire (PHQ) provided information on depression and anxiety levels. The author found disturbingly high anxiety, depression, and suicidality in students. Early adversity (in childhood) worsened current mental health, and the number of everyday stressors partially mediated this relationship.

Collectively, personal stress and anxiety appear to be related to weight-related behaviors, weight status, and other factors such as blood sugar levels, early childhood experiences, and financial strain.

The Structured Days Hypothesis (SDH) and Weight Gain

Other hypotheses and theories may help understand the relationship between environmental changes or 'disruptions' and weight-related behaviors and outcomes in college students. For example, the 'Structured Days Hypothesis' describes how changes to a person's environment from structured to less structured may alter their behaviors, typically in a more negative direction. [24] The SDH was developed to understand why children are gaining weight at an accelerated rate during summer months compared to school months. The hypothesis suggests that the children have more 'structure' and routine to their day during school months which ultimately positively shapes weight-related behaviors (i.e., keeps them consistent and predictable). Over summer, there is typically less structure to a child's day and, therefore, there may be opportunities to engage in more variable weight-related behaviors that can lead to weight gain (e.g., more screen/media time, less physical activity, irregular sleep patterns, less healthful diets, etc.) In the context of college students, the nature of transitioning to the college environment (i.e., high school students to first-year college students) could represent a vulnerable stage of dysregulation for college students. This notion is supported by other literature that has examined dietary changes in adolescence to early adulthood in the context of crucial life transitions,[25] the importance of establishing healthy and regular bedtime routines in obesity prevention during stressful periods,[26] and the importance of habits and routine in maintaining health overall.[27]

Winpenny et al. described dietary changes in consumption of fruit, vegetables, confectionery, and sugar-sweetened beverages (SSB) between four early adulthood life transition stages (leaving home, leaving education, entering employment, and cohabitation) using a longitudinal study design.[25] The study consisted of 1,100 participants aged 14 to 30. They obtained self-reported responses on intake of fruit, vegetables, confectionery, and sugar-sweetened beverages. The authors found that fruit and vegetable intake declined from age 14 to 23 and 21 before increasing to age 30. SSB and confectionery intakes increased to age 18 until reducing subsequently. Leaving their parent's home was associated with a decrease in fruit intake of 0.54 times per week and vegetable intake of 0.43 times per week. Leaving education was associated with increases in confectionery 0.33 times per week and SSB intakes 0.49 times per week. The authors conclude that leaving home and leaving education were related to adverse changes presenting opportunities for intervention. There is a need for further studies in this transitional phase to understand mediating associations between life transitions and changes in health-related behaviors and outcomes.

Another study explored the importance of establishing a proper bedtime during the COVID-19 pandemic and beyond to protect against obesity.[26] Covington et al. quoted theoretical models such as the SDH and Circadian and Circannual Rhythm Model in positing the importance of external structure (e.g., school or workdays for shaping schedules) for better health behaviors, weight maintenance as well as proper sleep hygiene. The authors conclude that early excess weight gain poses a risk for obesity and other chronic diseases later in life, and interventions may improve the home environment to help with maintaining sleep schedules. College students experiencing student life for the first time are often faced with decisions on when to sleep (or for how long) and face other conflicting activities such as staying up late to spend time with friends or study.

Lastly, Arlinghaus and Johnston presented information on the importance of habits and routine in maintaining health.[27] The authors concluded that health care providers might help individuals establish a way that works for them (in terms of age and stage of life) instead of changing their lifestyle drastically, ultimately, so that behavior change can occur more efficiently and with an element of sustainability. Their conclusion may inform interventions that focus on working with individuals to avoid excessive change in a rapid manner prone to subsequent relapse. Plausibly, this may lead to long-term, sustainable behavior change. Collectively, the literature would suggest that changes or alterations to one's external environment may manifest in a host of changes, both behaviorally and physiologically, that have the potential to lead to weight gain and other unfavorable health outcomes.

Summary

Overall, establishing and maintaining healthy habits is essential throughout life. Transitioning college students may, by nature, be forced out of routine. In this transition stage, they may have difficulty returning to healthy habits or establishing them, manifesting as stress and ineffective coping mechanisms. Excessive stress and inadequate coping mechanisms are key factors that can lead to weight gain, high blood pressure, and other factors associated with MetS. Further research is needed that incorporates longitudinal evaluation of metabolic and weight outcomes in relation to several key indicators addressed previously (knowledge, stress, coping, etc.) to determine causal pathways in this population better. Specifically, studies should explore differences between first-year students and students who have been exposed to the college environment for longer periods of time (i.e., juniors/seniors) on key variables to address the limitations of previous literature in this area (e.g., cross-sectional design, no comparative group, self-report anthropometric outcomes).

AIMS & HYPOTHESES

The primary aim of this study is to assess changes in college students' MetS risk factors in relation to predictor variables of coping resources, perceived stress, and MetS risk factors knowledge. A secondary aim will be to explore this by academic standing (i.e., between incoming or first time on campus (FTOC) students and students in their final years of undergraduate education) as the year of schooling may affect the level of these predictor variables. Transitioning to a new 'phase' of life can disrupt many different health-related factors previously established. Most final-year students have become accustomed to the adjustment and are less susceptible to weight gain and high stress. However, aspects of entering the job market or contemplating graduate or professional school may also alter student perceptions of stress in their final years of university. Students across all standings are subject to stress. Whether they perceive it is high or can manage it well enough with effective coping mechanisms or resources may be due to the experience that comes with being in an academic setting for a long time and will inform the hypothesis. Students in their final years, regardless of the stressors they face, may have a greater sense of their ability to overcome and, as a result, a lower stress perception. Given the potentially stressful nature of the transition into college, college students in their first semester of university from high school or a different institution may have more weight gain (greater change in BMI and percent body fat), higher blood pressure, less effective coping mechanisms, more inadequate stress management manifesting as higher perceived stress, and lower levels of knowledge on MetS compared to upper-level students, who have been a part of the college community longer (juniors or seniors).

METHODOLOGY

Study Design

A longitudinal cohort study over a semester assessed changes in FTOC student metabolic and anthropometric outcomes in relation to coping mechanisms, perceived stress, and MetS knowledge compared to students in their last year(s) of undergraduate education. This study had two-time points for data collection (early fall semester and late fall semester).

Sample

The target sample was 200 students majoring in Health Sciences at the University of Central Florida (UCF), 50% male, 100 juniors or seniors, and 100 first-year students, including recent transfer students and sophomores entering the campus for the first time. The eligibility criteria were students 18 years of age or older, Health Science major, those with an academic standing of first-year students, new transfer students, first-time on campus sophomores, juniors, or seniors. Exclusion factors included those who were not full-time status or those starting college well into adulthood, as they may not experience the same rigor or stresses. Participants were recruited from five classes offered by the Department of Health Sciences at UCF that typically serve either first-year students or juniors and seniors. Interested participants returned consent forms to the study team and scheduled the first of two visits. Students received a $20 gift card incentive for their participation in all study measures administered at the end of the study. The UCF Institutional Review Board approved all data collection procedures and materials.

Protocol

Participants completed assessments at two timepoints (T1 and T2) during the Fall 2021 semester. Eligible participants had their height, weight, and blood pressure measured at timepoint one (T1; early fall) and timepoint two (T2; late fall) by trained research assistants.

The height and weight stands were set up to measure student weight and then height. The data collectors ensured that the environment was quiet and private to avoid elevated blood pressure due to disturbances. Students not having their measurements taken would wait quietly outside, and participants were encouraged to use the bathroom or start the Qualtrics survey before taking measures, if necessary. Students who had consented to participate were asked to remove shoes, heavy clothing (e.g., jackets), empty pockets, and to wear light clothing before their appointment to avoid overestimation of weight. Data collectors calibrated the scale and measured weight in kilograms to the first decimal place. Height was measured to the first decimal place in centimeters.

Participants having their blood pressure taken were asked to sit so that the table supports the left arm at heart level, their legs were uncrossed, their back supported by the chair, and their feet flat on the floor. All data collectors attaining measurements were asked to avoid having a conversation with participants to ensure accurate blood pressure reading. The data collector would place the blood pressure cuff around the bare portion of the left arm 1-inch above the fold in the arm, making sure the blood pressure cuff tube aligns with the middle of the fold in the arm and the brachial artery. Before the first measurements, the participant was asked to wait in silence for five minutes. The data collector would record the systolic and diastolic blood pressure separately in the data entry sheet. Before the second measurement and between subsequent measurements, if necessary, data collectors waited two minutes to avoid potential alterations in blood pressure from the previous reading. A third measurement was not taken if the first and second measurements were within a five mmHg difference for systolic and diastolic pressure. However, a third measurement was required for blood pressures over 120 mmHg for systolic and over 80 mmHg for diastolic.

Before the participants left, they were informed about the Qualtrics survey (the three main components: metabolic risk factor knowledge evaluation, coping capacity, and perceived stress). Their email for the December follow-up was obtained, and data collectors gave them a Q.R. code to access the survey. Participants were told only to complete the survey once and be aware of an email about the next time point.

In addition to these measures at T1, participants completed a survey capturing their knowledge of MetS, perceived stress, and coping capacity. This survey was taken during or after their first visit to the Health Science lab.

At T2, follow-up height, weight, and blood pressure measurements were taken, and participants were asked follow-up questions regarding their awareness of and engagement with services offered by UCF to assist with college life.

Measures

Non-invasive measures were selected to minimize participant burden. Each scale used were validated through previous research. All metabolic and anthropometric measurements took place in a research lab space in the Health Science department. Survey data were collected electronically using Qualtrics on a local computer in the Health Science lab, personal computer, or personal device. After consenting to participating in the study, students were allowed to complete the surveys during or after their clinic visit to avoid survey fatigue.

Participant Demographics.

A basic questionnaire administered via Qualtrics retrieved demographic and descriptive information, including age, sex, race/ethnicity, employment status (i.e., work and study), and family income (support from parent/guardian/family member during college).

Metabolic and anthropometric measures (T1 and T2).

Body mass index (BMI) was captured by measuring participants' height and weight using a stadiometer for height (cm) and a digital scale for the weight (kg). Study participants were asked to remove their shoes and heavy clothing such as jackets and sweatshirts. The BMI was calculated using weight (kg)/height (m^2).

Participants' blood pressure was retrieved using the Omron Gold Blood Pressure monitor. The data collectors instructed students to remain seated and relaxed for five minutes before taking their blood pressure to obtain accurate measurements. A two-minute wait time was implemented to avoid alterations in the blood pressure readings from the previous measurement for subsequent measurements. A third measurement was required for elevated and hypertensive readings to ensure validity and reliability of measurement.

Measurements of BMI and blood pressure occurred during both time points. All anthropometric measurements took an estimate of 10-15 minutes.

Survey/Questionnaire Data (T1 only).

Students' knowledge of MetS was obtained from 42 questions on diabetes (n=16), adiposity (n=8), hypertension (n=12), and high serum cholesterol (n=6) adopted from a previous study by Becker et al. The questions were true or false questions scored based on accuracy, 1 point corresponding to a correct answer and 0 points corresponding to an incorrect answer. A copy of this questionnaire may be found in Appendix C.

Perceived stress levels were obtained through the validated Cohen's Perceived Stress Scale (PSS). The PSS is a 10-item questionnaire that assesses how different situations affect one's feelings and stress perception.[32] The questionnaire asked questions on the participant's likelihood of feeling or thinking a certain way in the last month. The choices for each question described the frequency of these thoughts and feelings. A '4' indicated very often, '3' indicated fairly often, '2' indicated sometimes, '1' indicated almost never, and '0' indicated never. The scores for questions 4, 5, 7, and 8 were reversed based on the scoring guidelines of the scale. Participant's individual scores could range from 0 to 40 with higher scores indicating higher perceived stress. Scores ranging from 0-13 were considered low stress, from 14-26 were considered moderate stress, and from 27-40 were high perceived stress. It is important to note that this is a measure of perception and that participants facing similar stressors had differing scores.

Coping resources were assessed via the Coping Resources Inventory. The Stress Coping Resources Inventory is a 32-item questionnaire that assesses how individuals respond to stress and categorizes scores into six scales: wellness (n=7), thought control (n=6), active coping (n=7), social ease (n=6), tension reduction (n=2), and spiritual practice (n=4).[33] Wellness questions assessed exercise frequency, sleep quality, energy levels, weight perception, nutrition, tobacco use, and alcohol use. Thought control questions assessed participants' ability to cope in stressful situations, control emotions under stress, maintain a positive outlook, not exaggerate negative experiences, focus on negative aspects one can control, and use thoughts to calm down. Questions on active coping assessed passivity, actions taken when frustrated, how participants deal with flaws, reactions to unexpected events, level of decision-making power at home and work, and belief in chance. Social ease questions assessed interactions with parents, perception of participants' mother, ability to make friends in strange situations, their likelihood to ask for help from relatives and friends when stressed, distrust in others, and confusion of others' intentions. Tension reduction questions assessed awareness of relaxing practices and how often they participate in highly relaxing practices. Finally, spiritual practice questions evaluated the frequency of spiritual practice, belief in a higher power, belief in high purpose, and amount of contact with a spiritual community. The students would answer each question with choices that provided four levels based on the frequency they experienced an event, participated in a particular behavior, or reacted to hypothetical events. The wellness, thought control, active coping, social ease, tension reduction, and spiritual practice scores were averaged to provide each participant's coping capacity score. An overall score of 3.5 and above indicated superior ability to cope with stress, 2.5-3.4 indicated above-average ability to cope with stress, 1.5 – 2.4 suggested average ability to cope with stress, and below 1.5 described below average coping capacity.

The questionnaires were administered via a Qualtrics form. These scales required quick and accurate responses; they took approximately 5 to 20-minutes to complete.

Awareness and Use of UCF Resources (T2 only)

Information on the use of UCF stress management, mental health, and coping resources was obtained through three follow-up questions completed at T2. Students were prompted to answer 2-3 questions. Depending on their response, more was asked. These questions can be found in Appendix D.

Analysis

Study participants were given a unique I.D. used for all electronic data and statistical analyses. We included first-year and sophomore students in the first time on campus (FTOC)group as they did not experience the on-campus environment until the Fall 2021 semester (delayed one year) due to the COVID-19 pandemic. To assess our primary aim, separate mixed-effects regression models were used to examine the relationship between key predictor variables (Perceived Stress, Coping Resources Inventory, and MetS knowledge) and two dependent variables (changes in BMI and blood pressure) incorporating sex and race/ethnicity as covariates for the model. To assess our secondary aim, we examined differences in our primary outcomes by college standing (FTOC versus final year) using separate independent t-tests to test differences in key variables of interest (weight gain, blood pressure, MetS knowledge, Perceived Stress, and Coping Resources Inventory). All statistical analyses were conducted in Microsoft Excel and Stata (v.16.1, College Station, TX).

RESULTS

Of the 100 students that enrolled, 57 students completed the first time point, and out of those 57 students, 43 students participated in each time point (13.95% first year students, 11.63% sophomore, 9.3% juniors, 65.12% seniors). The mean participant age was 20.5 (±1.5) years old. The gender breakdown was 86.05% female and 13.95%, male. In terms of ethnic/racial breakdown: 11.63% of participants were black or African American, 27.91% of participants were Asian or Pacific Islander, 32.56% of participants were White or Caucasian, 23.26% of participants were Hispanic or Latinx, and 4.65% of participants were Multiracial or Biracial. Regarding employment status, 4.56% worked full-time, 39.53% worked a heavy part-time schedule with 12-32 hours per week, 13.95% worked a light part-time schedule with less than 12 hours per week, and 41.86% did not work. Students paid for college expenses through a mixture of partial parental, guardian, and/or family support (60.47%), employment and financial aid (11.63%), and financial aid only (27.91%).

Students answered questions assessing their understanding of metabolic disease risk factors, coping capacity level, and perceived stress during their first visit. In terms of metabolic disease risk factors, the participants' average diabetes knowledge score was 12.8 out of 16, adiposity knowledge score was 6.0 out of 8, hypertensive knowledge score was 9.7 out of 12, and high serum cholesterol knowledge score was 3.1 out of 6. Regarding the psychosocial predictors, participants' perceived stress scores were either low (13.95%) or moderate (86.05%), and coping capacity scores were either average (9.3%), above average (81.4%), or superior (9.3%). These participant characteristics are outlined in Table 1.

Table 1. Participant Characteristics and Demographics (N=43)

Variable	N	Mean (±SD)
Age	43	20.5 (1.5)
MetS Knowledge scores		
Diabetes Knowledge	43	12.8 (1.8)
Adiposity Knowledge	43	6.0 (0.9)
Hypertensive Knowledge	43	9.7 (1.6)
High Serum Cholesterol Knowledge	43	3.1 (0.9)
Academic Standing	**N**	**%**
Freshmen	6	13.95
Sophomores	5	11.63
Juniors	4	9.3
Seniors	28	65.12
Sex		
Female	37	86.05
Male	6	13.95
Race/Ethnicity		
Black	5	11.63
Asian	12	27.91
White	14	32.56
Hispanic	10	23.26
Multiracial	2	4.65
College Funding		
Partial family support and financial aid	26	60.47
Uses financial aid only	12	27.91
Uses employment and financial aid	5	11.63
Employment		
Full-time (32+ hrs/week)	2	4.65
Heavy Part-time Schedule (12-30 hrs/week)	17	39.53
Light Part-time Schedule (<12 hrs/week)	6	13.95
Not Employed	18	41.86
Perceived Stress		
Low	6	13.95
Moderate	37	86.05
Coping Score		
Average	4	9.3
Above Average	35	81.4
Superior	4	9.3

During their first visit, baseline data of participant weight status and blood pressure were taken. The average BMI of all participants was normal at 22.3 kg/m^2. Normal BMI ranges from 18.5 to 25 kg/m^2.[34.] The average systolic blood pressure was normal at 101.1 mmHg. Normal or healthy systolic blood pressure is below 120 mmHg.[35] The average diastolic blood pressure was normal at 67.9 mmHg. Normal or healthy diastolic blood pressure is below 80mmHg.[35] This study was interested in assessing changes in these numbers. More information was obtained in their final visit on these risk factors. In their last visit, the average BMI was 22.3 $kg/m^{2,}$ which means there was an average change of 0 among all participants. In the final visit, the average systolic blood pressure was at 100.1 mmHg, meaning the average systolic blood pressure fell by one mmHg. During their final visit average diastolic blood pressure was at 68.9 mmHg, meaning it rose by 1.0 mmHg. These results are outlined in Table 2.

Table 2. Participant Clinical Outcomes at the Beginning and End of the Academic Semester (N=43)

	PRE-ASSESSMENT				POST ASSESSMENT				CHANGE			
Clinical Measures	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**±SD**	**Min**	**Max**
HEIGHT (cms)	164.4	6.6	153.8	183.0	164.8	6.4	154.2	183.8	0.4	0.7	0.0	3.3
WEIGHT (kgs)	60.5	11.0	40.0	91.1	60.7	11.0	40.3	90.8	0.2	2.0	-3.9	7.9
BMI (kg/m^2)	22.3	3.4	15.2	33.1	22.3	3.4	15.3	33.0	0.0	0.8	-1.3	2.7
Average Systolic Blood Pressure (mmHg)	101.1	10.4	77.5	125.0	100.1	11.2	81.0	121.3	-1.0	8.4	-19.2	18.5
Average Diastolic Blood Pressure (mmHg)	67.9	5.9	57.0	81.5	68.9	7.4	55.0	89.0	1.0	6.1	-16.7	14.5

Our regression analyses did not find any statistically significant associations between changes in clinical outcomes (BMI or systolic blood pressure) and coping, perceived stress, or MetS knowledge scores, adjusting for the covariates sex and race/ethnicity. Results from our regression our presented in Supplementary Table 1. Our secondary analysis was conducted to examine those who were FTOC and those in their final years on changes in BMI and blood pressure. Regarding BMI, those who were FTOC had an average increase in BMI of 0.485 kg/m^2, while those in their final years on campus had an average change in BMI of -0.210 kg/m^2. This difference was statistically significant with a p-value of 0.007. Weight for FTOC students had an average increase of 1.736 kg compared to final year students' average change in weight of -0.313 kg. This difference was also statically significant, having a p-value of 0.002. In terms of blood pressure, the FTOC students' average systolic blood pressure change was -3.197 mmHg, while final year student systolic blood pressure change was -0.266 mmHg. FTOC students' average diastolic blood pressure change was -0.303 mmHg, while final year students' average diastolic blood pressure change was +1.401 mmHg. Neither of these differences were statistically significant. They had p-values of 0.326 and 0.427, respectively. The clinical outcomes and predictor variables data are summarized in Table 3.

Table 3. Clinical Outcomes and Predictor Variables (MetS Knowledge, Stress, and Coping) of First Time on Campus and Final Year Students

	FIRST TIME ON CAMPUS (N=11)				FINAL YEARS STUDENTS (N=32)				P-value of difference*
Variable of Interest	Mean	SD	95% CI		Mean	SD	95% CI		
BMI Change (kg/m^2)	0.485	1.066	-0.231	1.201	-0.210	0.527	-0.400	-0.020	**0.007**
Height Change (cms)	0.464	0.800	-0.074	1.001	0.409	0.644	0.177	0.642	0.822
Weight Change (kgs)	1.736	2.764	-0.120	3.593	-0.313	1.375	-0.808	0.183	**0.002**
Systolic Blood Pressure Change (mmHg)	-3.197	10.047	-9.946	3.553	-0.266	7.839	-3.092	2.561	0.326
Diastolic Blood Pressure Change (mmHg)	-0.303	8.305	-5.882	5.276	1.401	5.157	-0.458	3.260	0.427
Diabetes Knowledge	12.000	1.342	11.099	12.901	13.063	1.865	12.390	13.735	0.090
Adiposity Knowledge	6.273	0.905	5.665	6.880	5.938	0.914	5.608	6.267	0.299
Hypertensive Knowledge	9.545	1.572	8.489	10.602	9.813	1.635	9.223	10.402	0.640
High Serum Cholesterol Knowledge	3.091	1.136	2.328	3.854	3.094	0.777	2.814	3.374	0.993
Perceived Stress Scores	17.636	3.233	15.464	19.809	17.188	4.518	15.558	18.817	0.764
Coping Scores	2.861	0.250	2.694	3.029	2.976	0.387	2.836	3.115	0.368

*Independent sample t-test of difference

The same subgroup analysis was performed regarding the predictor variables of perceived stress, coping resources, and metabolic syndrome knowledge. FTOC students' average diabetes knowledge score was 12.000 out of 16, while final year students had an average diabetes knowledge score of 13.063 out of 16. Their difference had a p-value of 0.090, which was not considered statistically significant. In terms of adiposity, FTOC students had an average adiposity knowledge score of 6.273 out of 8, while final year students had an average adiposity score of 5.938 out of 6. The differences in adiposity knowledge scores had a p-value of 0.299, so the difference was not statistically significant. Hypertensive knowledge scores for FTOC students were an average of 9.545 out of 12, while final year student average hypertensive knowledge scores were 9.813 out of 12. The difference was not statistically significant (p-value 0.640). FTOC students had an average high serum cholesterol knowledge score of 3.091 out of 6, while final year students had an average high serum cholesterol knowledge score of 3.094 out of 6. The difference was not statistically significant (p-value = 0.993). The average perceived stress in FTOC students was 17.636 out of 40, while the average perceived stress in final year students was 17.188 out of 40. The difference was not statistically significant (p-value = 0.764). The average coping capacity in FTOC students was 2.861 out of 4.0, while the average final year coping capacity was 2.976 out of 4.0. The difference was not statistically significant (p-value 0.368). A follow-up questionnaire on students' knowledge and usage of UCF resources found that approximately 89.36% of respondents were aware of mentoring, mental health, and coping resources, and 10.64% were not. Most respondents who stated they knew of these resources were aware of Counseling and Psychological Services (CAPS) (46.15%), followed by Peer Knights (27.69%) and the Psychology Clinic (26.15%). Students could select more than one. Many of the respondents (71.43%) aware of these resources did not use them. Approximately 28.57% used these resources.

DISCUSSION

This study assessed changes in metabolic syndrome risk in college students based on predictors of perceived stress, coping resources, and MetS knowledge. A secondary aim was to evaluate differences between FTOC and final year students. The primary findings demonstrated no statistically significant associations between the clinical outcomes (change in BMI and blood pressure) and predictors of perceived stress, coping, and MetS knowledge. However, we observed weight gain and meaningful change in BMI in FTOC compared to final year students. The average increase in weight/BMI in FTOC students compared to final year students highlights the need to provide education and resources to protect against metabolic syndrome risk in young adults, especially those undergoing major life changes such as those entering college for the first time. Trends in final year student clinical outcomes and their predictors illustrate how education may be a protective factor between the two groups of students.

Regarding the predictors of perceived stress, coping resources, and MetS knowledge, though no statistically significant associations were found with changes in clinical outcomes, the differences between FTOC and final year students in average values revealed some expected trends. FTOC average diabetes (12.000), hypertensive (9.545), and high serum cholesterol (3.091) knowledge scores were lower than the final year student scores (13.063, 9.813, and 3.094, respectively). Surprisingly, the only category that did not match this trend was knowledge of adiposity (6.273 in FTOC and 5.938 in final year students). This is an interesting finding because, as will be discussed further, the FTOC students had gained weight on average. However, because the results were not considered statistically significant, more investigation should be done in a larger sample over a larger period of time before establishing implications.

The lower adiposity knowledge aligns with results from a previous study conducted by Yahia et al., which illustrated that adiposity and high serum cholesterol knowledge tend to be lower in college students than in the other knowledge questionnaire categories.[10] In this previous study, final year students scored higher than first-year students overall in each category. Our sampled college student populations deviated from this trend where FTOC students scored higher in adiposity knowledge. This may illustrate that knowledge of adiposity did not prevent weight gain, as FTOC students still, on average gained more weight over the semester, and environmental factors may play a larger role in health outcomes.

FTOC student perceived stress was slightly higher than final year student perceived stress scores, 17.636 and 17.188, respectively. This aligns with our former hypothesis on stress perception; however, the difference is not statistically significant. Previous literature demonstrated how higher stress perception was related to several adverse activities that can explain changes in health outcomes. Wilson et al. demonstrated that higher perceived stress was related to emotional eating. [18] Emotional eating can lead to subsequent weight gain. Richards et al. demonstrated that higher perceived stress was associated with lower cognitive restraint for first-year students but did not affect students in higher class positions.[21] Lower cognitive restraint, in turn, adversely affects sleep schedules and eating patterns. Stress perception among the two groups in the sample was quite similar overall. This deviated from our hypothesis. Overall, students had a moderate perception of stress. In the former study by Richards et al., a small fraction of students had high perceived stress. Our sample did not have any students with high perceived stress, only low to moderate. Some reasons for lower-than-expected perceived stress can be that the transition onto campus may not have appeared as stressful to this sample, or students may underreport symptoms of perceived stress if they feel it may look poorly on them.

Finally, the FTOC student coping score was slightly lower than final year students, 2.861 and 2.976, respectively; the differences between these scores were not statistically significant. These scores are above average according to the coping resource scale. [33] This sample of students had positive coping resources, with few exceptions. Once again, there was not enough statistical power to truly say these differences were significant. However, students in their final years on campus had slightly lower perceived stress, marginally higher coping capacity, and knew more about metabolic syndrome risk factors. Weight gain in FTOC students may be more related to environmental changes.

Based on pre-and post-assessment scores, the participants appeared to maintain average BMI. Participants also seemed to have a slight decrease in average systolic blood pressure of 1.0 mmHg and a slight increase in average diastolic blood pressure of 1.0 mmHg. The change in BMI increased by 0.485 kg/m^2 and decreased by -0.210 kg/m^2 in FTOC students and final year students, respectively. This aligns with our hypothesis of potentially larger increases in BMI in FTOC students. Former theories on how changes in structure and major life transitions affect health helped formulate this portion of the hypothesis.[24-27] FTOC students underwent a change in the environment, causing a deviation from their usual schedules, and its effects ultimately led to poorer health outcomes (increased BMI and weight gain). Data on weight change illustrated this same trend. FTOC student weight change was an average increase of 1.736 kg, while final year students had an average decrease of -0.313 kg. A 2016 study conducted by Darling and colleagues found students in their first year of college tend to gain on average 4.55 lb.[17.] This is approximately 2.06 kg in a year. A former meta-analysis found mean weight gain for the first year in college was 3.86 lb or 1.75 kg.[36] Our sampled FTOC students gained on average 1.736 kg in the first semester of college, comparable to the former literature. If this rate continued throughout the year, our sample might have gained more than previously cited. One factor found in weight and BMI change that was not anticipated in the hypothesis is the decrease in final year student BMI and weight. The slight average weight loss in final year students is an interesting phenomenon that may be specific to the study sample but may have larger implications on the effect of college life on final year students. The absolute change in both variables of interest was markedly higher in the FTOC students, aligning with our original hypothesis.

Information on blood pressure change was mixed and inconclusive. Blood pressure is a very sensitive measure and is frequently victim to systemic or random error. Overall, none of the blood pressure measurement differences were statistically significant. Still, there were greater decreases in FTOC systolic blood pressure and smaller decreases in final year student blood pressure, while a slight decrease in FTOC diastolic blood pressure and increase in final year student diastolic blood pressure. The trends in blood pressure change were opposite to the hypothesis. Future studies are needed in a larger sample, over a longer period of time, and with more stringent data collection protocols (i.e., fasted versus non-fasted, same time of day for pre- and post-measures) to assist in clarifying whether a relationship exists between changes in blood pressure and key predictors such as stress, coping, and MetS knowledge in college-aged students.

A few limitations of the study have been identified. Our study only assessed two of the four risk factors outlined for metabolic syndrome. These risk factors included obesity, hypertension, dyslipidemia, and hyperglycemia/insulin resistance. We could not assess all the four risk factors because potential dyslipidemia and hyperglycemia measures would require invasive blood tests that may detract participants. In addition to this, though we used clinical research and practice standards for blood pressure measurements, there was room for error. From previous literature, very minimal information describes how much is a significant difference in consecutive measurements of blood pressure. We used the highest time interval recommended between successive measurements of two minutes to ensure accuracy. However, with measures that continuously fluctuated for uncontrollable reasons, there was still uncertainty of which reading would provide the most accurate representation of that individual's blood pressure. Our study had a smaller sample size than anticipated, which may reduce the generalizability of the results. We had reduced the possible invasive procedures and minimized the number of questions to the necessary amount for analysis, but the number of students who participated was still low. There may be response bias because students could take the questionnaires anywhere. Though most were encouraged to complete the survey during their appointment time, some students saved the survey for later. For students who may have faced distractions or completed the survey too quickly, there may be an issue with the validity of their responses. Due to the length of the first questionnaire, students may have experienced survey fatigue. More validity-based questions to test for any of these concerns or asking students if their answers were earnest may assist with understanding and validating some results better.

This study had a few strengths to note. Our study obtained a diverse sample of health science students, which increased the representativeness of the sample. This study adopted a longitudinal study design allowing for temporality when examining changes in clinical outcomes against predictors. Many previous studies have relied on cross-sectional data collection to examine associations. Students had the privacy to submit the survey for the health questionnaire completion, which may have enhanced the authenticity of their survey responses to more personal questions.

Future investigations may consider implementing validating questions to confirm honest effort in online questionnaires, obtaining objective measures of stress such as cortisol levels, assessing all four MetS risk factors, and recruiting from a larger sample of students. Some plausible next steps may be to conduct a study following students throughout their four years of university and comparing their initial responses in their first-year to their final-year. The format of this study used a combination of between-subjects and within-subjects analyses, a future study would benefit from assessing changes in key predictors over a longer period of time (within-subject analyses only).

CONCLUSION

The cardiometabolic state of the U.S. population is an area of major public health concern. Several theories have been used to explain these trends, and many point toward stress and changes in environment or structure. [24-27] Though college students typically do not develop metabolic syndrome, several risk factors, including weight gain, uncontrolled blood pressure, and insulin resistance, are important to pay attention to early on for prevention. This study assessed whether perceived stress, coping capacity, and risk factor knowledge may play in role in changes in weight and blood pressure and if students entering the college environment for the first time are more susceptible to weight and blood pressure changes than those who are more established in their college experience.

The change of environment seemed to affect students in the sample on campus for the first time (i.e., FTOC), as demonstrated by weight gain and BMI increases compared to students in their final years. Students in their final years on campus had slightly lower perceived stress, slightly higher coping capacity, and knew more about metabolic syndrome risk factors. These factors may explain the trend in higher weight gain in FTOC students compared to final year students. However, the small sample size limited our ability to detect an effect (i.e., underpowered).

We could not find a clear link on how education facilitates metabolic disease prevention through this study, but a larger study may provide more information on this. Finally, the sampled college students had positive coping resources to handle their perceived stress. However, there is still a need to provide continuous education and resources to protect against metabolic syndrome risk in young adults to avoid it later in life. Another line of research may want to design an intervention that will help inform students about metabolic disease, ways stress may induce risk factors for this disease (such as weight gain), and recommendations/prevention techniques to help manage unhealthy outcomes for college-aged students.

APPENDIX A
IRB APPROVAL LETTER

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

<u>APPROVAL</u>

July 23, 2021

Dear Keith Brazendale:

On 7/23/2021, the IRB reviewed the following submission:

Type of Review:	Initial Study, Category 4 and 7(b)
Title:	Stress management, coping mechanisms, and health outcomes in college students
Investigator:	Keith Brazendale
IRB ID:	STUDY00003298
Funding:	None
Grant ID:	None
IND, IDE, or HDE:	None
Documents Reviewed:	• Anthropometric Measures.pdf, Category: Test Instruments; • M01 Stress Coping Resources Inventory.pdf, Category: Survey / Questionnaire; • M01 The Perceived Stress Scale.pdf, Category: Survey / Questionnaire; • METs Survey - v2.pdf, Category: Survey / Questionnaire; • Study 3298 Consent Track Changes 07212021 - v3.pdf, Category: Consent Form; • Study 3298 Protocol Track Changes 07202021 - v2.docx, Category: IRB Protocol; • UCF Resources Questions.pdf, Category: Interview / Focus Questions

The IRB approved the protocol from 7/23/2021.

In conducting this protocol, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. Guidance on submitting Modifications and a Continuing Review or Administrative Check-in are detailed in the manual. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Katie Kilgore
Designated Reviewer

APPENDIX B
DEMOGRAPHIC QUESTIONNAIRE

B Demographic and Descriptive Information

Disclaimer: Your responses to this questionnaire are completely confidential and will not be disclosed to anyone outside of the research team. Your responses are linked to a unique and anonymous I.D., and will not be accessed outside of data analysis.

Q1 Please provide the initial of your first name followed by your last name (Example J. Smith):

Q2 Provide your age (Example 18 or 19):

Q3 Select your current college standing or position:

o First year student (including first year in college and incoming transfer student) (1)

o Sophomore (2)

o Junior (3)

o Senior (4)

Q4 Select your gender:

o Male (1)

o Female (2)

o Non-binary / third gender (3)

o Prefer not to say (4)

Q5 Select your race/ethnic identity:

o Black or African American (1)

o Asian or Pacific Islander (2)

o White or Caucasian (3)

o Hispanic or Latinx (4)

o Native American or Alaskan Native (5)

o Multiracial or Biracial (6)

o A race/ethnicity not listed here: (7)

____

o Prefer not to say (8)

Q6 Describe your current employment status:

o Working full-time (32+ hrs/week) (1)

o Working part-time (12-32 hrs/week) (2) o Working part-time (up to 12 hrs/week) (3)

o Other: (4) ____

o No employment (5)

Q7 How do you pay for college expenses (e.g., tuition, books, living expenses)? (Select all that apply)

▢ Parental, guardian, and/or family member support (1)

▢ Scholarships or grants (2)

▢ Loans (3)

▢ Full-time employment (4)

▢ Part-time employment (5)

▢ Other: (6) ____

APPENDIX C
REVISED METS AWARENESS SURVEY

MetS Knowledge questions

The knowledge questions were adopted from a previous study by Becker et al.

29. Becker BM, Bromme R, Jucks R: College students' knowledge of concepts related to the metabolic syndrome. Psychol Health Med 2008, 13(3):367–379.

About:

"The 90 questions about students' knowledge were about the conditions often leading to MetS, the outcome
and treatment of these conditions, and a description of physical changes relevant to MetS. The questions were divided into seven categories: diabetes (16 questions), adiposity (9 questions), hypertension (12 questions), high serum cholesterol (6 questions), arteriosclerosis (17 questions), stroke (12 questions), and myocardial infarction (18 questions). The response options to the questions were "true", "false", or "do not know". Students' responses were scored. The "correct" response was awarded one point and the "incorrect" and "do not know" responses were awarded zero points. The maximum possible total score for the MetS questions was 90."

Quote about questions taken from *Yahia, N., Brown, C., Rapley, M., & Chung, M. (2014). Assessment of college students' awareness and knowledge about conditions relevant to metabolic syndrome. Diabetology & metabolic syndrome, 6(1), 1-15.*

42 questions (by category) on next page →

Topic	**Question**	**Correct Answer (True T, False F)**
Diabetes (16)	Pregnant women have a reduced risk of acquiring diabetes.	F
	Eye disorders can be consequences of diabetes.	T
	There are several different types of diabetes	T
	Individuals with diabetes must have insulin shots.	F
	With diabetes, sugar cannot move in the blood.	F
	Hereditary factors play a major role in the development of diabetes	T
	An increased alertness is a frequent symptom of diabetes	F
	Hereditary factors play only a minor role in the development of diabetes.	F
	For some individuals with diabetes, it is not advisable to take insulin	T
	Individuals with diabetes may only eat special kinds of sweets for diabetes.	F
	With diabetes, sugar cannot enter the cells sufficiently	T
	Poor appetite is a frequent symptom of diabetes	F
	With diabetes, too much sugar enters the cells	F
	Pregnant women have an increased risk of acquiring diabetes	T
	Frequent urination is a classic symptom of diabetes	T
	Arteriosclerosis is one of the sequalae of diabetes	T
Adiposity (8)	An excessively fatty, high-caloric is the only factor that determines adiposity	F
	Adipose individuals have the same risk than non-adipose individuals of suffering a stroke	F
	Adiposity can be treated surgically	T

	Adipose individuals have an elevated risk of suffering myocardial infarction.	T
	Cessation of breathing while sleeping is a possible consequence of adiposity.	T
	Adipose individuals are more likely to suffer from arteriosclerosis	T
	The terms' overweight' and 'adiposity' are synonyms	F
	Liposuction is the best possible treatment in adiposity therapy	F
Hypertension (12)	Hypertension can cause dizziness.	T
	Hypertension is associated with heredity	T
	For the most part, a concrete single reason of why a patient suffers from hypertension can be determined.	F
	Pregnant women are less likely to suffer from hypertension	F
	After medication has lowered hypertension, the medication can usually be discontinued	F
	Individuals with hypertension are less likely to suffer from arteriosclerosis	F
	Hypertension can be caused by disorders of the thyroid gland	T
	Hypertension can cause renal damage	T
	Hypertension can lead to eye disorders	T
	Hypertension can be caused by cerebral tumors	T
	People with hypertension are as likely to suffer from arteriosclerosis as those with normal hypertension.	F
	Pregnant women are as likely to suffer from hypertension as non-pregnant women	F
High Serum Cholesterol (6)	High serum cholesterol does not cause acute ailments.	T
	High serum cholesterol is not associated with hereditary factors.	T
	A low cholesterol diet can supplement therapy for high serum cholesterol.	T
	High serum cholesterol can be treated with medication	T
	High serum cholesterol promotes arteriosclerosis	T

	Fatigue is a frequent symptom of high serum cholesterol	F

APPENDIX D
AWARENESS AND USE OF UCF RESOURCES

Students were prompted to answer the following questions:

1. Are you aware of the UCF transition mentoring services, including PeerKnights, mental health or coping resources such as CAPS and the Psychology Clinic, and stress management resources such as RESTORES available to help transition to college life? (YES/NO)

2. If you responded '**yes**' to **Q1**, please select the ones you have used:

- Transition Services
  - PeerKnights
  - Other
- Mental Health or Coping resources
  - CAPS
  - Psychology Clinic
  - Other (please write): ______________
- Stress Management resources
  - RESTORES
  - Other (please write): ______________

3. If you responded **'yes'** to **Q1**, have you used (e.g., contacted them, met with them, received help and/or guidance from them) these services in your time at UCF*?* (YES/NO)

APPENDIX E
RESULTS TABLES

E.1 TABLE 1 PARTICIPANT CHARACTERISTICS AND DEMOGRAPHICS

Table 1. Participant Characteristics and Demographics (N=43)

Variable	**N**	**Mean** (±SD)
Age	43	20.5 (1.5)
MetS Knowledge scores		
Diabetes Knowledge	43	12.8 (1.8)
Adiposity Knowledge	43	6.0 (0.9)
Hypertensive Knowledge	43	9.7 (1.6)
High Serum Cholesterol Knowledge	43	3.1 (0.9)
Academic Standing	**N**	**%**
Freshmen	6	13.95
Sophomores	5	11.63
Juniors	4	9.3
Seniors	28	65.12
Sex		
Female	37	86.05
Male	6	13.95
Race/Ethnicity		
Black	5	11.63
Asian	12	27.91
White	14	32.56
Hispanic	10	23.26
Multiracial	2	4.65
College Funding		
Partial family support and financial aid	26	60.47
Uses financial aid only	12	27.91
Uses employment and financial aid	5	11.63
Employment		
Full-time (32+ hrs/week)	2	4.65
Heavy Part-time Schedule (12-30 hrs/week)	17	39.53
Light Part-time Schedule (<12 hrs/week)	6	13.95
Not Employed	18	41.86
Perceived Stress		
Low	6	13.95
Moderate	37	86.05

Coping Score		
Average	4	9.3
Above Average	35	81.4
Superior	4	9.3

E.2 TABLE 2 PARTICIPANT CLINICAL OUTCOMES

Table 2. Participant Clinical Outcomes at the Beginning and End of the Academic Semester (N=43)

	PRE-ASSESSMENT				POST ASSESSMENT				CHANGE			
Clinical Measures	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**±SD**	**Min**	**Max**	**Mean**	**±SD**	**Min**	**Max**
HEIGHT (cms)	164.4	6.6	153.8	183.0	164.8	6.4	154.2	183.8	0.4	0.7	0.0	3.3
WEIGHT (kgs)	60.5	11.0	40.0	91.1	60.7	11.0	40.3	90.8	0.2	2.0	-3.9	7.9
BMI (kg/m^2)	22.3	3.4	15.2	33.1	22.3	3.4	15.3	33.0	0.0	0.8	-1.3	2.7
Average Systolic Blood Pressure (mmHg)	101.1	10.4	77.5	125.0	100.1	11.2	81.0	121.3	-1.0	8.4	-19.2	18.5
Average Diastolic Blood Pressure (mmHg)	67.9	5.9	57.0	81.5	68.9	7.4	55.0	89.0	1.0	6.1	-16.7	14.5

E.3 TABLE 3 SUBGROUP ANALYSIS

Table 3. Table 3. Clinical Outcomes and Predictor Variables (MetS Knowledge, Stress, and Coping) of First Time on Campus and Final Year Students

Variable of Interest	**FIRST TIME ON CAMPUS (N=11)**	**FINAL YEARS STUDENTS (N=32)**	**P-value of difference***

	Mean	SD	95% CI		Mean	SD	95% CI		
BMI Change (kg/m^2)	0.485	1.066	-0.231	1.201	-0.210	0.527	-0.400	-0.020	**0.007**
Height Change (cms)	0.464	0.800	-0.074	1.001	0.409	0.644	0.177	0.642	0.822
Weight Change (kgs)	1.736	2.764	-0.120	3.593	-0.313	1.375	-0.808	0.183	**0.002**
Systolic Blood Pressure Change (mmHg)	-3.197	10.047	-9.946	3.553	-0.266	7.839	-3.092	2.561	0.326
Diastolic Blood Pressure Change (mmHg)	-0.303	8.305	-5.882	5.276	1.401	5.157	-0.458	3.260	0.427
Diabetes Knowledge	12.000	1.342	11.099	12.901	13.063	1.865	12.390	13.735	0.090
Adiposity Knowledge	6.273	0.905	5.665	6.880	5.938	0.914	5.608	6.267	0.299
Hypertensive Knowledge	9.545	1.572	8.489	10.602	9.813	1.635	9.223	10.402	0.640
High Serum Cholesterol Knowledge	3.091	1.136	2.328	3.854	3.094	0.777	2.814	3.374	0.993
Perceived Stress Scores	17.636	3.233	15.464	19.809	17.188	4.518	15.558	18.817	0.764
Coping Scores	2.861	0.250	2.694	3.029	2.976	0.387	2.836	3.115	0.368

*Independent sample t-test of difference

E.4 SUPPLEMENTARY TABLE 1

Supplementary Table 1. Associations of Body Mass Index (BMI) or Systolic Blood Pressure change with Coping, Perceived Stress, and Metabolic Syndrome Knowledge

Dependent Variable	Model/Covariate(s)	β	S.E.	P value	95% Confidence Interval		Adjusted R-Squared
BMI	Perceived Stress Scale	0.03	0.03	0.28	-0.03	0.09	0.01

	Sex	-0.56	0.35	0.11	-1.26	0.14	
	Race/Ethnicity	0.01	0.11	0.95	-0.22	0.23	
	constant	-0.50	0.56	0.37	-1.63	0.62	
Systolic Blood Pressure	Perceived Stress Scale	0.24	0.33	0.47	-0.43	0.90	-0.05
	Sex	0.87	3.99	0.83	-7.20	8.94	
	Race/Ethnicity	0.01	1.28	0.99	-2.58	2.60	
	constant	-5.29	6.42	0.42	-18.28	7.70	
BMI	Coping Score	0.18	0.34	0.60	-0.50	0.86	-0.02
	Sex	-0.51	0.35	0.15	-1.22	0.19	
	Race/Ethnicity	-0.01	0.11	0.91	-0.24	0.21	
	constant	-0.47	1.00	0.64	-2.48	1.55	
Systolic Blood Pressure	Coping Score	-0.33	3.87	0.93	-8.16	7.49	-0.07
	Sex	1.57	4.00	0.70	-6.52	9.67	
	Race/Ethnicity	-0.10	1.28	0.94	-2.69	2.49	
	constant	-0.06	11.44	1.00	-23.21	23.08	
BMI	Diabetes Knowledge	0.02	0.07	0.78	-0.12	0.16	-0.02
	Sex	-0.47	0.34	0.18	-1.16	0.23	
	Race/Ethnicity	-0.02	0.12	0.88	-0.25	0.22	
	constant	-0.18	0.85	0.84	-1.90	1.54	
Systolic Blood Pressure	Diabetes Knowledge	0.21	0.78	0.79	-1.37	1.78	-0.07
	Sex	1.59	3.93	0.69	-6.36	9.54	
	Race/Ethnicity	-0.20	1.32	0.88	-2.88	2.48	
	constant	-3.50	9.73	0.72	-23.18	16.18	
BMI	Adiposity Knowledge	0.17	0.13	0.20	-0.09	0.42	0.02
	Sex	-0.43	0.34	0.21	-1.11	0.25	

	Race/Ethnicity	-0.03	0.11	0.82	-0.25	0.20	
	constant	-0.93	0.78	0.24	-2.51	0.66	
Systolic Blood Pressure	Adiposity Knowledge	-0.47	1.49	0.75	-3.49	2.54	-0.07
	Sex	1.37	3.94	0.73	-6.59	9.33	
	Race/Ethnicity	-0.06	1.29	0.96	-2.66	2.54	
	constant	1.74	9.14	0.85	-16.75	20.24	
BMI	Hypertensive Knowledge	-0.07	0.08	0.34	-0.23	0.08	0.001
	Sex	-0.43	0.34	0.22	-1.12	0.27	
	Race/Ethnicity	0.01	0.11	0.91	-0.21	0.24	
	constant	0.71	0.72	0.33	-0.75	2.17	
Systolic Blood Pressure	Hypertensive Knowledge	0.88	0.86	0.31	-0.86	2.63	-0.04
	Sex	0.89	3.91	0.82	-7.02	8.81	
	Race/Ethnicity	-0.38	1.29	0.77	-2.99	2.23	
	constant	-9.04	8.26	0.28	-25.75	7.67	
BMI	High Serum Cholesterol Knowledge	0.09	0.14	0.50	-0.18	0.37	-0.01
	Sex	-0.50	0.34	0.15	-1.19	0.19	
	Race/Ethnicity	-0.02	0.11	0.88	-0.24	0.21	
	constant	-0.22	0.46	0.63	-1.15	0.71	
Systolic Blood Pressure	High Serum Cholesterol Knowledge	-0.65	1.57	0.68	-3.82	2.52	-0.07
	Sex	1.65	3.93	0.68	-6.29	9.60	
	Race/Ethnicity	-0.06	1.28	0.97	-2.65	2.54	
	constant	0.86	5.27	0.87	-9.79	11.52	

*Linear mixed-effects regression models, p-value <0.05 indicates statistical significance

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