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OBESITY, PREDIABETES, AND PERCEIVED STRESS IN MUNICIPAL WORKERS

by

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A DISSERTATION

Submitted to the graduate faculty of The University of Alabama at Birmingham,  
in partial fulfillment of the requirements for the degree of  
Doctor of Philosophy

BIRMINGHAM, ALABAMA

2013

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# OBESITY, PREDIABETES, AND PERCEIVED STRESS IN MUNICIPAL WORKERS

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DOCTOR OF PHILOSOPHY IN NURSING

## ABSTRACT

Obesity and diabetes are major contributors to morbidity and mortality in the United States. According to the American Public Health Association and Partnership for Prevention, obesity is growing faster than any other public health problem in the United States. The prevalence of diabetes has also increased significantly with an estimated 79 million Americans aged 20 years or older suffering from prediabetes. Few studies have examined the influence of perceived stress on obesity and prediabetes among working adults. Investigations are needed to examine factors that can contribute to higher health care costs for both employees and employers.

The aims of this study were to examine the relationships among obesity, prediabetes, and perceived stress in municipal workers and determine the best subset of predictors for obesity and prediabetes in this population. Investigation of a subset of data from an employee health promotion program for a large municipality in the Southeastern U.S. was conducted. The Expanded Biobehavioral Interaction Model and Karasek and Theorell's Demand Control Model guided the study.

Secondary analysis of data from 3,501 municipal employees revealed that the majority of the sample was male (72.8%), African American (66.9%), 40-49 years of age

(31.4%), with police officers (30.1%) being the largest group of workers. The prevalence of obesity measured by BMI was 55.8% and 53.0% when measured by waist circumference. The prevalence of prediabetes measured by HA1c was 51% of the 1,963 participants who had HA1c screening. Logistic regression analyses revealed that age, black race, HA1c, physical activity, and occupation (especially police and public works) were significant predictors of obesity in municipal workers. When public safety workers were examined for obesity, age, female gender, HA1c, and physical activity were significant predictors. Prediabetes in municipal workers was predicted by age, black race, and BMI. Perceived stress was not a significant predictor of obesity or prediabetes in municipal workers. Findings from this study should guide the development of targeted health promotion and prevention programs in this employee population. Further research is needed to validate the models and explore the relationships among obesity, prediabetes, and stress.

Keywords: obesity, prediabetes, perceived stress, municipal workers.

## DEDICATION

I dedicate this work to my husband Gerry and my daughter Maria. Thank you to Gerry who provided understanding, encouragement, support, and love throughout various personal and professional pursuits enabling me to climb to the top of Maslow's pyramid. To Maria, my love and admiration are boundless as is my gratitude for the support throughout this process. I would not have made it through this journey without both of you at my side.

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## CHAPTER 1

### INTRODUCTION

Obesity and diabetes are major contributors to heart disease, which is the primary cause of death in the United States for both men and women (Centers for Disease Control and Prevention, 2010; LeBlanc, O'Connor, Whitlock, Patnode, & Kapka, 2011). Obesity is now considered a public health epidemic affecting all segments of the population in the United States (U.S.) regardless of gender, race, or socioeconomic status (Flegal, Carroll, Ogden, & Curtin, 2010; U.S. Department of Health and Human Services, 2010). The prevalence rate of obesity in the U.S. is 30%, and obesity is a known risk factor for chronic diseases such as diabetes, hypertension, stroke, hypercholesterolemia, heart disease, certain cancers, gallbladder disease, sleep apnea, respiratory problems and osteoarthritis (Flegal et al., 2010; Mokdad et al., 2001; U.S. Department of Health and Human Services, 2010). Diabetes, obesity, and physical inactivity are among the medical conditions and lifestyle choices that contribute to a higher risk for heart disease and are major causes of morbidity and mortality in the United States (LeBlanc et al., 2011). In addition, the risk for obesity, diabetes, and heart disease has been found to increase in the presence of perceived stress (Azagba & Sharaf, 2011; Michie, 2002; Ramey, 2003).

During the past three decades obesity rates have more than doubled in the United States going from 15% in the 1970s to 33% in 2007 (Ogden, Yanovski, Carroll & Flegal, 2007). Early in the 20<sup>th</sup> century obesity in the U.S. was associated with a high socioeconomic status and was a recognized public health problem that affected only those

in the higher economic strata of the population (Caballero, 2007). By the year 2000 the number of U.S. adults with excess weight surpassed the number of those who were underweight regardless of socioeconomic status (Gardner & Halwell, 2000; World Health Organization, 2012). This rise in obesity is seen globally and it is thought to be related to easy access to relatively inexpensive food, urbanization of rural communities, sedentary lifestyles, and lack of physical activity (Caballero, 2007; Gardner & Halwell, 2000).

The National Health and Nutrition Examination Survey (NHANES) data demonstrated an increase in the prevalence of obesity for both men and women in all age groups (Flegal et al., 2010). According to 2009–2012 data from the NHANES, 35.7% of adults in the U.S. were obese with similarities in the prevalence rates of obesity in men and women (Ogden, Carroll, Kit, & Flegal, 2012). When the United States was compared to European countries using self-report data and anthropometric measurements, the United States had the highest rate of obesity (Bassett, Pucher, Buehler, Thompson, & Crouter, 2008). According to Flegal and colleagues (2010) nearly two thirds of U.S. adults are overweight as measured by a body mass index (BMI) higher than 25 kg/m<sup>2</sup>. Obesity, defined as a BMI of greater than 30 kg/m<sup>2</sup> is considered to be a national health crisis, with a prevalence rate of 30% (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999; Flegal et al., 2010; Schulte et al., 2007; U.S. Department of Health & Human Services, 2010; World Health Organization, 2011). BMI is a useful measure for an initial assessment for weight gain (Brenner, Tepylo, Eny, Cahill, & El-Sohemy, 2010; Flegal et al., 2010; Klein et al., 2007).

According to the World Health Organization (2000), obesity is a global problem with more than one billion overweight adults and at least 300 million who are obese. In a

systematic analysis of health examination surveys and epidemiologic studies with 9.1 million participants, Finucane and colleagues (2011) reported an increase in BMI globally. Three million deaths a year occur as a consequence of excessive weight and its contribution to cardiovascular disease, diabetes, cancer, and musculoskeletal disease (Finucane et al., 2011).

In addition, the prevalence of diagnosed diabetes has increased significantly from 1988 to 2006 (Flegal et al., 2010). The number of individuals with diabetes worldwide is projected to increase to 333 million by the year 2025 and the annual cost of diabetes in the U.S. has reached \$174 billion (CDC, 2011). According to the Centers for Disease Control and Prevention an estimated 79 million American adults aged 20 years or older have prediabetes (CDC, 2011). Prediabetes is a state of elevated blood glucose levels that is a precursor to diabetes and is associated with \$25 billion annually in higher medical costs (Dall et al., 2010).

Compounding the problem of chronic health conditions such as obesity and prediabetes is the presence of perceived stress. The National Institute for Occupational Safety and Health (NIOSH) has long recognized the role of stress on health. In a 1999 publication regarding stress at work, NIOSH emphasized that job stress can lead to poor health, increasing the risk for cardiovascular disease, muscle and skeletal disorders, mood disturbances, workplace injuries, and mental health problems raising health care expenditures as much as 50% or greater for those workers reporting high levels of stress than for the rest of the working population (CDC, 1999).

The concept of stress was introduced by Hans Selye in the 1930s. Selye defined stress as the organism's response to any stress or demand (Selye, 1976). Subsequent



research explored the relationship of the individual to the environment, stressors, and other stimuli that trigger a stress response in the individual (Cooper, Dewe, & O'Driscoll, 2001). The American Psychological Association's Stress in America 2010 survey reported that money, work, and the economy are the most common causes of stress. Behavioral consequences of stress include overeating or eating unhealthy foods, irritability, fatigue, and lack of energy and motivation which could contribute to chronic health conditions such as prediabetes and obesity (American Psychological Association, 2010; Han, Storr, Trinkoff, & Geiger-Brown, 2011; Heraclides, Chandola, Witte & Brunner, 2012; Montes & Kravitz, 2011).

In a longitudinal cohort study of 21,290 female registered nurses, Cheng, Kawachi, Coakley, Schwartz, and Colditz (2000) reported that job stress can predict a decline in health that is similar to the decline brought on by smoking and a sedentary lifestyle. In addition, Franke, Ramey, & Shelley (2002) demonstrated the negative health-related effects of stress on cardiovascular health. In a large, prospective, nineteen year study of 6,895 men and 3,413 women, Brunner, Chandola, and Marmot (2007) demonstrated a positive relationship between work stress and obesity. About 70% of American workers consider their workplace a significant source of stress and 51% report that stress reduces their productivity (American Psychological Association, 2010).

Health care utilization related to stress-induced problems costs U.S. industries an estimated \$68 billion annually and reduces their profits by 10 % (American Psychological Association, 2010; Azagba & Sharaf, 2011; Gibson, 1993). Although the effect of stress on health has become both a societal and economic problem, little is

known about the influence of stress on chronic health conditions in working populations such as municipal employees.

### Statement of the Problem

The United States workforce is growing older; the downturn and uncertainty in the economy has contributed to a delay in retirement with employees staying in their jobs for longer periods (Lee et al., 2012). The proportion of workers 55 years and older is projected to increase from 18.1% of the labor force in 2008 to 23.9% in 2018 (Bureau of Labor and Statistics, 2011). The aging of the workforce contributes to the employee health care burden and rise in chronic health costs for such conditions as diabetes and obesity. Seventy-eight percent of the all health care spending in the United States and seven out of ten deaths per year are attributed to chronic illness, much of which is preventable (CDC, 2012). These chronic health conditions result in an enormous burden for both the individual and the employer especially since employers are the primary payers of health insurance premiums for workers (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009).

Obese workers were found to experience a higher level of absenteeism and a lower productivity output than non-obese workers (Schulte et al., 2007). Obesity was shown to be associated with higher health care costs than smoking, drinking, and poverty (Sturm, 2002; Sturm & Wells, 2001). Sturm (2002) reported that obesity increases health care costs 36% and medication costs 77% when compared with an individual at a normal weight and appears to have a stronger association with the occurrence of chronic medical conditions and reduced health-related quality of life than smoking and excessive

drinking. Obesity has become a public health priority because a larger proportion of the population is obese (23%) than the proportion of the population who are poor (14%), heavy drinkers (6%), or daily smokers (19%) (Sturm & Wells, 2001).

A report from the American Public Health Association and Partnership for Prevention (2009) reported that obesity is growing faster than any public health issue the United States has ever faced with the potential of having 103 million adults suffering from obesity by 2018 (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009). If obesity rates continue to rise at their current levels, the United States is expected to spend \$344 billion by the year 2018 on health care costs related to obesity with obesity-related expenditures accounting for more than 21% of the nation's direct health care spending (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009). The data for this analysis were obtained from the 2006 Household Component to the Medical Expenditure Panel Survey and the 1998 through 2008 Behavioral Risk Factor Surveillance System (BRFSS) files (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009). According to the BRFSS data, 36.3% of the adult population in Alabama was obese in 2008. By 2018, 49.3% of the adult population will be obese in Alabama. This will increase the obesity-attributable health care spending in Alabama from \$1,424 million in 2008 to \$5,592 million in 2018 (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009).

The most closely linked chronic condition to obesity is type 2 diabetes (Zhang et al., 2010). Type 2 diabetes is the leading cause of kidney failure, non-traumatic lower limb amputations, newly diagnosed cases of blindness among adults, and the seventh

leading cause of death in the United States (CDC, 2011; Qaseem et al., 2007). Based on fasting glucose or glycosylated hemoglobin (HA1c) levels, 35% of U.S. adults aged 20 years or older or an estimated 79 million Americans had prediabetes, a precursor to diabetes (CDC, 2011). The estimated 2007 direct medical costs of diabetes in the U.S. were \$116 billion. The average medical expenditures among people with diagnosed diabetes were 2.3 times higher than what the expenditures would be in the absence of diabetes (CDC, 2011).

Given that employed adults spend a quarter of their lives at work it is important to evaluate the work characteristics that affect workers' health and safety related to obesity and prediabetes (Schulte et al., 2007). Work schedules may influence health by causing job strain or alter health behaviors. For example, shift work may lead to disruption of normal eating times, reduce access to healthy food choices, and affect quantity and quality of sleep. These conditions may interfere with adherence to health behaviors leading to a higher risk for obesity and prediabetes (Han et al., 2011). Research is needed to explore how work environments, stress, and personal factors are associated with obesity and prediabetes. Obesity and prediabetes affect both work opportunities and performance. A study conducted with 478 career and 199 volunteer male firefighters in the Missouri Valley Region (Colorado, Iowa, Kansas, Missouri, North Dakota, Nebraska, South Dakota, and Wyoming) demonstrated that the prevalence of obesity exceeded that of the general population. Obesity in this cohort affected both job performance (difficulty climbing ladders with equipment) and safety (Poston et al., 2011).

Certain occupational groups such as police officers and firefighters are generally viewed as being in highly stressful work because of the risk of violence and exposure to

traumatic events. However other occupations held by municipal workers can also be perceived by these individuals as stressful (Collins & Gibbs, 2003). Organizational issues such as workload, shift work, managerial support, paperwork that is perceived as excessive or unnecessary, lack of input into decision-making, communication issues, and balancing family and work life have been found to cause more psychological distress than exposure to violence or traumatic events (Collins & Gibbs, 2003; Franke et al., 2002; Marchand, Demers, & Durand, 2005). In a review focusing on occupational stress, Mazzola, Schonfield, and Spector (2011) reported that organizational constraints, work overload, and interpersonal conflict were universal stressors in American, Australian, Chinese, English, Indian, and New Zealand workers. A component of organizational stress is the perception of a lack of control over decision-making, which has been defined as job strain. Brown, James, and Mills (2006) defined job strain as those roles that have minimal control over decision-making but carry great responsibilities.

Stress has been associated with negative health-related effects such as cardiovascular disease and its risk factors (Franke et al., 2002). In a review of nineteen case-control and cohort studies, Lee, Colditz, Berkman & Kawachi (2002) found an association between job strain and cardiovascular disease across a variety of occupations and settings. This association was enhanced in the presence of cardiovascular risk factors such as obesity (as measured by an elevated BMI), smoking, and hypertension (Lee et al., 2002). Multiple studies have demonstrated that stress can place a strain on the individual resulting in physiological changes leading to cardiovascular diseases (Collins & Gibbs, 2003; Kouvonen, Kivimaki, Cox, Cox, & Vahtera, 2005; Ramey, 2003; Ramey, Downing, & Knoblauch, 2008; Richmond, Wodak, Kehoe, & Heather, 1998; Violanti et

al., 2006). Given the dramatic increase in the prevalence of obesity, prediabetes, and stress in the last three decades, a better understanding is needed regarding the influence of stress and personal factors on obesity and prediabetes in municipal workers.

### Purposes of the Study

The purposes of the study were to: 1) examine the relationships among obesity, prediabetes, and perceived stress in municipal workers; 2) examine the relationship between perceived stress and occupation; 3) identify the best subset of predictors for obesity in municipal workers from the set of perceived stress, HA1c, shift schedule, level of activity, occupation, and personal factors (age, gender, and race); and 4) identify the best subset of predictors for prediabetes in municipal workers from the set of perceived stress, level of activity, BMI, shift schedule, and personal factors (age, gender, and race).

### Research Questions

1. What is the prevalence of prediabetes and obesity in municipal workers?
2. Is there a relationship between perceived stress and occupation in municipal workers?
3. What is the relationship between perceived stress and obesity in municipal workers?
4. What is the relationship between perceived stress and prediabetes in municipal workers?
5. Are there differences in obesity among municipal workers by shift schedule, education, or gender?

6. What are the relationships among level of activity, prediabetes, and obesity in municipal workers?
7. What is the best predictive model for obesity (BMI > 30) in municipal workers using perceived stress and the personal factors of age, gender, and race?
  - a. Does the inclusion of HA1c add to the predictive ability of the model?
  - b. Does the inclusion of shift schedule add to the predictive ability of the model?
  - c. Does the inclusion of level of activity add to the predictive ability of the model?
  - d. Does the inclusion of occupation add to the predictive ability of the model?
8. What is the best predictive model for obesity (defined as waist circumference > 40 inches in men and > 35 inches in women) in public safety workers using perceived stress, and the personal factors of age, gender, and race?
  - a. Does the inclusion of HA1c add to the predictive ability of the model?
  - b. Does the inclusion of shift schedule add to the predictive ability of the model?
  - c. Does the inclusion of level of activity add to the predictive ability of the model?
9. What is the best predictive model for prediabetes (HA1c between 5.7% and 6.4%) in municipal workers using perceived stress and the personal factors of age, gender, and race?
  - a. Does the inclusion of BMI add to the predictive ability of the model?

- b. Does the inclusion of shift schedule add to the predictive ability of the model?
- c. Does the inclusion of level of activity add to the predictive ability of the model?
- d. Does the inclusion of occupation add to the predictive ability of the model?

### Conceptual Framework

The conceptual frameworks used to guide this study are the Expanded Biobehavioral Interaction (EBI) Model and Karasek and Theorell's Demand Control Model (Kang, Rice, Park, Turner-Henson & Downs, 2010; Karasek & Theorell, 1990). The EBI Model explores links among psychosocial, behavioral, individual, and biological factors in relation to health outcomes and the Karasek and Theorell model is focused on the individual at the worksite and the psychosocial characteristics of that environment (Fernandez, Su, Winters, & Liang, 2010; Kang et al., 2010; Karasek & Theorell, 1990).



Conceptual Model: Combined EBI and Demand Control Model  
Applied to Study.

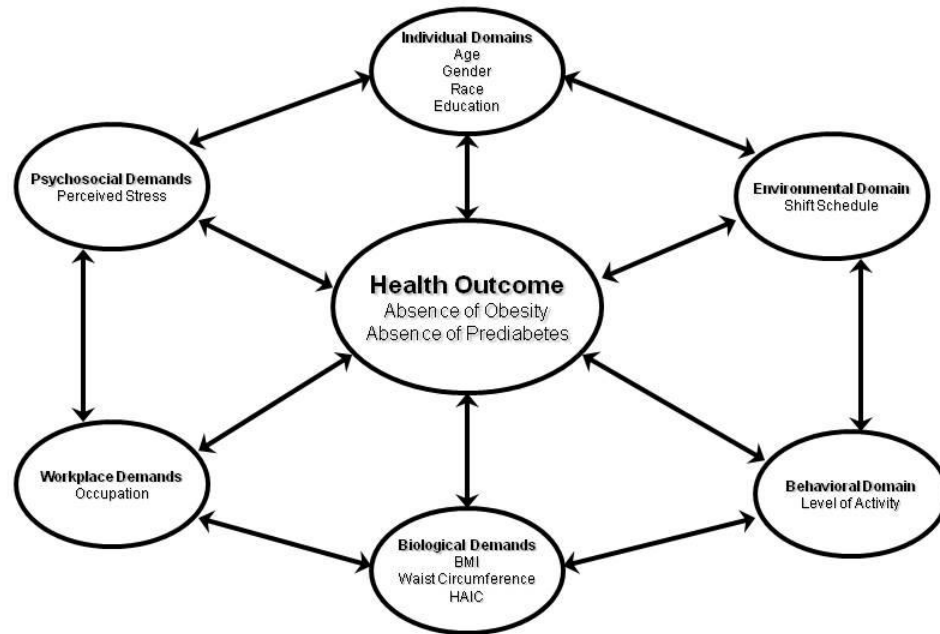


Figure 1. Conceptual Framework

In the EBI model, interactions among psychosocial, behavioral, individual, and environmental factors are explored (Kang et al., 2010). The core constructs of the EBI model include the five domains of individual, environmental, psychosocial, behavioral, and biological factors which influence health-related outcomes. The EBI model is adapted from Selye’s physiologic model of stress, Lazarus and Folkman’s Transactional Model of Stress and Coping, and the McEwen Stress, Allostasis, and Allostatic Load Model, bringing together the strengths from each model (Kang et al., 2010).

The clusters of individual, environmental, psychosocial, and behavioral factors can individually or interactively influence biological or physiological responses to affect health or health-related outcomes. A potential bidirectionality exists among these factors

because, for example, the presence of a chronic health condition can influence any of the domains.

The individual domain consists of characteristics of people such as gender, age, race, and education. Factors from the individual domain can influence factors of the psychosocial, behavioral, and biological domains as well as health outcomes (Kang et al., 2010).

The environmental domain is composed of social norms, stress, and physical environment that surround an individual. Factors in the environmental domain may influence factors of psychosocial, behavioral, and biological, domains and health outcomes (Kang et al., 2010).

The psychosocial domain includes factors such as stress, emotions, coping, and hardiness. Factors in the psychosocial domain may influence factors in the behavioral and biological domains as well as health outcomes.

The behavioral domain includes lifestyle factors such as smoking, drinking, diet, and physical activity. The behavioral domain may influence biological, psychosocial, individual, environmental domains as well as health outcomes.

The biological domain includes metabolic functions and body responses within the immune, endocrine, cardiovascular, pulmonary, and neuromuscular systems. This domain affects health outcomes as well as influencing and being influenced by the psychological and behavioral domains.

Health outcomes are the consequences of the individual, environmental, psychosocial, behavioral, and biological domains. In turn, health outcomes can influence

the psychosocial and behavioral factors such as when an individual is living with a chronic disease.

The Demand Control (also known as Job Strain Model) Model was initially conceived by Robert Karasek in 1979 and later developed with Tores Theorell (Karasek & Theorell, 1990). According to the Demand Control Model, an interaction exists between workload demands in the environment and the employee's ability to meet these demands. The model was developed for work environments with chronic stress in which the worker is overloaded psychologically and at the same time is deprived of control over the work environment. The stressors are not only chronic but are the product of human organizational decision-making. This combination is predicted to give rise to an increased risk of stress-related illness (Belkic, Landsbergis, Schnall, & Baker, 2004). The Demand Control Model has been used in previous studies to examine the effect of a high stress work environment and the development of cardiovascular disease (Belkic et al., 2004; Brunner et al., 2007; Chandola et al., 2008; Jacobs et al., 2010; Kang et al., 2004; Kouvonen et al., 2005).

The Demand Control Model posits that the combination of high work demand with low decision latitude results in job strain which leads to an increased risk of cardiovascular disease (Kang et al., 2004). The Demand Control Model postulates that psychological strain does not result from a single aspect in the work environment but from the joint effects of work demands and the lack of decision-making control available to the worker (Karasek, 1979). Job strain occurs when job demands are high and the scope of decision-making latitude is low. Work demands refer to workload and decision latitude refers to an individual's ability to control his or her work activities. These work

activities could encompass the pace and quantity of work, policies and procedures, times of breaks, and scheduled work hours (Kivimaki et al., 2008).

Karasek and Theorell's Demand Control Model assumes that job environments can be characterized in terms of two dimensions: psychological work demands and the amount of control workers have to meet these demands (Taris, Kompier, Geurts, Houtman, & van der Heuvel, 2010). Workers in low control/high demands jobs cannot respond optimally to the high demands of their job. Work that combines high demands with low control is predicted to cause a high state of job strain leading to the risk of psychological and physical morbidity such as cardiovascular disease. The highest risk of illness is assumed to be related to those jobs characterized by high demands and low job control (Kivimaki et al., 2008). The optimal combination is of high demand and high control, thus protecting themselves from excessive strain (McClenahan, Giles, & Mallett, 2007).

The Karasek and Theorell Demand Control Model categorizes workers into four distinct kinds of psychological work experiences. The four categories are: passive jobs (low demand and low control), low strain jobs (low demand and high control), high strain jobs (high demand and low control), and active jobs (high demand and high control) (Lee et al., 2002). Significantly it is not the demands themselves that are the risk factors for cardiovascular disease but it is the combination of high demand and low control. This was exemplified in the Whitehall II Study in Britain. Researchers examined the effect of stress on workers in the British Civil Service, and a wide range of illness was found in the lower grades of employment where lower amount of control over work is found (Council of Civil Service Unions, 2004).

## The Conceptual Models Applied to the Study

To identify factors contributing to obesity and prediabetes in the presence of perceived stress in municipal workers, this study focused on the individual, environmental, psychosocial, behavioral, biological domains, and the health outcomes explored in the EBI Model. Given that the population in this investigation consists of employed municipal workers, this study will also focus on the assumption in the Karasek and Theorell Model (1990) that psychological strain can result from the effects of work demands and the decision-making latitude available to the employee.

The development of obesity and prediabetes has been associated with a number of controllable factors such as stress, diet, lack of physical activity; and uncontrollable factors such as age, gender, and race (Bjontorp, 2001; Brunner et al., 2007; Chandola et al., 2008). It is important to explore the factors that contribute to controlled weight and blood glucose especially in the presence of stress. Obesity and diabetes lead to severe complications such as heart disease, stroke, and renal failure. These complications contribute to increased medical costs (Flegal et al., 2010).

Based on the EBI and Karasek and Theorell Model, achieving the health outcomes of controlled weight and normal blood glucose will lead to the absence of obesity and stop the transition from prediabetes to diabetes. The framework of both models will be used as a guide for exploration to identify the risks for obesity and prediabetes in municipal workers [see Figure 1] (Kang, 2010; Karasek & Theorell, 1990). The selected relationships examined are as follows:

### *Individual Domain*

The individual domain includes age, gender, race and education. According to national data, disparities exist in the prevalence of obesity and diabetes rates in the United States. NHANES data collected in 1999-2004 reported that prevalence for obesity increased with age in both men and women (Wang & Beydoun, 2007). The prevalence of overweight and obesity was higher in black men and women than whites and black men and women are at higher risk for type 2 diabetes than whites across all levels of body weight (Paeratakul, Lovejoy, Ryan, & Bray, 2002). Several studies demonstrated that obesity was more prevalent with lower education (Cavaliere & Banterle, 2008; Hall, Stephen, Reeder, Muhajarine & Lasiuk 2003; McLaren, 2007).

### *Environmental Domain*

Shift schedule is the environmental domain variable considered in this study. Shift work has been implicated with interruptions in circadian rhythm and changes in dietary patterns that promote insulin resistance, obesity, and the metabolic syndrome (Getz & Reardon, 2007; Wolk & Somers, 2007).

### *Psychosocial Domain*

Perceived stress was the only psychosocial domain variable considered in this study. Various studies have reported on the link between perceived stress and obesity. Brunner and colleagues (2007) reported that chronic stress can promote general and central obesity. Other studies have shown an association between perceived stress and an increase in BMI (Bjontorp, 2001; Chandola et al., 2008; Ramey, 2003; Violanti et al.,

2006). Stress is associated with the release of counter-regulatory hormones which can result in elevated blood glucose levels. Stress can also increase glucose levels through the disruption in self-care behaviors such as diet and exercise (Surwit et al., 2002). Several studies have reported an elevated HA1c with exposure to chronic stress (Cesana et al., 1985; Grossi, Perski, Evengard, Blimkvist, & Orth-Gomer, 2003; Kelly, Stedman & Leonardi-Bee, 2005; Netterstrom & Sjol, 1991).

### *Workplace Demands*

In this study occupation is examined as a workplace demand variable. Certain job characteristics have detrimental effects on an employee's health status. Since employees spend many hours at work over their lifespan, it is important to identify occupations in certain departments or job characteristics that could potentially have a negative effect on health (Michie, 2002).

### *Behavioral Domain*

The only variable in this study that falls under the behavioral domain is physical activity. Inactivity and obesity are both related to the risk of developing diabetes (Wing et al., 2001). In the presence of stress, participation in health promoting behavior such as exercise is likely to be disrupted (Surwit et al., 2002)

### *Biological Domain*

The biological domain includes BMI, waist circumference, and HA1c. BMI and waist circumference are indicators of obesity and are associated with the risk of

developing prediabetes and its transition into diabetes (Flegal et al., 2010). HA1c levels are used as a diagnostic measurement of prediabetes. A diagnosis of prediabetes predicts an increased risk for developing diabetes and its sequela (Zhang et al, 2010).

The combined EBI and Karasek's and Theorell's Demand Control Model illustrate the interactions between individual, environmental, behavioral, psychosocial, biological, and workplace demands and how they affect health outcomes (figure 1). This combined model is appropriate for this study because it demonstrates and supports the relationship among the research variables in a working population.

#### Definition of Terms

The following definitions are used in the research study:

*Obesity*: refers to the presence of a body mass index (BMI) of 30 kg/m<sup>2</sup> or greater (U.S. Department of Health and Human Services, 2010). BMI provides a standardized definition of overweight and obesity for the purposes of national surveillance, and is defined as weight in kilograms divided by the square of the height in meters (kg/m<sup>2</sup>) (World Health Organization, 2011). BMI was calculated using screen height and weight data by converting weight in pounds to kilograms (kg) divided by the square of height in meters (m<sup>2</sup>).

*Prediabetes*: refers to the presence of a state of elevated blood glucose reported as glycosylated hemoglobin (HA1c) levels between 5.7% to 6.4%. If the HA1c level is 6.5% or above, an individual has diabetes (CDC, 2011; Garber, 2011; Garber et al., 2008). HA1c will be obtained from the health screen biophysical data.



*Perceived stress:* refers to self-reported level of stress in the past two weeks as indicated on the health risk appraisal TeleForm® instrument. Response categories include: a lot, moderate amount, relatively little, and almost none.

*Level of Activity:* refers to self-reported activity level as recorded on the health risk appraisal TeleForm® instrument. Response categories of scoring include: at least 3 times per week, 1 or 2 times per week, and less than 1 time per week.

*Waist Circumference:* A high-risk waist circumference is defined as greater than 102 centimeters (approximately 40 inches) in men and 88 centimeters (approximately 35 inches) in women (Janssen, Katzmarzyk, & Ross, 2004; National Cholesterol Education Program, 2002). Results are measured in inches and recorded on the health risk appraisal TeleForm® instrument.

*Personal factors:* refer to the self-reported responses on the wellness program TeleForm® instrument. *Age:* was reported as a birth date, which was then converted into the nearest whole year of age. *Gender:* was a dichotomous choice of male or female. *Race:* was reported as White, Native American, Asian, Black, Pacific Islander, other or not known.

*Education:* was self-identified on the health risk appraisal TeleForm® instrument as grade school or less, some high school, high school graduate, some college, college graduate, and post graduate or professional degree.

*Occupation:* was self-identified by department on the health risk appraisal TeleForm® instrument as (1) police, (2) fire, (3) public works, and (4) city hall.

*Shift Schedule:* was a self-identified schedule of working time from the health risk appraisal TeleForm® instrument. For the purposes of this study, shift schedule was

reported as follows: 7:00am – 3:00pm, 8:00am – 5:00pm, 3:00pm – 11:00pm, 11pm – 7:00am, Shift A Fire, Shift B Fire, Shift C Fire, and other.

*Public Safety Workers:* refers to those individuals employed in the police and fire departments as police officers and fire fighters.

*Municipal workers:* refers to employees of a municipality located in the southeastern region of the United States who participated in the wellness health screens.

### Assumptions

The following assumptions were made for this study:

1. Municipal workers are in a constant, dynamic interaction with their environment.
2. The interaction of municipal workers with their environment has both direct and indirect effects on the workers' ability to maintain a state of wellness/stability state.
3. Municipal employees work in stressful situations.
4. A high workload with a lack of control over decision-making may contribute to increased stress and illness.
5. Obesity and prediabetes are chronic conditions that are risk factors for cardiovascular disease.

## CHAPTER 2

### LITERATURE REVIEW

The purpose of this chapter is to review the literature related to the variables under investigation in this study. This chapter will examine evidence in the literature on the relationships among obesity and prediabetes in the presence of perceived stress in municipal workers. There is ample evidence that obesity and prediabetes are highly prevalent in the adult population but there is a lack of research about the prevalence and the contribution of perceived stress on obesity and prediabetes in municipal workers (Brunner et al., 2007; Michie, 2002; Ramey, 2003).

#### Obesity in the Presence of Perceived Stress

Obesity has become the second leading preventable cause of death in the United States, second only to tobacco use (Wang & Beydoun, 2007). There are many causes of weight gain in adults, but in most individuals weight gain occurs because of an increase in calorie consumption and a lack of physical activity (Wang & Beydoun, 2007). Unhealthy behaviors account for 40% of all deaths each year and perceived stress is thought to shape the practice of health behaviors including weight control (Krueger & Chang, 2008; Mokdad, Marks, Stroup, & Gerberding, 2004).

The relationship between perceived stress and obesity has been examined in previous studies. In a large prospective 19 year study of 6,895 men and 3,413 women,

Brunner and colleagues (2007) were able to demonstrate a dose-response relationship between work stress and general and central obesity. Brunner and colleagues (2007) reported that employees who work under chronic stress conditions have 50% higher odds of obesity when compared with those who do not have work stress even after taking into consideration socioeconomic position and variation in adverse health behaviors. High fat food intake, and unhealthy behaviors such as smoking, increases under stressful working conditions and can contribute to the development of the metabolic syndrome and obesity (Chandola et al., 2008).

In an extensive review of the literature, Bjontorp (2001) demonstrated a potentially causal link between stress and the accumulation of visceral fat, in particular abdominal obesity. Bjontorp (2001) concluded that a biological neuro-endocrine stress-response is followed by visceral fat accumulation especially if the individual is genetically susceptible. This visceral fat accumulation is a result of a long-term stress exposure.

A cross-sectional study of 2,818 law enforcement officers compared with 9,650 general population participants from the 1999 BRFSS found an association between perceived stress and cardiovascular disease in police officers (Ramey, 2003). A greater prevalence of hypercholesterolemia, tobacco use, and increased body mass index was found in law enforcement officers compared to the general population. Diagnosed cardiovascular disease was considered to be job-related by the respective police departments in the study and most law enforcement officers chose to retire with this medical disability. When police officers retired under the umbrella of 'medical disability' the cost to the police departments was substantial since payment was based on

years of service with remuneration between 60% to 80% of their salary (Ramey, 2003). A limitation in this study was the homogeneity of the sample (all nine police departments were from the Midwest and participants were all male) which could affect generalizability of the results. The comparison data from the BRFSS had low response rates for some questions leading to the problem of missing data and potentially an underestimation of morbidity measures on the questionnaires. In another study, Ramey and colleagues (2008) reported greater prevalence of hypertension, overweight, and obesity among the Milwaukee Police Department officers than in the general population of Wisconsin.

The Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study integrated psychological, physiological, and subclinical measures of stress, disease, and mental dysfunctions. The BCOPS study reported that compared to populations of similar age, police officers had a slightly lower flow mediated dilation, lower carotid intima-media thickness, an elevated body mass index, and higher reported rates of depression and post traumatic stress disorder (Violanti et al., 2006). The major limitation of this study was the relatively small sample of 100 police officers however both genders were represented with 42 female and 58 male participants.

A weak association between work stress and body mass index was found among 45,810 Finnish public sector workers, after controlling for age, marital status, smoking, alcohol use, physical activity, and negative affectivity (Kouvonen et al., 2005). In this cross-sectional study, a higher BMI was associated with lower job-control and higher job strain. In men lower job demands were also associated with a higher BMI. Given that the study design was cross-sectional, reverse causality cannot be ruled out. Did the

presence of obesity give rise to the perceived stress or did the perceived stress give rise to over-eating which led to obesity?

Further research is needed on obesity and perceived stress in other working populations. Investigations are needed to examine predictors of obesity in employees such as municipal workers who have wellness programs and health insurance yet who have high rates of obesity. Research in this area will guide occupational health professionals in identifying targeted interventions designed to decrease cardiovascular morbidity.

#### Prediabetes in the Presence of Perceived Stress

The term prediabetes was initially used in the 1960s to denote abnormalities of pregnancy, such as high birth-weight babies and hydramnios, or a strong family history of diabetes (Alberti, 2007; Grundy, 2012). The term was later discarded by the World Health Organization because of the danger of falsely labeling individuals as prediabetics when some individuals would not convert to diabetes even with a borderline elevated glucose (Grundy, 2012).

The American Diabetes Association (ADA) re-introduced the term prediabetes in 2005 to cover impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) and in 2010 recommended the use of a Hemoglobin A1c (HA1c) measurement of 5.7% to 6.4% as a diagnosis of prediabetes (ADA, 2010; ADA, 2012). In a systematic review of 44,203 individuals from 16 cohort studies, Zhang and colleagues (2010) demonstrated that individuals with a HA1c between 5.5% and 6.0% had a substantially increased risk of diabetes and a 5 year incidence ranging from 9% – 25%. In addition, individuals with

a HA1c range of 6.0% to 6.5% had a 5 year risk of developing diabetes between 25%-50% and relative risk 20 times higher compared with a HA1c of 5% (Zhang et al., 2010). Selvin and colleagues (2010) compared the prognostic value of HA1c when compared with fasting glucose values to predict which non-diabetic adults were at risk for diabetes or cardiovascular disease. This study was a community-based prospective cohort study of 15,792 middle-aged black and white adults from four U.S. communities. HA1c was found to be a stronger predictor of subsequent diabetes and cardiovascular events than fasting glucose (Selvin et al., 2010). In a prospective population study in Great Britain with a sample of 10,232 individuals aged 45 to 79 years of age, those with a HA1c less than 5% (which made up one quarter of the sample) had the lowest rates for mortality and cardiovascular disease (Khaw et al., 2004).

When compared to a two-hour oral glucose tolerance test or a fasting glucose, HA1c has several advantages as a diagnostic test. HA1c can be measured any time of day without the need for fasting and it is more convenient for a patient (no fasting or waiting time of two hours as in the glucose tolerance test). The HA1c test avoids the problem of day to day variability in the glucose value since it reflects average plasma glucose over the past 2 to 3 months. HA1c has a close correlation with the risk of long-term diabetes complications and mortality such as cardiovascular disease, obesity, nephropathy, and retinopathy (Choi et al., 2011; Goldenberg, Cheng, Punthakee & Clement, 2011; Selvin et al., 2010; & Zhang et al., 2010).

The main disadvantages are that HA1c must be measured using a validated assay standardized to the National Glycohemoglobin Standardization Program and it is affected by hemoglobinoaphies, anemias, and severe hepatic and renal disease (Goldenberg et al.,

2011; Kumar et al., 2010). Various ethnicities such as African Americans, American Indians, Hispanics, and Asians have HA1c values up to 0.4% higher than Caucasians at similar levels of glycemia (Goldenberg et al., 2011). HA1c values are also affected by age, rising by up to 0.1% per decade (Goldenberg et al., 2011).

HA1c was shown to be elevated in individuals reporting chronic stress exposure (Cesana et al., 1985; Grossi et al., 2003; Kelly et al., 2005; Netterstrom & Sjol, 1991). Some older studies identified HA1c as a potential biological marker for chronic stress allowing researchers and practitioners to identify individuals who have been exposed to chronic stress and whose health can be negatively impacted by this long-term exposure (Kelly et al., 2005). In several studies a positive correlation has been found between job strain and HA1c in non-diabetics (Cesana et al., 1985; Hansen, Kaergaard, Andersen, & Netterstrom, 2003; Kawakami et al., 2000). A significant dose-response relationship was found between job strain and HA1c in the Kawakami and colleagues study (Kawakami et al., 2000). In addition, respondents that had adequate social support at the workplace had lower concentrations of HA1c after controlling for age, occupation, obesity, alcohol consumption, smoking, and family history of diabetes mellitus (Kawakami et al., 2000).

In an early study, Cesana and colleagues (1985) reported a link between chronic psychological stress and elevated HA1c in a population of workers (pressmen) at a newspaper. A total of 100 pressmen exposed to stressors such as noise, overwork, and rotating shifts were compared to 200 clerical workers who were not exposed to those stressors, HA1c was found to be elevated in the pressmen but not in the clerical workers. The authors emphasized the utility of HA1c as a screening test for chronic stress.



HA1c has been reported as a marker for the development of cardiovascular diseases such as atherosclerosis, myocardial infarction, strokes, and cataracts (Kelly, Hertzman, & Daniels, 1997). Netterstrom and Sjol (1991) demonstrated higher HA1c with job stress, high daily coffee consumption, and low alcohol consumption. A Danish study on 130 female sewing machine operators demonstrated that workers who performed repetitive work and who were exposed to chronic stress had HA1c elevations as compared to those who did not perform repetitive work and who were not exposed to chronic stress (Hansen et al., 2003).

Positive associations were reported between HA1c levels and socioeconomic status in non-diabetics after controlling for fasting glucose levels, age, and weekly alcohol consumption in both men and women (Kelly et al., 2005). The researchers hypothesized that transient increases in glucose, as seen in frequent episodes of physiological response to stressors, can generate a slow, insidious increase in the proportion of proteins that are glycosylated.

One study on burnout in 213 white-collar employees at three social insurance offices in Sweden reported a positive association between HA1c and burnout (Grossi et al., 2003). A similar study with 290 Dutch managers did not support any association (Langelaan, Bakker, Schaufeli, van Rhenen, & van Doornen, 2007). The authors attribute this lack of association to the cross-sectional study design, commenting that results might be different in a longitudinal design, where relationships can be established (Langelaan et al., 2007).

Based on three independent approaches including extensive literature review of stress hormone data from healthy individuals, review of stress data from cardiovascular

clinical trials, and empirical measurements of blood glucose, Mathews and Liebenberg (2011) were able to demonstrate the production of blood glucose above basal level in the presence of chronic stress. The production of glucose was quantified as equivalent teaspoons of sugar (ETS) using mathematical formulas. They demonstrated that an extra 2.2 times above basal level were produced in times of chronic stress. These results demonstrated the impact perceived stress has on the progression of disorders such as obesity and prediabetes (with transition to diabetes).

No studies have examined the relationship between levels of HA1c and perceived stress in municipal workers. Most studies that specifically evaluated the relationship of HA1c and job strain were published between 10 to 24 years ago (Cesana et al., 1985; Kawakami et al., 2000; Netterstrom & Sjol, 1991). More studies are needed to establish the relationship between HA1c and perceived stress (Cesana et al., 1985; Kawakami et al., 2000). If HA1c can be used as a parameter for perceived stress and a marker for cardiovascular disease, it can be useful to identify those workers at risk and target interventions (Cesana et al., 1985 & Kelly et al., 1997). HA1c is practical for cross-sectional studies and appears to be a marker for cardiovascular risk factors, making it ideal as a predictor of diabetes and future illness (Cesana et al., 1985; Kelly et al., 1997). More studies are needed to understand the relationship between HA1c and perceived stress and the effect on obesity and prediabetes especially in adult working populations.

### Occupation and Perceived Stress

The National Institute for Occupational Safety and Health [NIOSH] (1999) defined occupational stress as the deleterious effect on health that occurs when the

requirements of the job exceed the capabilities of the worker (CDC, 1999). Stress at work is characterized by a negative work environment and the individual's response to that threatening situation (Smith, 2001). A review of the literature demonstrated that certain job characteristics have detrimental effects on an employee's health status. A high prevalence of work related stress, depression, and anxiety have been found in nurses, teachers, care workers, managers and professionals (Smith, 2001; Stansfeld, Rasul, Head, & Singleton, 2011). No one job was identified as causing the most deleterious health effects. The difficulty in recruiting a sizeable number of workers across a range of occupations for investigations may contribute to the lack of evidence on this topic (Stansfeld et al, 2011).

Since workers spend many hours at work over their life span, it is important to identify those job characteristics that could potentially have a negative effect on physical and psychological health. In general, content of work and the social and organizational aspects of the job have been found to be associated with stress and health risks (Michie, 2002). Specific stress-inducing work factors that have been identified include: role conflict, job demands, job insecurity, inadequate supervisor support, workload demands, poor social support at work, long working hours, lack of control over work, lack of participation in decision making, and unclear management (Fletcher, Sindelar, & Yamaguchi, 2011; Michie, 2002; Michie & Williams, 2003). Having responsibility for other people and managers who are highly critical and unsupportive create stress whereas a positive social and supportive atmosphere at work reduces stress (Michie, 2002).

Some occupational groups are exposed to many stressful work demands. Sources of stress for municipal workers such as police officers include working with the public,

exposure to violent crime, working in a noisy environment, shift work, job demands, lack of input into decision-making and large amounts of paperwork (Collins & Gibbs, 2003; Franke et al., 2002; Ramey, Franke, & Shelley, 2004; Tang & Hammontree, 1992; Tomei et al., 2006; Violanti et al., 2006). In addition, Deschamps, Paganon-Badinier, Marchand, and Merle (2003) identified a shortage of fellow police workers, a long workday, courtroom duties, and poor police-community relations as sources of stress. In England, occupational health physicians and psychiatrists report that police work is one of the top three occupations for occupational stress and mental illness (Collins & Gibbs, 2003). In addition, up to 26% of medical retirements in the police force have been found to be due to psychological illness (Collins & Gibbs, 2003).

A study comparing self-reports of stress and job strain (anxiety, blood pressure control, and alcohol consumption) in 487 police, firefighters, and other municipal workers in a U.S. west coast city of 400,000 predominantly white residents, police officers viewed themselves as experiencing the most stress in comparison to firefighters and other municipal workers. In contrast, the evaluation of strain demonstrated that municipal workers and not the police experienced the most health problems. Municipal workers had the worst results on anxiety while firefighters had the worst measures of strain in regards violence while drinking. The authors attributed these findings to the self-selection of individuals who are able to manage stress and avoid strain and the 'healthy worker' effect in firefighter and police since both occupations have to pass physical examinations prior to recruitment (Pendleton, Stotland, Spiers, & Kirsch, 1989). Limitations in this study included the age of the study, inclusion of only males in the investigation, and the lack of minorities in the study.

A cross-sectional analysis of 4,825 French male and female manual workers and clerks reported that smoking behaviors were mediated by perceived stress at work and that poor working conditions contributed to health inequalities fueling both stress and unhealthy behaviors leading to increased morbidity and mortality (Peretti-Watel, Constance, Seror, & Beck, 2009). Limitations of this study included the cross-sectional design and self-reported working conditions.

Workers have been found to experience job strain in positions that have minimal decision-making responsibility but have high psychological demands (Brown et al., 2006). Despite the violence and trauma associated with police work, the major sources of stress that have been reported for these workers were organizational issues and culture. Police officers perceived administration and lack of support as sources of stress that were just as important as the actual dangers of the job (Collins & Gibbs, 2003; Ramey, 2003; Tang & Hammontree, 2003; Violanti et al., 2006). A component of organizational stress is the perception of a lack of control over decision-making.

Occupations with high levels of stress also exhibit increased absenteeism and turnover. The quantity and quality of work is reduced as well as job satisfaction and morale. For the individual, the presence of stress at work can be deleterious to quality of life, health, self-esteem, and personal development (Michie, 2002).

Occupational stress has been found to contribute to psychological distress in occupational groups. Wang and colleagues (2011) investigated the relationship of occupational stress and depression rates in physicians in Taiwan. Using Karasek's Model, they demonstrated that physicians with higher work demands, eight to ten days of shift duty per month and alcohol use had significantly higher depression scores. There

were lower depression scores in a comparable group of physicians with higher job control or higher workplace social support (Wang et al., 2011). A cross-sectional study with physicians in Germany explored the relationships between job stress and job performance (Klein, Frie, Blum, & von dem Kenesbeck, 2011). A significant association was found between psychosocial stress at work and quality of care provided.

In a longitudinal analysis of psychological distress experiences among 6,359 Canadian workers in 471 occupations, Marchand and colleagues (2005) found that an individual's position at work played a limited role in perceived stress when life outside work (family, social life) was not taken into account. Further, an increase in decision authority did not lessen psychological distress. This longitudinal study was conducted over six years. The researchers reported that the instruments used to assess skill utilization, decision authority, psychological demands, and social support had low internal consistency when compared to Karasek's Job Content Questionnaire (Karasek et al., 1998). In addition because the variables under study were not measured in each of the four cohorts and workplace factors related to the physical environment were not taken into account, limited comparisons were provided.

Shields (2006) examined the association between stress level and depression in the Canadian employed population aged 18 to 75 years of age using data from the 2002 Canadian Community Health Survey and the longitudinal component of the 1994-1995 through 2002-2003 National Population Health Survey. The sample size from the Canadian Community Health Survey consisted of 36,984 individuals and the sample from the National Population Health Survey included 20,095 people. Shields (2006) reported that men and women with occupations high in psychological demands but limited in

skills or the authority to address these demands had higher rates of depression. In women this association of high job strain and depression did not persist when various sources of stress were considered simultaneously (Shields, 2006).

In summary, studies have demonstrated the negative effect of perceived stress on health in different working populations such as physicians (Klein et al., 2011), police (Ramey, 2003), manual workers and clerks (Peretti-Watel et al., 2009), firefighters (Pendleton, 1989), the Canadian employee population (Shields, 2006), hospital physicians in Taiwan (Wang et al., 2011), and various occupations in the United Kingdom (Stansfeld et al., 2011). A gap in knowledge exists in identifying variables that contribute to chronic conditions, such as obesity and prediabetes, in the presence of perceived stress in workers.

#### Shift Schedule

According to 2004 data from the Bureau of Labor Statistics, about 15 million people perform shift work (NIOSH, 2012). Shift work is defined as evening shifts, irregular shifts, rotating shifts, and night shift. Vyas and colleagues (2012) performed an analysis of more than 2 million workers from 34 studies and reported that people who work shifts are at increased risk for heart attacks and strokes. The researchers reported that these cardiovascular events were more common among shift workers than day (non-shift) workers. Shift workers experienced a 23% increased risk of heart attack, a 24% increased risk of some coronary event, and a 5% increased risk of stroke (Vyas et al., 2012).

Working irregular hours interferes with the body's circadian rhythm affecting the cardiovascular system, metabolism, immune system, and hormonal balance. Shift work

raises the risk of cardiovascular disease by 40 % and the risk increases, the longer a person continues to work night shift. The risk for obesity rises with shift work because of poor diet and lack of exercise. Hormonal imbalance might also play a role in increasing the risk for obesity and diabetes (Geiger-Brown & Trinkoff, 2010; Knutsson, 2003; Munir, Clemens, Houdmont, & Randall, 2012; Pietroiusti et al., 2010).

Bray and Young (2006) contend obesity should not be blamed simply on overeating or a lack of physical activity. Disruption of the sleep-wake cycle, such as with shift work, can impair the circadian clock. The disruption between sleeping and eating alters the intracellular circadian clocks which affect circulating levels of glucose, fatty acids, triglycerides, and hormones such as insulin and glucocorticoids. These circulating levels of nutrients and hormones disrupt metabolism and fat accumulation leading to obesity and potentially could be the physiological reason for weight gain with shift work.

Zhao, Bogossian, Song, and Turner (2011) examined the association between shift work and unhealthy weight in nurses and midwives and found that among 2,494 participants only 1% were underweight, 31.8% were overweight, and 26.9% were obese. This study found lower levels of physical activity among shift workers compared to day workers, yet there were no differences in lifestyle behaviors such as smoking and diet among the two groups (shift versus day workers). Limitations in this study include the use of cross sectional data precluding a better understanding of the causal relationship between shift work and weight and the use of self-report data that could have been affected by social desirability (Zhao et al., 2011).



## Obesity, Age, Gender, Race, and Education

Associations of obesity with age, gender, race, and socioeconomic status are complex and dynamic (Lear, Humphries, Kohli, & Birmingham, 2007; Paeratakul et al., 2002; Wang & Beydoun, 2007; Yu, 2012). Most studies utilize education and occupation as the indicators of socioeconomic status. Of significance, the proportion of the population with at least some college education has increased from 12% to 56% in the last three decades (Yu, 2012).

The majority of investigations on the relationship of education and obesity have demonstrated an inverse relationship between these two variables (Cavaliere & Banterle, 2008; McLaren, 2007; McLaren & Godley, 2009; Paeratakul et al., 2002; Yu, 2012). Using the National Health and Nutrition Examination Surveys (NHANES) for the periods of 1971-1980 and 1999-2006 for non-Hispanic whites and blacks in two separate age groups (25-44 years versus 45-64 years), Yu (2012) examined the educational differences in obesity in the United States. Yu (2012) found that among whites and younger black women aged 25-44 years, the less educated are more likely to be obese than college graduates. The differences are less significant for males in the same age group or for black men or women in the 45-64 year age group. The increase in obesity was significantly greater for younger women with some college experience (Yu, 2012).

Zhang and Wang (2004) evaluated NHANES data for the period from 1971 to 2000 in adults ages 20 to 60 years of age to evaluate the association between obesity and socioeconomic status in the United States. Overall they found that there is a disproportionate increase in the prevalence of obesity in the high socioeconomic group and a weakened association between socioeconomic status and obesity in most gender

and ethnic groups. Zhang and Wang (2004) attributed this rising prevalence in obesity to social and environmental factors rather than to individual factors. The availability of abundant food at a relatively low cost in the face of sedentary behaviors could contribute to the rise in obesity (Wang & Beydoun, 2007). Of interest is the finding that the adverse effects of obesity on mortality risk are worse in adults younger than 65 years of age.

Using data from the Third National Health and Nutrition Examination Survey (NHANES) from 1988 to 1994 with 4,437 men and 5,166 women, the influence of age on the association between various measures of obesity and all-cause mortality was investigated. The researchers concluded that weight loss was important for reducing morbidity in obese adults of any age. The link was not clear whether weight loss was beneficial for reducing mortality risk in older adults. Therefore obesity maybe a greater concern in younger than older adults (Kuk & Ardern, 2009).

Wang and Beydoun (2007) examined data from both NHANES and the Behavioral Risk Factor Surveillance System (BRFSS) surveys and found large racial/ethnic disparities in obesity among women, children, and adolescents in the United States. Although low socioeconomic groups including non-Hispanic black women and children, Mexican American women, Native Americans, and Pacific Islanders were disproportionately affected in increased prevalence of obesity, the NHANES data showed a dramatic increase in the prevalence of obesity across all population groups (Wang & Beydoun, 2007).

In Canadian studies where income, education, and occupation were used as indicators of class, a consistent inverse relationship between education and obesity was found. Hall and colleagues (2003) investigated differences by education in dietary

variables related to obesity in 396 Saskatchewan women aged 18 to 74 years. For the 18 to 34 years age group obesity was significantly more prevalent with lower education and the trend was similar for the older age groups (Hall et al., 2003). In Italy, Cavaliere and Banterle (2008) conducted a survey of 776 subjects to evaluate economic factors affecting obesity. Results demonstrated that obesity increased with age, especially in males, and that obesity decreased with increasing levels of education and increased for people with less education. McLaren (2007) demonstrated that in highly developed countries, lower education and socioeconomic status correlated with a large body size. This correlation was especially prominent in women.

McLaren and Godley (2009) examined the relationship between obesity and socioeconomic status in Canadian adults. Socioeconomic status was evaluated using income and education as indicators of socioeconomic status. For both males and females an inverse relationship was found between body mass index and education. The authors attributed this to a greater comprehension and ability to comply with health promotion messages concerning food and exercise. McLaren and Godley (2009) opined that the social value of thinness and the stigmatization of obesity contributed to maintaining an appropriate body size related to gender.

Paeratakul and colleagues (2002) evaluated 9,643 adults in three racial groups (non-Hispanic whites, non-Hispanic blacks, and Hispanics) in the United States. The results demonstrated that the rate of overweight was higher in men while the rate of obesity was higher in women. The prevalence of overweight and obesity was higher in blacks and Hispanics compared to white people. Overall, low income and low education

may be associated with both obesity and obesity co-morbidities including diabetes, hypertension, and hypercholesterolemia (Paeratakul et al., 2002).

In developing countries such as Brazil and Latin America, the change in the structure of employment which includes a more sedentary lifestyle has altered the pattern of obesity (Monteiro, Conde, and Popkin, 2001). The authors demonstrated that in the less developed regions in these countries both males and females were found to have a positive association between income and obesity, but an inverse relationship was found between education and obesity in females and no relationship was found between education and obesity in males. In the highly developed regions, females and males had an inverse relationship between obesity and education. The hypotheses from the authors were that in developing countries income is a risk factor for obesity and education is protective for both genders (Monteiro et al., 2001).

Overall the prevalence of obesity among adults in the United States has increased from 13% to 32% between the 1960s and 2004 with minority and low socioeconomic groups disproportionately represented (Wang & Beydoun, 2007). For both U.S. males and females there is an inverse relationship between education and obesity (McLaren & Godley, 2009; Paeratakul et al., 2002; Yu, 2012). More research is needed to examine the relationships among obesity, age, gender, race, and education in minority populations especially in an area of the country that has a higher prevalence of obesity and chronic diseases such as diabetes.

## Obesity, Prediabetes, and Level of Activity

The relationship of obesity, prediabetes, and physical activity has been extensively studied but not in municipal workers. Given the increasing prevalence of obesity in the U.S. more research is needed to identify the populations that are more likely to be obese and prediabetic. Approximately 57 million individuals in the United States have prediabetes and two-thirds of the adult population are categorized as overweight and obese (Flegal et al., 2010; Mctigue et al., 2003). Inactivity and obesity are independently related to the risk in developing diabetes (Aldana et al., 2006; Garber, 2011; Wing et al., 2001). Data from the Nurses' Health Study suggest that the lowest risk for diabetes occurs in individuals with a BMI < 21, with increasing prevalence seen as obesity levels increase (Carey et al., 1997).

Findings from two landmark randomized clinical trials, the National Institutes of Health Diabetes Prevention Program (DPP) and the Look AHEAD study demonstrated that lifestyle modifications such as physical activity can reduce the transition from prediabetes to type 2 diabetes (Dorsey & Songer, 2011; Look AHEAD Research Group, 2010; Malin, Gerber, Chipkin & Braun, 2012; National Institute of Health [NIH], 2008; Schrauwen, 2007). The Look AHEAD study was the first trial to examine the effects of an intensive lifestyle intervention through four years of follow-up in a large cohort of overweight and obese individuals with type 2 diabetes. Participants were recruited at 16 centers in the United States and a total of 5,145 participants were randomized; 2,570 to intensive lifestyle intervention including physical activity and 2,575 to diabetes support and education (DSE). Overall, 59.5% of the participants were women and 36.9% were from racial or ethnic minorities. Across the four years, the intensive lifestyle intervention

group experienced the greatest benefit in the reduction of cardiovascular risk factors (Look AHEAD research group, 2010).

The DPP recruited participants from 27 clinical centers in the United States. All 3,234 participants were overweight and had prediabetes and 45% were from minority groups that were at increased risk of developing diabetes. The participants were randomized to a lifestyle intervention group, a medication group, and a control group. Lifestyle intervention participants were given intensive instruction in diet, physical activity, and behavior modification. The second group was prescribed 850 mg of Metformin twice a day. The third group received placebo pills instead of the Metformin. The Metformin and placebo groups also received information about diet and exercise but no intensive motivational counseling. The DPP findings indicated that high-risk individuals can delay or avoid the onset of type 2 diabetes by losing weight through regular physical activity and a diet low in fat and calories (NIH, 2008).

The Nurses' Health Study with 87,253 female participants in the United States demonstrated that women who participated in vigorous exercise at least once per week had a 33% lower-adjusted risk for type 2 diabetes than women who did not exercise weekly (Helmrich, Ragland, Leung & Paffenbarger, 1991). Findings from the Physicians' Health Study with 21,271 male participants demonstrated that those who exercised vigorously at least once a week lowered their risk for the development of type 2 diabetes (Manson et al., 1992). These prospective epidemiological studies contributed to the body of knowledge concerning physical activity and the prevention of type 2 diabetes (Hu, Lakka, Kilpelainen & Tuomilehto, 2007). A limitation for the Nurses' Health Study and the Physicians' Health Study is that both were large studies that examined health

issues in populations that are at a higher educational and socioeconomic level than the general working population.

In an extensive review of the literature, Gill and Cooper (2008) reported that regular physical activity reduced the risk for obesity and type 2 diabetes. The authors reviewed 20 longitudinal cohort studies and six large-scale diabetes prevention intervention trials. The data from these studies demonstrated that any physical activity was beneficial in reducing the risk for chronic diseases such as obesity and diabetes when compared to a sedentary lifestyle (Gill & Cooper, 2008).

### Summary

In conclusion, strong, research-based evidence has demonstrated that obesity contributes to the risk for chronic disease including type 2 diabetes because prediabetes often transitions into type 2 diabetes. Although lifestyle interventions are being developed to prevent this chronic disease in all populations, many gaps in knowledge exist regarding predictors of obesity and prediabetes especially in a region where the prevalence of chronic diseases such as diabetes and obesity is high (CDC, 2011; Dorsey & Songer, 2011; Hu, et al., 2007; Look AHEAD Research Group, 2010; NIH, 2008; U.S. Census Bureau, 2011). In addition, more investigations are needed to examine influences of perceived stress on obesity and prediabetes among working populations such as municipal workers. Research in this area will aid occupational health professionals in targeted interventions to enhance health, address the prevalence of obesity and prediabetes and decrease cardiovascular morbidity in working adults.

## CHAPTER 3

### METHODOLOGY

The following methodological components will be presented in this chapter: research design, protection of human subjects, setting, sample, instruments, data collection procedure, data management, and data analysis.

#### Research Design

This study utilized a non-experimental, correlational design to examine the relationships among obesity, prediabetes, and perceived stress in municipal workers. The independent variables included personal factors such as age, race, gender, education, shift schedule, occupation, level of activity, BMI, waist circumference, and HA1c. The best predictive models for the dependent variables, obesity and prediabetes were explored.

A secondary analysis of a subset of data from an employee health promotion program for a large municipality in the Southeastern U.S. was examined in this study. This wellness program collects data during health screening sessions three times per year, with each screen lasting six days. The health screening and health risk appraisals are provided for approximately 2,700 employees each year. Since some departments are screened only every other year, a two year time frame is required to conduct screening on a complete cohort of city employees (Personal communication, Dr. Kathleen Brown, October 12, 2011). Therefore, data from 2010 to 2011 were used in this study.



One of the most common methods for examining an association or relationship among variables is correlation (Rumrill, 2004). Correlation is a statistical method that demonstrates the nature and degree of the relationship between quantitative variables (Patten, 2007). The magnitude of the relationship is expressed in a correlation coefficient that provides the researcher with insight regarding the hypothetical association between variables (Rumrill, 2004). It measures the strength and direction between variables and is collected from a single sample. Relationships can be positive or negative [sometimes referred to as inverse] (Burns & Grove, 2009).

Results from correlational studies have to be interpreted carefully to ensure that the reported relationships between variables truly reflect the findings and are not a product of selection bias (Polit & Beck, 2012). A limitation of correlational research is that it does not determine cause and effect (Polit & Beck, 2012). On the other hand, correlational research is a practical and efficient means of collecting and analyzing large amounts of data (Polit & Beck, 2012; Rumrill, 2004). The researchers do not manipulate the independent variable to examine the association between variables or to predict a relationship.

The goal of this study was to examine relationships among obesity, prediabetes, and perceived stress in municipal workers. An exploration of the nature of the relationships among the variables was based on a combined Expanded Biobehavioral Interaction (EBI) Model and Karasek and Theorell's Demand Control Model related to occupational stress (Karasek & Theorell, 1990). Relationships among the selected variables were explored. The inclusion of multiple independent variables helped in

building a predictive model, focusing on obesity and prediabetes in municipal workers (Polit & Beck, 2012).

### Protection of Human Subjects

The study adhered to the guidelines implemented by the Institutional Review Board (IRB) at the University of Alabama at Birmingham for protection of human subjects. After IRB approval was obtained, a limited data set was provided for this research from the original database and was coded to maintain anonymity of the participants. To protect the population of municipal workers that participated in this limited data set, anonymity, confidentiality, and assurance of voluntary participation was maintained. Protection of individuals who voluntarily agree to participate in research is essential to integrity in research (Institute of Medicine, 2002). The identity of the participants was separated from the individual responses provided on the TeleForm® instrument. This separation ensured that information from particular participants cannot be linked or deduced from their responses. Any private information that can be linked back to the participants can lead to a breach of confidentiality. Data were only accessed by members of the research team who had password access to the computer server.

Wellness program data collectors were trained regarding confidentiality and anonymity and were required to maintain the participants' data securely under lock and key. Identifiers were deleted in order not to link the information from a particular individual and raw data are destroyed after five years according to the wellness program policies and procedures (Good Health Program, 2011).

Workers as research participants are considered a vulnerable population because of the researcher's access to confidential information and implied coercion to participate in the research study (Rose & Pietri, 2002). When employees are hired by the municipality they are given the choice to participate in one of the employee-sponsored health plans which include regular health screenings. The employees are given the option to have their own personal physician perform health screening or to participate in the wellness program health screens. Historically participation in the wellness program health screens has been significant (93% participation). The municipality does not receive any personal employee health information but only aggregate reports on health risks on the worker population, and to avoid any coercion, does not use participation in the screening as a requirement for hiring or retaining an employee (Personal communication, Dr. Kathleen Brown, October 12, 2011).

### Setting

The wellness program began in the mid-1980s, conducting regularly scheduled health screenings for all municipal employees. Since 1991 the health screenings have been the responsibility of the University of Alabama at Birmingham School of Nursing. The screenings are a form of limited medical examination designed specifically for the purpose of identifying risk factors for cardiovascular disease, cancer, preventable injury, and occupational injury and as a means to improve employee health for the approximate 4,800 individuals employed by the municipality. The setting for the wellness program data collection was in municipal buildings and a firefighter training classroom. Individual stations were set up to measure blood pressure, height, weight, waist

circumference and to collect physiological data including glycosylated hemoglobin. Space and privacy were provided for participants to complete survey forms and to talk privately to the wellness program personnel present at the screenings.

### Sample

The municipality employs over 4,800 workers. Within this population, 80% are male, 47% are African American, and over one-third are in minimum-wage jobs. These municipal workers are employed at 156 different worksites and 30 diverse departments. The wellness program uses health-risk appraisals via TeleForm® questionnaires and performs health screening of employees. Interventions target topics such as smoking cessation, blood pressure control, nutrition and cholesterol, exercise, and back care. Referrals and follow-up are included in the health services (Brown et al., 1995). All municipal departments were represented, with the three largest departments being police, fire, and public works, which account for approximately 62% of city employees. The accessible population included approximately 3,000 employees who participated in the health screens in 2010 and 2011. The wellness program routinely performs HA1c measurement on employees age 40 and older. HA1c was measured on 1,963 participants during the 2010-2011 time frame.

### Inclusion and Exclusion Criteria

Inclusion criteria included those participants who had HA1c measured as part of their screening. Exclusion criteria include a diagnosis of diabetes (Teleform® item 75)

or had HA1c greater than 6.4%. Those participants with a diagnosis of diabetes have already transitioned from prediabetes to diabetes.

### Power Analysis

In estimating the appropriate size of the sample needed, three components were determined: the significance criterion, the population effect size, and power (Polit & Beck, 2012). The significance criterion was set at .05 and the power was set at the conventional standard of 0.80. A population  $R^2$  of .20 is typical of behavioral studies to estimate small effect size (Cohen, Cohen, West, & Aiken, 2003). The power analysis formula for multiple regression/correlation analyses with nine predictor variables was used to determine the sample size of municipal workers for this study (Polit & Beck, 2012). According to the table for power analysis for multiple regression provided by Polit and Beck (2012) an estimated sample size of 188 municipal workers was needed with a set of nine predictors and for power of 0.80.

### Instruments

Teleform ® health risk appraisal instruments were used to collect data for this study. Data included both self-report and staff measured variables. The full self-report Teleform ® health risk appraisal consists of 84 questions regarding demographic data, health habits, personal, and family medical history. Only items pertaining to the present study was analyzed. Biophysical data such as height, weight, body mass index, waist circumference, and HA1c are also collected in the wellness screen.

## Reliability

The wellness program has incorporated methods to help ensure the accuracy and consistency of the information collected, which includes a procedure manual, standardized data collection and entry procedures, and standardized training of screening wellness program personnel. The screening manual is provided for all personnel during training in the procedures for which they are responsible during the screen, and wellness personnel must successfully accomplish a return demonstration of the procedures before being certified to collect data (Good Health Program, 2011). Due to secondary analysis of cross-sectional data, test-retest reliability was not assessed for this study.

## Validity

Measures for body mass index, waist circumference, and HA1c are based on guidelines and procedures which have been recognized as being valid (Flegal, Carroll, Kit, & Ogden, 2012; Flegal et al., 2010; Gerstein, 2004; Goldberg, 2003; National Institutes of Health, 2000).

## Data Collection

The investigator received a limited data set that consisted of self-reported measures and health screen biophysical data. Self-report measures were used to obtain data on personal factors (age, gender, race, and education), level of activity, occupation, and perceived stress.

Biophysical measures included height, weight, body mass index, waist circumference, and HA1c. Weight was measured by using a calibrated scale. Subjects

removed outer garments and other heavy garments or equipment prior to weighing, stepped firmly onto the center of the digital scale and waited until the scale was stabilized (Good Health Program, 2011). Height was measured by using a height board. Subjects took shoes off and while barefoot, stood with back to measuring device and heel against wall. The center of the back of the head was against the measuring device. Wellness program personnel slid the bar section on the measuring device down to the top of the subject's head, and recorded the height in inches, to the nearest  $\frac{1}{4}$  inch.

Body mass index indicates total body adiposity and is derived from the ratio of weight to height. Weight and height measurements were converted to the metric scale and BMI was calculated by dividing kilograms of body weight by height in meters squared ( $\text{kg}/\text{m}^2$ ). According to National Institutes of Health guidelines (2000), the classifications for body mass index is as follows: underweight with a BMI less than  $18.5 \text{ kg}/\text{m}^2$ , normal weight with a BMI between  $18.5$  to  $24.9 \text{ kg}/\text{m}^2$ , overweight with a BMI between  $25$  to  $29.9 \text{ kg}/\text{m}^2$ , obese class I with a BMI between  $30$  to  $34.9 \text{ kg}/\text{m}^2$ , obese class II with a BMI between  $35$  to  $39.9 \text{ kg}/\text{m}^2$ , and extreme obesity class III with a BMI over  $40 \text{ kg}/\text{m}^2$ .

Waist circumference is the measurement of abdominal girth or central adiposity in inches using a Gulick II tape measure. Waist circumference was measured to the nearest  $\frac{1}{4}$  inch at the level of the umbilicus while standing with arms perpendicular to the body during a normal exhalation phase. Across genders and ethnicity, there is a very strong correlation between BMI and waist circumference ( $r$  from  $0.88$  to  $0.92$ ) indicating high validity in these two variables (Zhu et al., 2005).

## Statistical Analysis

The secondary data set in this study was analyzed using the Statistical Package for the Social Sciences (SPSS) software program version 21. Analyses were interpreted at a significance level of .05 to balance between Type I and Type II errors (Polit & Beck, 2012). Outcome variables were tested for violations of the assumptions of normality, homoscedasticity, and independence. Additionally, collinearity diagnostics were examined for the independent variables. Frequencies, means, percentages, and standard deviations were calculated to describe the study sample. The distribution of each variable was appropriately evaluated based on the measurement level (i.e. nominal, ordinal, or interval).

## Research Questions

The analysis for each research question was conducted as follows:

Research question 1 is: *What is the prevalence of obesity and prediabetes in municipal workers?* The prevalence of obesity (BMI > 30) and prediabetes (as measured by HA1c of 5.7% to 6.4%) was described using percentages, means, standard deviation, and histogram or frequency distribution.

Research question 2: *Is there a relationship between perceived stress and occupation in municipal workers?* The relationship between perceived stress and occupation (department) was examined using Chi square analyses.

Research question 3: *What is the relationship between perceived stress and obesity in municipal workers?* The relationship between perceived stress and obesity was



examined using Spearman Rho correlation to test the strength and direction of the relationships between the variables.

Research question 4: *What is the relationship between perceived stress and prediabetes in municipal workers?* Spearman Rho correlation was utilized to test the strength and direction of the relationships between the variables of perceived stress and prediabetes. Subjects with HA1c > 6.4% were excluded.

Research question 5: *Are there differences in obesity of municipal workers based on shift schedule, education, or gender?* ANOVA was utilized to examine the differences in obesity by shift work, education, or gender. *T*-test was utilized to assess the differences in BMI for gender.

Research question 6: *What are the relationships among level of activity, prediabetes, and obesity in municipal workers?* Spearman Rho correlation was performed between level of activity and prediabetes; and level of activity and obesity to examine the relationships between these variables. Chi square was utilized to examine the relationships between prediabetes and obesity.

Research question 7: *What is the best predictive model for obesity (BMI > 30) in municipal workers using perceived stress, and the personal factors of age, gender, and race?* Research question 7a: *Does the inclusion of HA1c add to the predictive ability of the model?* Research question 7b: *Does the inclusion of shift schedule add to the predictive ability of the model?* Research question 7c: *Does the inclusion of level of activity add to the predictive ability of the model?* Research question 7d: *Does the inclusion of occupation add to the predictive ability of the model?* Collinearity diagnostics were run to reveal any issues with multicollinearity. Preliminary analyses

were performed to examine the bivariate relationships between obesity and the set of proposed predictors (perceived stress, level of activity, HbA1c) to reveal any significant relationships. Logistic regression was performed to examine the influence of the multiple independent variables on the dependent variable obesity. A goodness-of-fit statistic can demonstrate the fit of a predictive model and will allow evaluation of the significance of the association of the independent variables with the dependent variable.

Research question 8: *What is the best predictive model for obesity (defined as waist circumference > 40 inches in men and > 35 inches in women) in public safety workers using perceived stress, and the personal factors of age, gender, and race?*

*Research question 8a: Does the inclusion of HbA1c add to the predictive ability of the model? Research question 8b: Does the inclusion of shift schedule add to the predictive ability of the model? Research question 8c: Does the inclusion of level of activity add to the predictive ability of the model?* Collinearity diagnostics were run to reveal any issues with multicollinearity. Preliminary analyses were performed to examine the bivariate relationships between prediabetes and the set of proposed predictors (perceived stress, level of activity, BMI, waist circumference) to reveal any significant relationships.

Logistic regression will be performed to examine the influence of the multiple independent variables on the dependent variable prediabetes. A goodness-of-fit statistic can demonstrate the fit of a predictive model and will allow evaluation of the significance of the association of the independent variables with the dependent variable.

Research question 9: *What is the best predictive model for prediabetes in municipal workers using perceived stress, and the personal factors of age, gender, and race?* Research question 9a: *Does the inclusion of BMI add to the predictive ability of*

*the model?* Research question 9b: *Does the inclusion of shift schedule add to the predictive ability of the model?* Research question 9c: *Does the inclusion of level of activity add to the predictive ability of the model?* Research question 9d: *Does the inclusion of occupation add to the predictive ability of the model?* Collinearity diagnostics were run to reveal any issues with multicollinearity. Preliminary analyses were performed to examine the bivariate relationships between prediabetes and the set of proposed predictors (perceived stress, level of activity, BMI, waist circumference) to reveal any significant relationships. Logistic regression was performed to examine the influence of the multiple independent variables on the dependent variable prediabetes. A goodness-of-fit statistic can demonstrate the fit of a predictive model and will allow evaluation of the significance of the association of the independent variables with the dependent variable.

### Missing Data

All missing data were handled in a consistent manner through pairwise deletion appropriate for the research question. Pairwise deletion only removes the specific missing values from the analysis, not the entire case. Pairwise deletion is useful when trying to avoid deleting subjects that have missing values. This method assumes that the data are missing completely at random (Polit & Beck, 2012). Pairwise deletion avoids reduction of the original sample size available for analysis (Munro, 2005). A limitation of pairwise deletion is the potential for a varying sample size on which the findings are based (Cohen et al., 2003).

### Limitations of the Study

A methodological limitation of this study is that it used a cross-sectional, correlational design, thereby precluding the ability to assess a causal relationship. Therefore, cause and effect relationships cannot be determined from this study because a cross-sectional design is not as strong as a prospective cohort design in determining predictors of an outcome. Another limitation is the use of self-report data. The researcher has to assume that the participants are honest in their answers yet there might be concerns about the accuracy of self-reported data (Polit & Beck, 2012).

The use of secondary data for the analysis poses certain limitations. Since the researcher was not involved in the original study any issues regarding consistency in data collection and data entry were not known. Secondary analysis also prevents the researcher from identifying additional variables that may be of interest (Polit & Beck, 2012).

## CHAPTER 4

### FINDINGS

This chapter outlines the results of the data analysis pertinent for this study. The first section provides a description of the sample characteristics and study variables. The second section presents the findings from the analysis of data relevant to the nine research questions.

#### Description of the Sample

A total of 3,501 municipal employees were included in this study. Demographic data, including gender, age, race, education, occupation, and shift schedule are presented in Table 1. The majority of the sample was male (72%), and the most common age group was 40 - 49 years. Approximately two-thirds (66.9%) of the sample was black, nearly one-third (29.8%) of the sample was white, and the remaining racial group comprised less than 5% of the sample. Almost one-fifth (21.3%) of the sample had completed high school and nearly double that number finished some college. Over one-third (35.3%) of the employees were college graduates. Police officers were the largest group (30%) of municipal workers in this sample.

One fourth (24.9%) of the sample were employed in Public Works, another one-fourth (24%) were employed in City Hall, and 20.3% were firefighters. Most employees (47%) worked during the hours of 7:00 a.m. to 5:00 p.m., but shifts were worked

throughout the 24 hour period. The majority of the 3,501 participants reported moderate amount of stress (41%), or a lot of stress (11.9%). Almost 48% of the participants reported physical activity at least three times per week.

Table 1

*Demographic Characteristics of Sample (N = 3,501)*

Characteristic	Frequency	%
<b>Gender</b>		
Male	2,549	72.8
Female	951	27.2
<b>Age*</b>		
20-29 years	414	11.8
30-39 years	821	23.5
40-49 years	1,098	31.4
50-59 years	960	27.4
60 years or more	208	5.9
<b>Race</b>		
White	1,042	29.8
Native American	17	.5
Asian	6	.2
Black	2,343	66.9
Pacific Islander	3	.1
Other	43	1.2
Not Known	22	.6
<b>Hispanic</b>		
Yes	35	1.0
No	3,448	98.5
<b>Highest Education</b>		
Grade School or Less	11	.3
Some High School	104	3.0
High School Graduate	746	21.3
Some College	1,391	39.7
College Graduate	996	28.4
Post Graduate or Professional Degree	243	6.9

Table 1 (Continued)

Characteristic	Frequency	%
<b>Occupation</b>		
Fire	712	20.3
Police	1,054	30.1
Public Works	872	24.9
City Hall	841	24.0
<b>Shift Schedule</b>		
7:00 AM - 3:00 PM	911	26.0
8:00 AM - 5:00 PM	734	21.0
3:00 PM - 11:00 PM	208	5.9
11:00 PM - 7:00 AM	190	5.4
Shift A Fire	213	6.1
Shift B Fire	209	6.0
Shift C Fire	213	6.1
Other	769	22.0
<b>Reported Stress</b>		
A Lot	415	11.9
Moderate Amounts	1,437	41.0
Relatively Little	1,076	30.7
Almost None	554	15.8
<b>Level of Activity</b>		
At least 3 times per week	1,671	47.7
1 or 2 times per week	1,168	33.4
Less than 1 time a week	631	18.0

*Note.* \* $M = 43.77$ ;  $SD = 10.75$

### Findings Related to Research Questions

In this section, descriptive information about the study variables and relationships among the variables are included using descriptive statistics and bivariate correlations.

#### *Research Question 1*

What is the prevalence of obesity and prediabetes in municipal workers?

The prevalence of obesity and prediabetes is described using frequencies and percentages (Table 2). Means and standard deviations of the study variables (BMI, waist circumference, and HA1c) are provided in Table 3.

The findings indicate that the majority of the 3,501 municipal employees were obese ( $n = 1,908$ , 55.8%) according to BMI. The lowest BMI measured was 16.62 and the highest was 67.03. The percentage of municipal workers who were normal weight or underweight was particularly low at 12.0% and 0.2% respectively; the rest were classified as overweight or obese. When obesity was defined by waist circumference, 53% of the sample was obese, and the mean waist circumference was nearly 40 inches, for males and females. HA1c was measured in 1,963 participants. Out of this number, 1,001 (51%) were identified as prediabetic, and 309 cases (15.7%) were identified as diabetic. The highest HA1c measured was 14.40.

Table 2

*Frequency and Percentages of Study Variables*

Variable	Frequency	%
<b>Obesity by BMI (kg/m<sup>2</sup>)</b>		
Not Obese (< 30)		
Underweight (< 18.5)	6	0.2
Normal Weight (18.5 – 24.9)	395	12.0
Overweight (25 – 29.9)	1,073	32.0
Obese (> 30)	1,908	55.8
<b>Obesity by Waist Circumference (inches)</b>		
Not Obese (Males < 40; females < 35)	1,551	47.0
Obese (Males > 40; females > 35)	1,756	53.0
<b>Classification of HA1c</b>		
Normal HA1c (< 5.7%)	653	33.3
Prediabetes (5.7% - 6.4%)	1,001	51.0
Diabetes (> 6.4%)	309	15.7



Table 3

*Means and Standard Deviations of Study Variables (N = 3,501)*

	<i>n</i>	Minimum	Maximum	Mean	SD
Body Mass Index	3,419	16.62	67.03	31.63	6.38
Waist Circumference	3,307	22.50	68.00	39.62	6.05
Hemoglobin A1c	1,963	4.40	14.40	6.10	1.17

### *Research Question 2*

Is there a relationship between perceived stress and occupation in municipal workers?

A Chi square analysis revealed a significant relationship between perceived stress and occupation ( $\chi^2 = 94.669$ ,  $df = 9$ ,  $p = .000$ ). Across all occupations, a moderate amount of stress was the most frequently reported level of stress. Among the different municipal occupations, the highest frequency of stress in three of four stress categories was reported by the police (Table 4). Public Works reported the highest frequency of almost no stress. Conversely, Public Works reported the lowest percentage of the category, a lot of stress.

Table 4

*Stress in Past 2 Weeks Reported by Occupation (N = 3,479)*

Occupation	Stress Categories							
	A Lot		Moderate Amounts		Relatively Little		Almost None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Fire	96	23.4	324	22.6	217	20.3	71	13.0
Police	138	33.7	450	31.4	325	30.3	135	24.7
Public Works	76	18.5	294	20.5	281	26.2	216	39.6
City Hall	100	24.4	365	25.5	248	23.2	124	22.7
Total	410	100.0	1,433	100.0	1,071	100.0	546	100.0

*Research Question 3*

What is the relationship between perceived stress and obesity in municipal workers?

Analysis using Spearman Rho correlation analyses revealed no significant relationship between perceived stress and obesity ( $r_s = -.017, p = .331$ ) [Table 5]. Both obese (BMI >30) and not obese (BMI <30) groups were similar in proportions of participants reporting stress levels. The obese group reported the highest percentage of moderate amounts of stress (41.2%).

Table 5

*Relationship between Perceived Stress and Obesity (BMI)*  
( $N = 3,365$ )

Stress	Not Obese		Obese	
	Frequency	%	Frequency	%
A Lot of Stress	157	10.7	239	12.6
Moderate Amounts of Stress	602	41.0	782	41.2
Relatively Little Stress	486	33.1	560	29.5
Almost No Stress	223	15.2	316	16.7
Total	1,468	100.0	1,897	100.0

*Research Question 4*

What is the relationship between perceived stress and prediabetes in municipal workers?

Using Spearman Rho correlation analyses, the findings revealed no correlation between perceived stress and prediabetes ( $r_s = .027, p = .275$ ) as demonstrated in Table 6. Subjects with HA1c > 6.4% were excluded. Results of perceived stress were similar

between participants with normal and prediabetic levels of HA1c. Almost 42% of participants classified as prediabetic reported moderate stress.

Table 6

*Relationship between Perceived Stress and Prediabetes (HA1c = 5.7% to 6.4%)*  
(N = 1,651)

Stress	Normal		Prediabetes	
	Frequency	%	Frequency	%
A Lot	91	14.0	131	13.1
Moderate Amounts	288	44.2	418	41.8
Relatively Little	178	27.3	304	30.4
Almost None	94	14.4	147	14.7
Total	651	100.0	1,000	100.0

*Research Question 5*

Are there differences in obesity of municipal workers based on shift schedule, education, or gender?

ANOVA was used to examine the differences in obesity by shift work and education. T-tests were used to assess the differences in BMI for gender. The Bonferroni post hoc test was used to compare multiple means at one time.

*Shift schedule and BMI.* Fire shifts A to C had the lowest BMI when compared to the rest of the municipal workers' shifts (Table 7). The mean BMI (30.34) for Fire Shift was lower than the mean BMI (31.63) for the whole sample. The highest BMI recorded (32.84) was for the 11 p.m. to 7 a.m. shift.

Table 7

*Means and Standard Deviations for Body Mass Index by Shift Schedule (N = 3,366)*

Shift Schedule	Body Mass Index		
	<i>n</i>	<i>M</i>	<i>SD</i>
7:00 AM - 3:00 PM*	901	32.07	6.46
8:00 AM - 5:00 PM	709	31.53	6.52
3:00 PM - 11:00 PM	206	31.61	6.88
11:00 PM - 7:00 AM†	184	32.84	7.02
Shift A Fire*†‡	210	30.33	4.51
Shift B Fire*†‡	203	30.31	4.65
Shift C Fire*†‡	203	30.38	4.75
Other‡	750	32.01	6.90

*Note.* Significant differences between means at  $p < .05$  are noted with \*†‡

Multiple comparisons between the means were conducted with Bonferroni post hoc test as indicated in Table 7. Statistical differences were found among fire A, B and C shifts and 7:00 a.m. to 3:00 p.m. shift (noted with \*); fire A, B, and C shifts and 11:00 p.m. to 7 a.m. shifts (noted with †); and fire A, B, and C shifts and ‘other’ (noted with ‡). The shifts with the highest BMIs were the 7:00 a.m. to 3:00 p.m. (32.07), 11:00 p.m. to 7:00 a.m. (32.84), and other (32.01). The mean BMIs were compared using ANOVA (Table 8). Significant differences were found among the shift schedules ( $F = 5.609$ ;  $df = 7, 3358$ ;  $p < .00$ ).

Table 8

*Analysis of Variance for Body Mass Index and Shift Schedule*

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1581.534	7	225.933	5.609	0.00
Within Groups	135251.1	3358	40.277		
Total	136832.6	3365			

*Education and Body Mass Index.* The municipal workers with some college education demonstrated the highest BMI (31.98) [Table 9]. Conversely, those municipal workers with high school or less had the lowest BMI (30.36).

Table 9

*Means and Standard Deviations for Body Mass Index by Education*  
( $N = 3,409$ )

Education	Body Mass Index		
	Frequency	<i>M</i>	<i>SD</i>
High School or Less	109	30.36	6.38
High School Graduate <sup>†</sup>	736	31.14	6.24
Some College <sup>*†</sup>	1,358	31.98	6.45
College Graduate	973	31.90	6.24
Post Graduate or Professional Degree <sup>*</sup>	233	30.64	6.81

*Note.* Significant differences between means at  $p < .05$  are noted with <sup>\*</sup> and <sup>†</sup>

A significant difference in BMI was found between education and BMI ( $F = 5.033$ ;  $df = 4, 3404$ ;  $p < .000$ ) [Table 10]. The Bonferroni post hoc test found statistical differences between the category, some college with a BMI of 31.98 and the category, post graduate or professional degree groups with a BMI of 30.64 [Table 9]. It also found differences between the category, some college (BMI 31.98) and high school graduate (BMI 31.94) [Table 9].

Table 10

*Analysis of Variance for Body Mass Index and Education*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	816.269	4	204.067	5.033	0.00
Within Groups	138,021.663	3,404	40.547		
Total	138,837.931	3,408			

*Gender and BMI.* As shown in Table 11, female municipal workers had a mean BMI of 32.75, and males had a mean BMI of 31.21. This difference in BMI by gender was statistically significant ( $t = -6.307, df = 3416, p = .000$ ).

Table 11

*Means and Standard Deviations for Body Mass Index and Gender (N = 3,418)*

Gender	Body Mass Index		
	Frequency	<i>M</i>	<i>SD</i>
Male	2,502	31.21	5.92
Female	916	32.75	7.37

*Research Question 6*

What are the relationships between level of activity, prediabetes, and obesity in municipal workers?

Spearman Rho correlation was performed between level of activity and prediabetes, and level of activity and obesity to examine the relationships between these variables. Chi square was utilized to examine the relationships between prediabetes and obesity.

*Level of activity and prediabetes.* Spearman Rho demonstrated a statistically significant, weak negative relationship between level of activity and prediabetes ( $r_s = -.048, p = .05$ ). Both the normal and prediabetes groups have similar level of activity at the 1-2 times per week. There was a slightly higher percentage of reported activity at the 3 times per week in the normal group as compared to the prediabetic group (Table 12).

Table 12

*Relationship between Level of Activity and Prediabetes (N = 1,642)*

Level of Activity	HA1c			
	Normal <5.7%		Prediabetes 5.7%-6.4%	
	Frequency	%	Frequency	%
Less Than 1 Time Per Week	108	16.7	200	20.1
1 or 2 Times Per Week	233	36.0	364	36.6
At Least 3 Times Per Week	307	47.4	430	43.3
Total	648	100.0	994	100.0

*Level of activity and obesity.* There was a statistically significant, weak negative correlation between level of activity and obesity ( $r_s = -.091, p = .00$ ). Similar to the reported activity described above, the highest percentages of municipal workers reported a level of activity of at least three times a week. However, in the category of ‘1 or 2 times per week of activity’, the higher percentage was in the obese group as compared to the not obese group (Table 13).

Table 13

*Relationship between Level of Activity and Obesity (BMI) (N = 3,352)*

Level of Activity	Body Mass Index			
	Not Obese (<30)		Obese (>30)	
	Frequency	%	Frequency	%
Less Than 1 Time Per Week	242	16.5	370	19.6
1 or 2 Times Per Week	432	29.5	687	36.4
At Least 3 Times Per Week	790	54.0	831	44.0
Total	1,464	100.0	1,888	100.0

*Prediabetes and obesity.* Chi square analysis revealed a statistically significant, positive relationship between prediabetes and obesity ( $\chi^2 = 58.55$ ,  $df = 1$ ,  $p = .000$ ). The highest percentage of prediabetes was found in the obese category (Table 14).

Table 14

*Relationship between Prediabetes and Obesity (BMI) (N = 1,631)*

HA1c	Not Obese		Obese	
	Frequency	%	Frequency	%
Normal	275	53.3	372	33.0
Prediabetes	241	46.7	743	67.0

*Research Question 7*

What is the best predictive model for obesity (BMI > 30) in municipal workers using perceived stress and the personal factors of age, gender, and race? Research question 7a: Does the inclusion of HA1c add to the predictive ability of the model? Research question 7b: Does the inclusion of shift schedule add to the predictive ability of the model? Research question 7c: Does the inclusion of level of activity add to the predictive ability of the model? Research question 7d: Does the inclusion of occupation add to the predictive ability of the model?

Collinearity diagnostics were run to reveal any issues with multicollinearity. Preliminary analyses were performed to examine the bivariate relationships between obesity and the set of proposed predictors (perceived stress, level of activity, HA1c) to reveal any significant relationships. Logistic regression was performed to examine the influence of the multiple independent variables on the dependent variable obesity. A



goodness-of-fit statistic can demonstrate the fit of a predictive model and will allow evaluation of the significance of the association of the independent variables with the dependent variable.

The data were entered into the binary logistic regression in the steps as outlined above. For categorical variables, the reference comparisons were as follows: stress (almost none), gender (male), race (white), shift (day), physical activity (at least 3 times per week), and occupation (city hall). Preliminary collinearity diagnostics did not reveal any issues with multicollinearity, thus all variables were entered as planned.

In step 1, stress, age, gender, and race were entered as predictor variables. As shown in Table 15, these contributed to a statistically significant model predicting obesity in municipal workers. In Models 2, 3, 4, and 5 the predictor variables were significant in predicting obesity. Shift schedule was the weakest predictor. Shift schedule was omitted from the model but no improvement was seen in the overall model and so it was added back to the model. Therefore, the best predictor model was Model 5. Age, gender, race, HA1c, shift schedule, physical activity, and occupation were significant predictors of obesity in this sample of municipal workers.

Table 15

*Significance of Overall Models with Predictor Variables Predicting Obesity (BMI) of Municipal Workers (N = 1,865)*

	Predictor Variables	Chi Square ( <i>df</i> )	Nagelkerke R <sup>2</sup>	<i>p</i>
Model 1	Stress, Age, Gender, Race	58.708 (11)	0.044	.00
Model 2	HA1c	76.026 (12)	0.057	.00
Model 3	Shift Schedule	76.054 (13)	0.057	.00
Model 4	Physical Activity	89.352 (15)	0.066	.00
Model 5	Occupation	138.680 (18)	0.102	.00

The binary logistic regression for Model 5 with its beta weights, standard error, Wald, degrees of freedom, and odds ratios are shown in Table 16. The analysis revealed that age, black race, HA1c, physical activity, and occupation (especially police and public works) were significant predictors of obesity. Model 5 correctly predicted 96.1% of the sample as obese. However, it predicted only 12.4% correctly as not obese (Table 17).

Table 16

*Binary Logistic Regression Analysis Predicting Obesity (BMI) of Municipal Workers (N = 1,865)*

Study Variables	B	S.E.	Wald	df	Sig.	OR
Stress (Almost None)*			1.38754	3	0.708	
A Lot	0.046	0.207	0.049	1	0.826	1.05
Moderate Amount	-0.127	0.163	0.601	1	0.438	0.88
Relatively Little	-0.091	0.172	0.280	1	0.597	0.91
Age	-0.030	0.006	28.319	1	0.000	0.97
Gender – Female	-0.016	0.124	0.017	1	0.897	0.98
Race (White)*			9.667	6	0.139	
Native American	0.493	0.833	0.351	1	0.554	1.64
Asian	-0.012	1.348	0.000	1	0.993	0.99
Black	0.361	0.121	8.950	1	0.003	1.43
Pacific Islander	20.534	2.83E+05	0.000	1	0.999	8.27E+09
Other	0.237	0.548	0.187	1	0.666	1.27
Not Known	0.823	0.811	1.029	1	0.310	2.28
HA1c	0.180	0.057	10.129	1	0.001	1.20
Shift Schedule – Not Day	0.126	0.123	1.056	1	0.304	1.13
Physical Activity (3 x Wk)*			14.099	2	0.001	
Less than 1 x Wk	0.429	0.149	8.236	1	0.004	1.54
1 to 2 x Wk	0.392	0.119	10.793	1	0.001	1.48
Occupation (City Hall)*			47.667	3	0.000	
Fire	0.205	0.167	1.500	1	0.221	1.23
Police	0.688	0.140	24.170	1	0.000	1.99
Public Works	0.989	0.165	35.897	1	0.000	2.69
Constant	0.349	0.443	0.620	1	0.431	1.42

Note. \*Reference category

B = Beta weights S.E. = Standard error, Wald = Chi-square statistic, df = degrees of freedom, OR = Odds ratio.

Table 17

*Predicted Obesity (BMI) based on Logistic Regression Model (N = 1,865)*

Observed	Predicted		% Correct
	Not Obese	Obese	
Not Obese	69	487	12.4
Obese	51	1,258	96.1

### *Research Question 8*

What is the best predictive model for obesity (defined as waist circumference > 40 inches in men and > 35 inches in women) in public safety workers using perceived stress and the personal factors of age, gender, and race? Research question 8a: Does the inclusion of HA1c add to the predictive ability of the model? Research question 8b: Does the inclusion of shift schedule add to the predictive ability of the model? Research question 8c: Does the inclusion of level of activity add to the predictive ability of the model?

Collinearity diagnostics were run to reveal any issues with multicollinearity. Preliminary analyses were performed to examine the bivariate relationships between obesity and the set of proposed predictors to reveal any significant relationships. Logistic regression was performed to examine the influence of the multiple independent variables on the dependent variable obesity. A goodness-of-fit statistic can demonstrate the fit of a predictive model and will allow evaluation of the significance of the association of the independent variables with the dependent variable.

The data were entered into the binary logistic regression in the steps as outlined above. For categorical variables, the reference comparisons were as follows: stress (almost none), gender (male), race (white), shift (day), and physical activity (at least 3 times per week). Preliminary collinearity diagnostics did not reveal any issues with multicollinearity, thus all variables were entered as planned.

In step 1, stress, age, gender, and race were entered as predictor variables. As shown in Table 18, these contributed to a statistically significant model predicting obesity in public safety workers. In Models 2, 3, and 4, the predictor variables were significant in predicting obesity. Shift schedule was the weakest predictor. The best predictor was Model 4 and it included all the variables (stress, age, gender, race, HA1c, shift schedule, and physical activity).

Table 18

*Significance of Overall Models with Predictor Variables Predicting Obesity (Waist Circumference) of Public Safety Workers (N = 1,689)*

	Predictor Variables	Chi Square ( <i>df</i> )	Nagelkerke R <sup>2</sup>	<i>p</i>
Model 1	Stress, Age, Gender, Race	44.751 (11)	0.034	.00
Model 2	HA1c	68.353 (12)	0.052	.00
Model 3	Shift Schedule	72.078 (13)	0.054	.00
Model 4	Physical Activity	91.428 (15)	0.069	.00

The binary logistic regression for Model 4 with its beta weights, standard error, Wald, degrees of freedom and odds ratios are shown in Table 19. The analysis revealed that age, female gender, HA1c, and physical activity were significant predictors of obesity in public safety workers. Model 4 correctly predicted 99.8% of the sample as obese. However, it predicted only 1.1% correctly as not obese (Table 20).

Table 19

*Binary Logistic Regression Analysis Predicting Obesity (Waist Circumference) of Public Safety Workers (N = 1,689)*

Study Variables	B	S.E.	Wald	df	Sig.	OR
Stress (Almost None)*			1.645	3	0.649	
A Lot	0.009	0.206	0.002	1	0.966	1.01
Moderate Amount	-0.108	0.160	0.456	1	0.500	0.90
Relatively Little	-0.173	0.167	1.069	1	0.301	0.84
Age	-0.015	0.006	6.867	1	0.009	0.99
Gender -- Female	0.618	0.127	23.641	1	0.000	1.85
Race (White)*			1.950	6	0.924	
Native American	0.319	0.840	0.145	1	0.704	1.38
Asian	0.003	1.236	0.000	1	0.998	1.00
Black	0.097	0.119	0.665	1	0.415	1.10
Pacific Islander	20.547	2.82E+05	0.000	1	0.999	8.36E+09
Other	-0.082	0.514	0.026	1	0.873	0.92
Not Known	0.897	0.800	1.258	1	0.262	2.45
HA1c	0.257	0.061	17.906	1	0.000	1.29
Shift Schedule -- Not Day	-0.191	0.108	3.114	1	0.078	0.83
Physical Activity (At Least 3 x Wk)*			19.298	2	0.000	
Less than 1 x Wk	0.454	0.150	9.108	1	0.003	1.57
1 or 2 x Wk	0.473	0.118	16.046	1	0.000	1.60
Constant	-0.259	0.4469802	0.337	1	0.562	0.77

*Note.* \*Reference category

B = Beta weights S.E. = Standard error, Wald = Chi-square statistic, df = degrees of freedom, OR = Odds ratio

Table 20

*Predicted Obesity (Waist Circumference) based on Logistic Regression Model (N = 1,689)*

Observed	Predicted		% Correct
	Not Obese	Obese	
Not Obese	61	224	1.1
Obese	52	527	99.8

*Research Question 9*

What is the best predictive model for prediabetes in municipal workers using perceived stress and the personal factors of age, gender, and race? Research question 9a: Does the inclusion of BMI add to the predictive ability of the model? Research question 9b: Does the inclusion of shift schedule add to the predictive ability of the model? Research question 9c: Does the inclusion of level of activity add to the predictive ability of the model? Research question 9d: Does the inclusion of occupation add to the predictive ability of the model?

The data were entered into the binary logistic regression in the steps as outlined above. For categorical variables, the reference comparisons were as follows: stress (almost none), gender (male), race (white), shift (day), physical activity (at least 3 times per week), and occupation (city hall). Preliminary collinearity diagnostics did not reveal any issues with multicollinearity, thus all variables were entered as planned.

In step 1, stress, age, gender, and race were entered as predictor variables. As shown in Table 21, these contributed to a statistically significant model predicting prediabetes in municipal workers. In Models 3, 4, and 5 the predictor variables were significant in predicting prediabetes, but contributed little to the variance (Nagelkerke R<sup>2</sup>). However, shift schedule, physical activity, and occupation were the weakest

predictors. Therefore, Model 2 and Model 5 offer the same capability for predicting prediabetes.

Table 21

*Significance of Overall Models with Predictor Variables Predicting Prediabetes of Municipal Workers (N = 1,593)*

	Predictor Variables	Chi Square ( <i>df</i> )	Nagelkerke R <sup>2</sup>	<i>p</i>
Model 1	Stress, Age, Gender, Race	147.294 (11)	0.120	.00
Model 2	BMI	211.897 (12)	0.169	.00
Model 3	Shift Schedule	212.103 (13)	0.169	.00
Model 4	Physical Activity	212.269 (15)	0.169	.00
Model 5	Occupation	214.312 (18)	0.170	.00

The binary logistic regression for Model 2 with its beta weights, standard error, Wald, degrees of freedom, and odds ratios are shown in Table 22. The analysis revealed that age, black race, and BMI were significant predictors of prediabetes.

Table 22

*Binary Logistic Regression Analysis Predicting Prediabetes of Municipal Workers (N = 1,593)*

Study Variables	B	S.E.	Wald	df	Sig.	OR
Stress (Almost None)*			4.850	3	.183	
A Lot	.273	.210	1.687	1	.194	1.31
Moderate Amounts	.265	.169	2.457	1	.117	1.30
Relatively Little	.394	.179	4.848	1	.028	1.48
Age	.051	.006	72.631	1	.000	1.05
Gender -- Female	-.242	.124	3.823	1	.051	.79

Table 22 (continued)

Study Variables	B	S.E.	Wald	df	Sig.	OR
Race (White)*			73.861	6	.000	
Native American	.263	.842	.097	1	.755	1.30
Asian	-.532	1.234	.186	1	.666	.59
Black	1.044	.124	71.335	1	.000	2.84
Pacific Islander	.174	1.448	.014	1	.904	1.90
Other	.818	.593	1.901	1	.168	2.26
Not Known	1.524	.831	3.367	1	.067	4.59
BMI	.076	.010	57.722	1	.000	1.08
Constant	-5.238	.507	106.544	1	.000	.01

\*Reference category

B = Beta weights S.E. = Standard error, Wald = Chi-square statistic, df = degrees of freedom, OR = Odds ratio

Table 23

*Predicted Prediabetes based on Logistic Regression Model (N = 1,593)*

Observed	Predicted		% Correct
	Normal	Prediabetes	
Normal	284	343	45.0
Prediabetes	159	807	83.2

Model 2 correctly predicted 83.2% of the sample as prediabetic. It predicted 45.0% correctly as normal HA1c (Table 23). This outcome was the same as Model 5, so for the sake of parsimony, Model 2 was selected as the best predictor of prediabetes.



## CHAPTER 5

### DISCUSSION, CONCLUSIONS, LIMITATIONS, IMPLICATIONS, AND RECOMMENDATIONS

This study employed a non-experimental, correlational design to explore the relationships among obesity, prediabetes, and perceived stress in municipal workers. Discussion of key findings, conclusions and limitations are presented in the first section of this chapter. The second section outlines the implications for nursing education and practice and recommendations for future research.

#### Discussion of Findings

##### *Obesity*

Overall 87.8% (2,981) of the municipal workers in this sample were overweight or obese. Almost one-third of the sample (32%) was overweight, over one half (55.8%) were obese, and only 12% were normal weight, with 0.2% underweight. These findings are of concern because being overweight or obese increases the risk for injury, absenteeism, unemployment, or disability (Schulte et al., 2007).

The prevalence of obesity in this sample (55.8%) was greater than the prevalence rate of obesity (32%) reported by the CDC for the state where this study was conducted (CDC, 2010). If obesity rates continue to rise at their current level, by 2018, 49.3% of the adult population in this state will be obese and the percentage of obese employees in

this municipality will also escalate (United Health Foundation, American Public Health Association and Partnership for Prevention, 2009).

In the current study, the model that best predicted obesity was the model that used BMI as the dependent variable. Age, black race, HA1c, physical activity, and occupation were significant predictors of obesity in this sample of municipal workers. The model was highly predictive of obesity with 96% accuracy. In terms of clinical practice, the model can be used to identify employees at highest risk for becoming obese and of developing the chronic health problems associated with obesity. In previous research with data from the same health screening program, similar findings were reported by Grizzle (2009), where age, gender, and race were statistically significant predictors of body composition (BMI and waist circumference). Findings from this study and from Grizzle (2009) were congruent with previous research that modeled obesity (Paeratakul et al., 2002).

Because individuals with large amounts of lean tissue and small amounts of body fat may have a falsely elevated BMI, this study also used waist circumference as a measure of obesity in public safety workers (firefighters and police). This group of municipal workers is expected to maintain a certain level of physical fitness to cope with the rigors of the job because obesity in firefighters and police can affect job performance and safety. Poston and colleagues (2011) reported on the same finding on their study with firefighters.

The best predictors of obesity in public safety workers were age, female gender, HA1c, and physical activity. This logistic regression model correctly classified 99.8% of the sample as obese. Waist circumference, like BMI, is used to classify individuals into

the categories of overweight and obesity but waist circumference is not calculated using height and weight. Public safety workers, especially firefighters are expected to maintain a certain level of physical fitness to maintain job performance. In previous research with data from the same health screening program, Damrongsak (2008) reported that the average BMI in firefighters was 29; however in the current study, the average BMI for all fire shifts was above 30.

Numerous studies in the literature have examined the use of BMI and waist circumference as predictors of obesity and subsequent cardiometabolic disease (Brenner et al., 2010; Janssen et al., 2004; Klein et al., 2007; Lear et al., 2007). BMI is the gold standard for identifying patients at increased risk for adverse health outcomes related to obesity (NIH, 2000). Waist circumference measurement has a utility in clinical situations but BMI is linked with a broader range of health outcomes, and most treatment studies use BMI as an obesity and disease marker (Mctigue et al., 2003). In the current study obesity, by BMI, was reported at 55.8% of the sample. Meanwhile, the measure of obesity by waist circumference was reported at 53.1% for the same sample.

One of the predictors of obesity in public safety workers and municipal workers was age. An unexpected finding from this study, in both logistic regression models, was that as age increased, there was a slightly lower probability for obesity. This finding could be attributed to participation in the wellness initiatives provided by the Good Health Program in the form of educational programs and services of a registered dietitian.

The slightly lower probability of obesity as age increased could also be related to the increasing prevalence of obesity in young adults. Wang and Beydoun (2007) reported that the prevalence of overweight and obesity in adults and children in the U.S. has more

than doubled since the 1970s. Kuk and Arden (2009) in their study of 9,603 adults from the NHANES 1988-1994 cohort reported that the mortality risk from obesity was worse in adults less than 65 years of age.

HA1c was a predictor of obesity in public safety workers. This study demonstrated that as HA1c rises, so does the risk for obesity. The finding of the concomitant presence of obesity and prediabetes is supported in other studies. Two-thirds of the adult population in the U.S. is categorized as overweight and obese and nearly 80 million have prediabetes (Flegal et al., 2010; Garber et al., 2008). Obesity is an independent risk factor for the development of diabetes and data from the Nurses' Health Study demonstrated that the prevalence of diabetes increases in the presence of obesity (Carey et al., 1997; Wing et al., 2001).

Physical activity was a predictor of obesity in public safety workers and in municipal workers as a whole. In this category, those participants with physical activity less than three times a week were at a higher risk for developing obesity. This finding is supported by other studies that demonstrated physical activity as beneficial in reducing the risk for chronic diseases such as obesity and diabetes (Gill & Cooper, 2008; Hu et al., 2007). The results in the current study reported an inverse relationship between level of activity and obesity. This was consistent with results discussed in the studies by Dobson and colleagues (2013) and Han and colleagues (2011).

The largest ethnic group in the current study was African American, making up 66.9% of the sample. Black race was found to be a statistically significant predictor of obesity; this finding is consistent with a study conducted by Paeratakul and colleagues (2002) in which the prevalence of obesity was higher in blacks than in whites. Similarly,

Wang and Beydoun (2007) reported minorities were disproportionately represented in the prevalence of obesity when compared to whites. NHANES data from 2009 – 2010, based on estimates of BMI that included measured weight and height, reported a higher prevalence of obesity (BMI > 30) in non-Hispanic blacks, Hispanics, and Mexican American adults when compared to white adults (Flegal et al., 2012).

In the current study, female participants made up 27.2% of the sample. When gender and BMI were compared, female municipal workers were more obese than males. This finding was consistent with results from other studies. Paeratakul and colleagues (2002) evaluated 9,643 U.S. adults in three racial groups (non-Hispanic whites, non-Hispanic blacks, and Hispanics) and demonstrated that the rate of obesity was higher in women than in men. In addition, the results from the NHANES 2009 – 2010 data reported a higher BMI for non-Hispanic blacks, Hispanics, and Mexican American females than males across all age groups (20 to > 60 years). Only the non-Hispanic white females demonstrated a lower BMI than non-Hispanic White males (Flegal, 2012). In contrast, an analysis conducted in Northern Italy of 776 adults revealed a greater percentage of obesity and overweight was found in men than in women (Cavaliere & Banterle, 2008).

The current study examined the relationship between obesity and education, and the findings showed a significant relationship between these variables. The highest BMI was found in those participants who reported ‘some college’ and the lowest BMI was found in those reporting ‘high school or less’. This finding is surprising and inconsistent with most studies where an inverse relationship between obesity and education [obesity decreased with increasing education] was found (Cavaliere & Banterle, 2008). McLaren

(2007) also reported an inverse relationship between obesity and education when education was used as an indicator for SES (the lower the SES, the higher the body size). Another study demonstrated that low income and low education were associated with obesity and obesity comorbidities (Paeratakul et al., 2002). When Yu (2012) examined the educational differences in obesity in the United States, the less educated among whites and younger black women aged 25-44 years were more likely to be obese than college graduates. The findings of this study could perhaps be explained by employment that provided insurance coverage and easy access to health care regardless of education. It should also be noted regardless of educational background, the mean BMI for this municipal population was above 30 in all categories. Lack of variability in measures of obesity may have influenced the result.

Numerous studies have reported that shift schedules can affect workers' health (Dobson et al., 2013; Han et al., 2011; Knutsson, 2003; Munir et al., 2012; Zhao et al., 2011). When the current study evaluated the BMI by shift schedule, the highest BMI was found in the 11 p.m. to 7 a.m. shift (police and firefighters). Knutsson (2003) reviewed studies that investigated the health disorders of shift workers and also reported that weight gain was more prevalent among nurses working the night shift versus the day shift. Han and colleagues (2011) argued that work schedules may lead to obesity in nurses because the long hours or different schedules disrupt normal eating times and reduce access to healthy food, and shift rotation may affect circadian rhythms with a detrimental effect on sleep quantity and quality. Even when obese nurses had the same quantity of sleep as the normal weight nurses, their sleep was restless (Han et al., 2011).

The Nurses' Sleep Study demonstrated that nurses working successive 12-hour shifts slept 5.5 hours on average between shifts (Geiger-Brown & Trinkoff, 2010). Bray and Young (2006) reported a potential link between a lack of adequate sleep duration and disorders such as obesity and type 2 diabetes in a study with offshore personnel. Age and years of shift work were found to be the best predictors of BMI, with the highest BMI among the night shift workers. This is consistent with the finding from the current study in which the highest BMI was found among those who worked 11 p.m. to 7 a.m. and therefore possibly related to disruption of the circadian cycle.

In the current study, firefighters working rotating shifts 24 hours on and 48 hours off were found to have the lowest BMIs. This was an unexpected finding because as an occupational group, firefighters have one of the highest prevalence rates of obesity, ranking third in prevalence among male occupations (Dobson et al., 2013). Munir and colleagues (2012) reported that in North America, 80% of U.S. firefighters were overweight or obese. In a qualitative study, firefighters reported sleep interruptions, snacking, and using caffeinated drinks to stay alert during a 24 hour shift (Dobson et al., 2013). Bray and Young (2006) report that irregular sleep/wake cycles possibly alter intracellular circadian clocks inducing metabolic changes that may potentiate adipose accumulation and obesity.

The results obtained in the current study can possibly be explained by the level of physical fitness reported in this group of firefighters from the same screening health program by a previous researcher, who found that 94.7% of firefighters performed physical activity one or two times per week at a medium to high level (Damrongsak, 2008). In addition, in the current study, a certain level of physical fitness is expected in

this group of firefighter participants to maintain job performance and being off work for two days between shifts might present more time to be physically active. The increased awareness of healthy diets and the opportunity to participate in group exercise at the fire stations may have contributed to the lower BMI found in firefighters in the current investigation.

### *Prediabetes*

In the current study, age, black race, and BMI were significant predictors of prediabetes. Using the logistic regression model containing the significant variables developed from the analysis, 83.2% of the sample was correctly classified as being prediabetic. This finding is clinically significant because a healthcare provider who knows only three pieces of information (age, black race, and BMI) could tailor interventions to avert the onset of prediabetes and diabetes. The logistic model was able to correctly classify 45% of cases in the sample as being normal. The model is also important because it has the ability to classify cases as positive (prediabetes) and negative (normal). This gives healthcare providers a better ability to aggressively focus preventive interventions on a subset of their patient population.

The link between BMI and the risk for developing prediabetes has been previously studied and the burden it places on individual workers and the employer is recognized (Aldana et al., 2006; Garber, 2011; Wing et al., 2001; Zhang et al., 2010). Nearly 80 million U.S. residents have prediabetes, and if even one-third transition to diabetes, it will result in a large increase in prevalence. Identification of those individuals who are obese and prediabetic can aid in targeted screening in wellness programs.



Overweight, obesity, and non-white ancestry are among the risk factors identified by the American College of Endocrinology and the American Association of Clinical Endocrinologists to target screening of individuals for prediabetes (Garber et al., 2008). These risk factors were among the significant predictors of prediabetes identified in the current study.

In the current study, HA1c was measured on 1,963 participants and 51% of these participants were identified as prediabetic. HA1c is routinely measured on employees aged 40 and older. Consistent with other research, the current study demonstrated an inverse relationship between level of activity and prediabetes (Gill & Cooper, 2008; Hu et al., 2007; Manson et al., 1992). Findings from two landmark randomized clinical trials (DPP and Look AHEAD studies) demonstrated lifestyle modifications such as physical activity were found to reduce the transition from prediabetes to diabetes (Dorsey & Songer, 2011; Look AHEAD Research Group, 2010; Malin et al., 2012; National Institute of Health, 2008; Schrauwen, 2007). Helmrich and colleagues (1991) reported that participants in the Nurses' Health Study who exercised vigorously at least once a week had a lower risk for developing diabetes than women who did not exercise.

Obesity and inactivity are closely linked to the development of prediabetes and data from the Nurses' Health Study suggest the lowest risk for diabetes occurs in individuals with a BMI < 21, with increasing prevalence seen as obesity levels increase (Carey et al., 1997; Wing et al., 2001). This was consistent with findings from the current study where a statistically significant relationship was demonstrated between prediabetes and obesity. The association between obesity and prediabetes is well established such that evidence-based weight loss programs are recommended for

Medicare beneficiaries who are obese and at risk for the development of diabetes (Thorpe & Yang, 2011).

In previous studies, HA1c was shown to be elevated in individuals exposed to stress (Grossi et al., 2003; Hansen et al., 2003; Kelly et al., 2005; Netterstrom & Sjol, 1991). This was not the case in the current study where no correlation was found between perceived stress and prediabetes. Reports of perceived stress were similar between participants with normal and prediabetic HA1c levels. This finding could be attributed to analysis of self-report data regarding perceived stress. Perceived stress was assessed with a single question on the TeleForm® instrument. This single item may not have been sufficiently sensitive to capture the relationships of the variables that were being examined. Also, working populations such as firefighters and police are accustomed to working in stressful situations, and crisis events in their personal and professional lives might be not be viewed as unduly stressful. Because there was no measure of resilience (the ability to cope with stress), the effect of this intervening variable cannot be ruled out.

### *Perceived Stress*

The current study did not demonstrate a significant relationship between perceived stress and obesity in municipal workers, although the obese group reported the highest percentage of moderate amounts of stress. In addition, perceived stress was not a significant predictor of obesity or prediabetes in any of the study models. In a large study, Brunner and colleagues (2007) reported employees who worked under stressful conditions had 50% higher odds of obesity than those who did not experience stress, even

after controlling for socioeconomic status and variation in adverse health behaviors. Associations between stress and obesity were found in other studies and reviews of literature (Bjontorp, 2001; Ramey, 2003). Kouvonen and colleagues (2005) reported a weak association between stress and obesity in public sector workers in Finland.

Findings in the current study did demonstrate a significant relationship between perceived stress and occupation with the highest frequency of stress reported by the police and the lowest frequency of stress being reported by Public Works employees. Multiple studies have demonstrated a correlation between stress and certain occupations (Collins & Gibbs, 2003; Franke et al., 2002; Pendleton et al., 1989; Peretti-Watel et al., 2009; Ramey et al., 2004; Tang & Hammontree, 1992; Tomei et al., 2006; Violanti et al., 2006). Investigations on stress and occupations are important because of the amount of time individuals spend at work over their life span, the effect of stress on the mental and physical well-being of the workers, and the resultant decrease in productivity and increase in absenteeism.

NIOSH recognized the problem of stress and occupation early on with the publication of the documents, '*Stress....at Work*' in 1999 and '*Total Worker Health*' in 2012 (CDC, 1999; CDC, 2012). NIOSH acknowledged the effect stress has on workers' health and recommended guidelines for prevention and intervention. The World Health Organization (WHO) recommends an adequate work-life balance to promote healthy workers (WHO, 2011). One of the Healthy People 2020 goals in the area of occupational safety and health is to increase the proportion of employees who have access to workplace programs that prevent or reduce stress (U.S. Department of Health and Human Services, 2010).

In the 1989 study by Pendleton and colleagues, police, firefighters, and other municipal workers were compared for stress and job strain. In this self-report study, police officers viewed themselves as experiencing the most stress in comparison to firefighters and other municipal workers. Grizzle (2009) found that police officers in the same health screening program as the current study had higher occupational stress than firefighters. This could be attributed to the nature of police work, excessive paperwork, 8-hour shift work, and working alone, whereas firefighters work in close knit groups and the 48 hours off between shifts allows for attention to personal needs (Bureau of Labor Statistics, 2011; Grizzle, 2009).

In England, police work is considered to be one of the top three occupations for stress and mental illness (Collins & Gibbs, 2003). In other studies, perceived stress at work contributed to health problems leading to increased morbidity and mortality (Peretti-Watel et al., 2009). In contrast, Marchand and colleagues (2005) found an individual's position at work played a limited role in perceived stress when family and social life were not taken into account.

### *Conceptual Framework*

Based on the findings of this study, there is support for the use of the Combined Expanded Biobehavioral Interaction (EBI) Model and Karasek and Theorell's (demand-control) Model. The findings that correspond to the different domains of the EBI Model will be discussed below.

### *Individual Domain*

The current study was able to demonstrate that in the individual domain, black race was a significant predictor of obesity, and obesity was more prevalent in women than men. Age, race, and gender were all significant predictors of obesity and prediabetes in municipal workers.

### *Environmental Domain*

In the environmental domain, shift work was the only variable considered in this study. The current findings were able to demonstrate that there was a difference in obesity in relation to shift work. The highest BMI was found in the 11 p.m. to 7 a.m. shift. Shift work has been implicated with interruption of circadian rhythms and change in dietary patterns that could explain the increase in BMI in the 11 p.m. to 7 a.m. shift. Further research on the specific effects of shift work is warranted.

### *Psychosocial Domain*

Perceived stress was the variable that was considered in the psychosocial domain. The current study did not demonstrate a significant relationship between perceived stress and obesity in municipal workers. This finding could be related to the cross-sectional design of the study and to the temporal design of the survey question that asked about the amount of stress experienced by the participant in the past two weeks. Perceived stress was significant by occupation. Police officers reported the highest frequency of stress which was a finding similar to previous reports (Grizzle, 2009).

### *Workplace Demands*

The variable considered in this domain was occupation. As described above, police officers reported the highest amount of stress. Given the length of time across the lifespan that employees spend in the workplace, it is important to identify job characteristics that could have a detrimental effect on health. Job characteristics during the 11p.m. to 7a.m. and 7a.m. to 3p.m. shifts warrant further exploration, given the finding of high BMIs. Overall, a high prevalence of obesity (54%) was found in these study participants. Prediabetes was also highly prevalent in the group ( $n = 1963$ ) that had HA1c measured (51%).

### *Behavioral Domain*

Level of activity was the variable considered in the behavioral domain. Almost 48% of the participants reported physical activity at least three times per week. Physical activity was found to be a significant predictor of obesity in both public safety workers and in municipal workers as a whole. A weak but significant relationship was found among level of activity, prediabetes, and obesity.

### *Biological Domain*

BMI, waist circumference, and HA1c were the variables considered in the biological domain. BMI is the gold standard for identifying patients at increased risk for adverse health outcomes related to obesity (NIH, 2000). BMI is linked with a broader range of health outcomes and most treatment studies use BMI as an obesity and disease marker (Mctigue et al., 2003). In the current study, BMI was a significant predictor of

prediabetes, and HA1c was a significant predictor of obesity in municipal workers. While waist circumference as a measure of obesity can be predicted by age, gender, HA1c, and physical activity, its best use is for individual treatment plans rather than population based analysis.

Overall, the EBI and the Karasek and Theorell's Models provided guidance in identifying the variables that predicted obesity and prediabetes in municipal workers. Age, gender, race, HA1c, shift schedule, physical activity, and occupation were significant predictors of obesity in municipal workers. Age, race, and BMI were significant predictors of prediabetes in municipal workers. When public safety workers were investigated separately from the rest of the municipal workers, age, female gender, HA1c, and physical activity were significant predictors of obesity.

### Conclusions

Based on the findings of this study, conclusions were as follows:

1. Age, gender, race, HA1c, shift schedule, physical activity, and occupation were significant predictors of obesity (as measured by BMI) in municipal workers.
2. Age, female gender, HA1c, and physical activity were significant predictors of obesity (as measured by waist circumference) in public safety workers.
3. The majority of the 3,501 municipal workers were obese.
4. The highest BMI recorded was for the 11 p.m. to 7 a.m. shift and the lowest BMI recorded was for Fire Shift A, B, and C.
5. Age, race, and BMI were significant predictors of prediabetes in municipal workers.

6. More than half of the 1,963 municipal workers who had a measurement of HA1c were prediabetic.
7. An inverse relationship was found between level of activity and the dependent variables, obesity and prediabetes.
8. The highest percentage of prediabetes was found in the obese group.
9. No significant relationships were found between perceived stress and the dependent variables obesity and prediabetes.
10. The highest frequency of perceived stress was reported by police officers.

#### Limitations

The following is a discussion of several limitations of the present study:

1. The use of secondary data prevented the use of additional variables or research questions such as investigating the relationships among obesity, shift schedule, circadian rhythms, and obstructive sleep apnea.
2. A small amount of variance was explained in the three models. Adding more variables to the models in future investigations may improve the explanatory power of the predictors and further enhance understanding of obesity and prediabetes in this population.
3. A methodological limitation was the cross-sectional, correlational design precluding the interpretation of a causal relationship.
4. The use of self-report survey items might have increased the possibility for socially desirable responses on certain items on the questionnaire.



5. The exploration of a correlational relationship among perceived stress, obesity, and prediabetes was limited because of the temporal design of the survey question which inquired about the amount of stress experienced by the participant in the past two weeks.
6. The use of a single occupational cohort from one southeastern city may limit the generalizability of the findings. The cohort used in the study were all employed and insured, and even though different races, genders, and ages were represented, there was still an element of homogeneity.

### Implications for Nursing Education, Practice, and Research

#### *Implications for Nursing Education*

Nursing curricula should focus on age, gender, race, occupation, shift schedule, and physical activity as predictors of obesity and prediabetes in employee populations. Healthy People 2020 goals include the reduction of the proportion of persons at high risk for obesity and prediabetes; therefore emphasis should be placed on health promotion and prevention content that take into consideration the predictors identified in the current study (U.S. Department of Health & Human Services, 2010).

Community health courses should include occupational and public health content that addresses the growing prevalence of obesity and prediabetes. Special focus should be placed on occupational health in nursing education in both undergraduate and graduate programs given the fact that large numbers of adults in the community can be reached with health education in the workplace. Employers want to lower health benefit costs by retaining healthy, productive, and engaged employees. The high cost of

providing health insurance to employees is deflected by workers who engage in healthy behaviors to prevent obesity and prediabetes.

These chronic health issues should be presented within a relevant conceptual framework such as the EBI and Karasek and Theorell's Models to provide a context and consistency in teaching students factors that contribute to obesity and prediabetes in a working population. Health promotion theories could be discussed to guide students in identifying appropriate interventions to decrease the risk of obesity and prediabetes in employee populations.

#### *Implications for Nursing Practice*

The choice of a conceptual model will also provide a framework for practice. The Combined EBI and Karasek and Theorell's Models will aid in understanding an individual's behavior and how it is affected by environmental, biological, or psychosocial forces. Because age, race, HA1c, physical activity, and occupation were significant predictors of obesity, nurses should assess these factors when evaluating an individual in the occupational health setting. On-site wellness clinics are growing in popularity with both employers and employees for the cost savings benefits available to both parties. Advanced practice nurses are uniquely educated for this role in wellness clinics because a large part of their education focuses on prevention of illness and promotion of healthy behaviors. The current study emphasized the relationship of healthy behaviors such as physical activity with obesity and prediabetes.

Given the high percentages of obesity and prediabetes in the study population, screening with BMI, waist circumference, and HA1c by occupational health nurses is of

utmost importance and relevance. Obesity is a known risk factor for chronic conditions such as metabolic syndrome, diabetes, and cardiovascular disease. Advanced practice nurses are especially well trained in providing counseling regarding lifestyle behaviors and in identifying those individuals who are at risk or currently have prediabetes and diabetes.

Occupational health nurses should design programs to target obesity and prediabetes, and based on the findings of the current study special focus should be placed on identifying the predictors of these chronic conditions, namely age, gender, race, HA1c, BMI, physical activity, and occupation. Health issues such as obesity and prediabetes can affect work performance especially in professions such as firefighters and police work. Obesity can hinder performance when climbing a ladder, or in the case of a police officer, hinder reaction time if faced with a violent situation. In maximizing the well-being and functional capacity of each individual, occupational health nurses have the potential to make a great contribution to improving population health.

#### *Implications for Nursing Research*

Despite the health coverage and screening at this workplace, 32% of participants were overweight and 55.8% had BMIs that indicated an obese state. Further research is warranted to investigate risk reduction programs specifically aimed at reducing obesity and prevention of prediabetes in this population. More research is needed to explore how the work environment fosters or deters the development of obesity.

Before implementation of new programs, research should focus on the barriers that prevent employees from utilization of existing programs. The Combined EBI and

Karasek and Theorell's Model can be used to guide further investigations into the psychosocial, environmental, and workplace demands of the different occupational groups to tailor programs according to those needs.

### Recommendations for Future Research

Recommendations for further research include:

1. Given the high prevalence of obesity and prediabetes in municipal workers, future studies should focus on development and testing of worksite interventions that address modifiable risk factors such as level of activity, BMI, and HA1c to reduce obesity and prediabetes in municipal workers.
2. Work environment factors such as work demands and shift schedule should be investigated in relation to the development of obesity.
3. Differences in BMI by occupational group within a municipality should be investigated.
4. Further research within this municipal worker population is needed on the prevalence of co-morbidities associated with obesity such as obstructive sleep apnea.
5. Explore relationships between obstructive sleep apnea and progression of prediabetes to diabetes in municipal workers.
6. Future research should examine the effect of shift schedule on circadian rhythms, obesity, and the development of prediabetes.
7. Longitudinal research is needed to evaluate the progression of prediabetes to diabetes in these municipal workers.

8. An alternate valid and reliable instrument to measure perceived stress is recommended to further investigate the effect of stress on obesity and prediabetes in municipal workers.

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APPENDIX A

HEALTH RISK APPRAISAL TELEFORM ® INSTRUMENT



GOOD HEALTH PROGRAM, UAB SCHOOL OF NURSING

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HEALTH QUESTIONNAIRE - SCREENING INFORMATION

INSTRUCTIONS: Double check prefilled information. Do not bend or fold the form. USE A BLACK PEN.

Shade circles like this: [filled circle] Not like this: [circle with X] [circle with checkmark]

For optimum accuracy, please print carefully and avoid contact with the edges of the box. The following will serve as an example:

1 2 3 4 5 6 7 8 9 0

LAST NAME FIRST NAME MI SCREEN DATE DEPARTMENT SCREENING ID NUMBER DATE OF BIRTH (mm/dd/yy) WORK PHONE NUMBER

1. Checkout Personnel Only

Employees: Please Answer Questions # 2-85. If you are pregnant, please call 934-7549 before starting.

- 2. What shift do you work? ... 3. Sex: ... 4. How many times per day do you usually use smokeless tobacco? ... 5. How many cigars do you usually smoke per day? ... 6. How many pipes of tobacco do you usually smoke per day? ... 7. How would you describe your cigarette smoking habits? ... 8. How many cigarettes a day do you smoke? ... 9. How many times in the last year have you made a serious attempt to quit ...





- 10. How many years has it been since you smoked cigarettes fairly regularly?   years.
- 11. What was the average number of cigarettes per day that you smoked in the 2 years before you quit?   cigarettes per day.
- 12. On a typical day, how do you USUALLY travel? (select one only)
  - Walk
  - Bicycle
  - Motorcycle
  - Sub-compact or compact car
  - Mid-size or full-size car
  - Truck or van
  - Bus, subway or train
  - Mostly stay home
- 13. In the next 12 months, how many thousands of miles will you probably travel by car, truck, or van?   thousand miles.  
(Note: U.S. average travel = 15 thousand miles per year.)
- 14. In the next 12 months, how many thousands of miles will you probably travel by motorcycle?   thousand miles.
- 15. What percent of the time do you usually buckle your safety belt when driving or riding?    percent of the time.
- 16. On the average, how close to the speed limit do you usually drive?
  - Within 5 mph of limit
  - 6-10 mph over limit
  - 11-15 mph over limit
  - More than 15 mph over limit
- 17. How many times in the last month did you drive or ride when the driver perhaps had too much alcohol to drink?
- 18. How many bottles or cans of beer do you drink in a typical week?
- 19. How many glasses of wine do you drink in a typical week?
- 20. How many wine coolers do you drink in a typical week?
- 21. How many mixed drinks or shots of liquor do you drink in a typical week?

**MEN: Please skip down to Question #32.**

---

- 22. Women only: At what age did you have your first menstrual period?   years old.
- 23. Women only: How old were you when your first child was born? (If no children, mark 00)   years old.
- 24. Women only: How long has it been since your last breast X-ray (mammogram)?
  - Less than 1 year ago
  - 1 year ago
  - 2 years ago
  - 3 or more years ago
  - Never
- 25. Women only: How many women in your natural family (mother and sisters only) have had breast cancer?
- 26. Women only: Have you had a hysterectomy operation (had your womb removed)?  Yes  No  Not sure
- 27. Women only: How long has it been since you had a Pap smear test?
  - Less than 1 year ago
  - 1 year ago
  - 2 years ago
  - 3 or more years ago
  - Never



28. Women only: How often do you examine your breasts for lumps?  Monthly  
 Once every few months  
 Rarely or never
29. Women only: About how long ago has it been since you had your breast examined by a doctor or nurse?  
 Less than a year ago  1 year ago  2 years ago  3 or more years ago  Never
30. Women only: About how long ago has it been since you had a rectal exam?  
 Less than a year ago  1 year ago  2 years ago  3 or more years ago  Never
31. Women only: Are you currently taking estrogen?  Yes  No

**WOMEN: Please skip down to Question #34.**

---

32. MEN ONLY: About how long ago has it been since you had a rectal or prostate exam?  
 Less than 1 year ago  1 year ago  2 years ago  3 or more years ago  Never
33. MEN ONLY: How long has it been since you had a blood test for prostate cancer?  
 Less than 1 year ago  1 year ago  2 years ago  3 or more years ago  Never
34. How long has it been since your last complete physical examination (including blood work) with your doctor?  
 Less than 1 year ago  1-3 years ago  3 or more years ago  Never
35. Have you had a tetanus shot (booster) in the last 10 years?  Yes  No  Never
36. Do you have any chronic condition that requires frequent visits to your doctor?  Yes  No
37. A stool test is when the stool is examined to determine if it contains blood. How long has it been since you had this test done?  
 Less than 1 year ago  1 year ago  2 years ago  3 or more years ago  Never
38. Did you do the blood stool test yourself or was it done by a doctor or medical person?  
 Self  Doctor/Medical Person  Does not apply
39. A proctoscopic exam is when a tube is inserted in your rectum to check for problems. How long ago did you have one?  
 Less than 1 year ago  1 year ago  2 years ago  3 or more years ago  Never
40. When not on the job, how many times in the last year did you witness or become involved in a violent incident where there was a risk of serious injury to someone?  
 4 or more times  2 or 3 times  1 time or never  Not sure
41. When on your job, how many times in the last year did you witness or become involved in a violent incident where there was a risk of serious injury to someone?  
 4 or more times  2 or 3 times  1 time or never  Not sure



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42. Considering your age, how would you describe your overall physical health?  Excellent  Good  Fair  Poor
43. In an average week, how many times do you perform lively physical activity which lasts at least 20 minutes? Lively activity is exercise or work which lasts at least 20 minutes without stopping, and which is hard enough to make you breathe heavier and your heart beat faster.  
 Less than 1 time per week  1 or 2 times per week  At least 3 times per week
44. In an average week, what type of activities do you usually do for exercise? (Mark ALL that apply)  
 None  Calisthenics  
 Walk  Lift weights  
 Run or jog  Basketball  
 Aerobics  Swim  
 Bicycle  Other  
 Stair climb
45. How long does each exercise session usually last?  
 0 to 20 minutes  21 to 60 minutes  61 to 120 minutes  More than two hours
46. How vigorous, on average, is your exercise session?  
 Light activity (small increase in breathing rate)  
 Medium activity (some increase in breathing rate, some perspiration)  
 Heavy activity (large increase in breathing rate, heavy perspiration)
47. Which of the following best describes the level of physical effort in your daily activities?  
 Light (office work, driving, sitting)  Medium (walking, carpentry, housework)  Heavy (pushing or carrying heavy objects)
48. If you ride a motorcycle or all-terrain vehicle (ATV), what percent of the time do you wear a helmet?  
 75% to 100%  25% to 74%  Less than 25%  Does not apply to me
49. Is there a working smoke detector in your household?  Yes  No
50. How often do you eat out?  
 Once a week  2-4 times per week  5-7 times per week  More than 7 times per week  Never
51. Do you eat some food every day that is high in fiber, such as whole grain bread, cereal, fruits or vegetables?  Yes  No
52. Do you eat foods every day that are high in cholesterol or fat, such as red meat, cheese, fried foods or eggs?  Yes  No





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53. Do you eat foods every day that are high in salt, such as fried foods, salty snacks, canned foods, prepackaged frozen dinners, processed luncheon meats, or salted nuts?  Yes  No
54. Do you eat foods that are high in processed sugar, such as cake, cookies, pies, pastries, doughnuts, sugary cereals, candy, candy bars, or baked desserts?  Yes  No
55. How many times a day do you eat snacks, such as doughnuts, cookies, packaged crackers, chips, candy bars, and any of the other foods listed in the previous two questions?  0-1  2-3  more than 3  Never
56. In general, how satisfied with life are you?  Mostly satisfied  Partly satisfied  Not satisfied
57. In general, how satisfied with your job are you?  Mostly satisfied  Partly satisfied  Not satisfied
58. During the past two weeks, how much stress would you say you experienced?  
 A lot  Moderate amount  Relatively little  Almost none
59. Have you suffered a personal loss or misfortune in the past year that had a serious impact on your life? (For example, a job loss, disability, separation, jail term, or death of someone close to you.)  
 Yes, 1 serious loss or misfortune  Yes, 2 or more  No
60. What is your race?  
 Aleutian, Alaska Native, Eskimo, American Indian  Asian  Black  Pacific Islander  White  Other  Don't know
61. Are you of Hispanic origin, such as Mexican-American, Puerto Rican, or Cuban?  Yes  No
62. What is the highest grade you completed in school?  
 Grade School or less  
 Some high school  
 High school graduate  
 Some College  
 College Graduate  
 Post Graduate Degree
63. Are you currently:  Never married  Married  Divorced  Separated  Widowed
64. Have you ever had any pain in your lower back?  Yes  No
65. Do you still have back pain occasionally?  Yes  No
66. If you still have back pain occasionally, what year did your problems first start? 

--	--	--	--
67. If you still have back pain occasionally, did the pain start with an injury at work?  Yes  No
68. If you still have back pain occasionally, have you received any medical treatment for back pain?  Yes  No
69. If you still have back pain occasionally, do you do any exercises now to strengthen your back?  Yes  No



- 70. Have you ever been told that you have high blood pressure?  Yes  No If yes, how many years ago were you first told?
- 71. Have you ever been told that you have had a heart attack?  Yes  No If yes, how many years ago were you first told?
- 72. Have you ever been told that you have had a stroke?  Yes  No If yes, how many years ago were you first told?
- 73. Have you ever been told that you have angina (chest pain caused by heart disease)?  Yes  No If yes, how many years ago were you first told?
- 74. Have you ever been told that you have asthma?  Yes  No If yes, how many years ago were you first told?
- 75. Have you ever been told that you have diabetes (sugar diabetes)?  Yes  No If yes, how many years ago were you first told?
- 76. Have you ever been told that you have arthritis?  Yes  No If yes, how many years ago were you first told?
- 77. Have you ever been told that you have any form of cancer?  Yes  No If yes, how many years ago were you first told?

Have any of your grandparents, parents, brothers, or sisters had any of the following?

- |   |  |
|---|--|
| 78. High Blood Pressure <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know | 79. Heart Attack <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know |
| 80. Stroke <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know              | 81. Angina <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know       |
| 82. Asthma <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know              | 83. Diabetes <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know     |
| 84. Arthritis <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know           | 85. Cancer <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Don't know       |

**NOTICE:** In order to provide me with information on preventive health education programs and disease awareness programs, the results collected in the questionnaire will be sent from the Good Health Program to my chosen health carrier.

In an effort to promote wellness and health awareness among City employees, the City of Birmingham encourages all employees to participate in health screenings. Periodic health screenings are a requirement for enrollment in a City-sponsored health insurance program.

For the health screen, I understand that:

- By completing and returning this questionnaire, which will take about one hour, with testing, I am agreeing to participate in the City's Good Health Screen.
- The benefits I will receive will include information on improving my health and a personal health risk appraisal report, which will be mailed to me in a sealed confidential envelope approximately six weeks after the screen.
- There is minimal risk to me from participation in the health measurements, mainly bruising or soreness from the blood draw.
- I am free to have my physician obtain these measurements and send the results to the Good Health Program instead of being measured at the screen.
- The results of this screen will provide guidance for developing health education and exercise programs for City employees. Any information collected will remain confidential, with results reported only as group averages.



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Items 201 - 242  
To be Filled Out By Good Health Staff

**I. Blood Pressure**

NOTE: Enter a leading 0 (zero) if the reading has fewer digits than is provided for. e.g.: A diastolic BP of 88 would be entered as 088.

201. Pulse #1

202. Blood pressure #1  /

203. Pulse #2

204. Blood pressure #2  /

INITIALS

205. Referral for abnormal pulse or BP made? (Complete appropriate referral logs if required)  No  13-day  Immediate

206. Taking antihypertensive?  Yes  No  Don't know

207. Indicate class of antihypertensive:

Diuretic  Beta Blocker  Ca Ch Blocker  ACE Inhib.  AR Blocker  Comb.  Other  Don't know

208. Taking any medications for the following diseases?

Diabetes  High Cholesterol  Asthma  Arthritis  None

**II. Blood Work**

209. Fasting: Hours since last ate or drank (record nearest hour)

NOTE: Code fasting hours as 99 if refusing blood work.  
Code as 88 if medically excused.  
Code as 77 if unable to obtain specimen.

210. Has had Hepatitis B immunization:  Yes  No  In process

**III. Height, Weight, & Body Composition**

211. Weight: Pounds  .

INITIALS

212. Waist circumference: Inches  .

213. Height: Inches  .





**IV. Vision**

214. Time since last eye doctor vision exam?  
 6 months or less     More than 6 months-Less than a year     1-3 years     More than 3 years
215. Wears glasses or contact lenses for distance vision?  Yes     No
216. Wears glasses or contact lenses for near vision?     Yes     No
217. Excluded because did not have lenses for distance vision?  Yes     No    INITIALS
218. Excluded because did not have lenses for near vision?     Yes     No

**For vision results, enter leading '0' (i.e.: 030).**

219. Distance Vision: Right    220. Near Vision: Right    221. Distance Vision: Left    222. Near Vision: Left

20 /       20 /       20 /       20 /

**V. Pulmonary Function**

NOTE: Record liters and 1/100 liter.    223. FEV1  .      224. FVC  .

225. Exclude due to high blood pressure?  Yes     No
226. Exclude due to cough/cold/respiratory infection past 7 days?  Yes     No    INITIALS

**VI. Hearing**

For each frequency below, record the lowest decibel (dB) at which the sound was heard for each ear. For example, if the lowest decibel level heard at 2000 Hz in the right ear is 25 dB, then write 25 in the space provided.

	Right Ear		Left Ear				
227.	500 Hz	<input type="text"/> <input type="text"/>	dB	234.	500 Hz	<input type="text"/> <input type="text"/>	dB
228.	1000 Hz	<input type="text"/> <input type="text"/>	dB	235.	1000 Hz	<input type="text"/> <input type="text"/>	dB
229.	2000 Hz	<input type="text"/> <input type="text"/>	dB	236.	2000 Hz	<input type="text"/> <input type="text"/>	dB
230.	3000 Hz	<input type="text"/> <input type="text"/>	dB	237.	3000 Hz	<input type="text"/> <input type="text"/>	dB
231.	4000 Hz	<input type="text"/> <input type="text"/>	dB	238.	4000 Hz	<input type="text"/> <input type="text"/>	dB
232.	6000 Hz	<input type="text"/> <input type="text"/>	dB	239.	6000 Hz	<input type="text"/> <input type="text"/>	dB
233.	8000 Hz	<input type="text"/> <input type="text"/>	dB	240.	8000 Hz	<input type="text"/> <input type="text"/>	dB

INITIALS

241. If not passing on 1 or more frequencies (more than 35 dB), check if any of the following apply:  
 Otitis/Fluid present     Obstructed canal     Ruptured membrane     High ambient noise level
242. Subject indicates that he/she is exposed to noise on a regular basis outside of work at Fire Dept.:  Yes     No

APPENDIX B  
IRB APPROVAL FORMS



Form 4: IRB Approval Form  
Identification and Certification of Research  
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on August 29, 2016. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator: BROWN, KATHILEEN C

Co-Investigator(s):

Protocol Number: **X950621001**

Protocol Title: *City of Birmingham Health Promotion Project (Good Health Program)*

The IRB reviewed and approved the above named project on 1-24-12. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.

IRB Approval Date: 1-24-12

Date IRB Approval Issued: 1-24-12

*Marilyn Doss*

Marilyn Doss, M.A.  
Vice Chair of the Institutional Review  
Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

470 Administration Building  
701 20th Street South  
205.934.3789  
Fax 205.934.1301  
irb@uab.edu

The University of  
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Form 4: IRB Approval Form  
Identification and Certification of Research  
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on January 24, 2017. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator: O'KEEFE, LOUISE

Co-Investigator(s):

Protocol Number: **E121101001**

Protocol Title: **OBESITY, PREDIABETES, AND PERCEIVED STRESS IN MUNICIPAL WORKERS**

The above project was reviewed on 11/16/12. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This project qualifies as an exemption as defined in 45CFR46.101, paragraph 4.

This project received EXEMPT review.

IRB Approval Date: 11/16/12

Date IRB Approval Issued: 11/16/12

  
Cari Oliver  
Assistant Director, Office of the  
Institutional Review Board for Human  
Use (IRB)

Investigators please note:

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

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