RELATIONSHIPS BETWEEN WORK FACTORS, PREGNANCY WEIGHT GAIN, AND POSTPARTUM WEIGHT RETENTION: THE COMPARATIVE EFFECTIVENESS AND PROVIDER INDUCED DEMAND COLLABORATION (EPIC) STUDY

by

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DEDICATION

This work is dedicated to my husband, Ben, and three children who have stood by me and have given this journey meaning and purpose.

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May 17, 2019

ABSTRACT

Relationships between work factors, pregnancy weight gain, and postpartum weight retention: The Comparative Effectiveness and Provider Induced Demand Collaboration (EPIC) Study

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Background: Pregnancy is a common condition among active duty military women of childbearing age treated by the Military Health System. Excessive gestational weight gain and postpartum weight retention can increase risk of adverse health outcomes for both women and their offspring, and can impact military readiness. Many factors affect the health of the mother and infant during pregnancy and the postpartum period, including demographic, biological, psychosocial, behavioral, and occupational variables. The purpose of the study is to examine the relationship of these factors to gestational weight gain and postpartum weight retention in an active duty population seeking care in the Military Health System between 2010-2014. **Study Aims**: In active duty military women, to determine the relationship of the following variables on pregnancy weight gain and postpartum weight retention: 1) demographic factors and variables affecting home demands; 2) having a mental health diagnosis (anxiety, depression, PTSD, or adjustment disorder); 3) service branch and work factors, including rank; 4) region of TRICARE service; and 5) delivery type (vaginal birth vs. cesarean delivery) and the development of preeclampsia. **Methods:** The study utilized 2010-2014 TRICARE claims

data from the Military Health System Data Repository (MDR) under the Comparative Effectiveness and Provider Induced Demand Collaboration (EPIC) Project. A total of 28,771 women met the inclusion and exclusion criteria of the overall study. The sample size for individuals with preeclampsia was 1,792 women. **Data Analytic Plan:** Data were analyzed using linear and logistic regression. Depending on the analysis, predictor variables examined included marital status, parity, pre-pregnancy body mass index (BMI), the presence of a mental health diagnosis, military service branch, military rank, region of TRICARE service, delivery type, and a diagnosis of preeclampsia. Dependent variables were body weight change during pregnancy and postpartum weight retention. Linear and logistic regressions were followed by group comparisons using Bonferroni correction. **Results**: Being single, enlisted, having preeclampsia, and having a cesarean delivery were associated with greater pregnancy weight gain and weight retention. Individuals who were in the Marine Corps or living in Alaska evidenced more weight gain during pregnancy. Parity and having an overweight BMI were not related to weight gain, but were associated with weight retention, and mental health was not related to weight gain or retention. **Discussion**: Similar to civilians, greater gestational weight gain and postpartum weight retention are found in active duty women who are single, of lower socioeconomic status (enlisted vs. officer), have a cesarean delivery, or have preeclampsia. In contrast to civilians, active duty military women who are obese gain and retain less weight compared to those who are normal weight. These study findings have implications for research, practice, and policy relating to women's health, pregnancy, and weight policies in the military.

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CHAPTER 1: BACKGROUND

INTRODUCTION

Pregnancy is a common health condition treated in active duty service members and TRICARE dependents. Approximately 119,000 births occur in military and network facilities each year (Centers for Disease Control and Prevention, 2010; Klein, Gildengorin, Mosher, & Adelman, 2010; Military Health System, 2015; TRICARE, 2016). There are a number of factors that place pregnant active duty women at risk for adverse maternal outcomes and infant mortality and morbidity. Specifically, low birth weight, preterm birth, excessive gestational weight gain, and postpartum weight retention are associated with a number of demographic, psychosocial, biologic and behavioral, and work factors that all impact the health of the mother and infant during pregnancy and the postpartum period (Davis et al., 2012; Dunkel-Schetter & Tanner, 2012; Elsenbrunch et al., 2007; Endres et al., 2015; Figa-Talamanca, 2006; Fraser et al., 2012; Goedhart et al., 2010; Hartley et al., 2015; Hochner et al., 2012; Linné, Barkeling, & Rössner, 2002; Littleton, Radecki Breitkopf, & Berenson, 2007; Luppino et al., 2010; & Salihu, Myers, & August, 2012). Adverse maternal and infant outcomes among military members negatively impact military readiness (Krukowski et al., 2016). The Department of Defense and Veterans Administration have developed clinical practice guidelines during pregnancy and the postpartum period to mitigate risks of negative outcomes for pregnant and postpartum women and their offspring (Department of Veteran Affairs, & Department of Defense, 2009). Despite these guidelines, over 40% of military women gain excess weight during pregnancy affecting maternal and infant outcomes and military readiness (Krukowski et al., 2016). Therefore, further research is needed to determine factors affecting excessive gestational weight gain in military members. Mitigating excessive gestational weight gain during pregnancy lessens the risk for adverse

maternal and infant outcomes and decreases the negative impact these outcomes have on military readiness. The proposed study expands the current literature by examining demographic factors, work and home demands, service branch and work factors, TRICARE service region, and mental health diagnoses affecting pregnancy weight gain and postpartum weight retention among pregnant and postpartum active duty members.

WOMEN IN THE MILITARY HEALTH SYSTEM

The United States government provides TRICARE health services to over 9 million individuals (Buckler, 2011; Crawford III, Wu, Park, Barbour, 2007; TRICARE, 2016). Active duty members only account for approximately 20% of TRICARE claims (Schoenfeld et al., 2017; Zogg et al., 2016). In addition to the active duty members, TRICARE provides services to an additional estimated 3.9 million beneficiaries that are family members of active duty and activated National Guard and Reserve members. The majority of women (i.e., active duty, reserves, National Guard, TRICARE dependents) receiving care in the military health system (MHS) are within childbearing age (Grindlay, Yanow, Jelinska, Gomperts, & Grossman, 2011; Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016). The most common reasons for which women of childbearing age seek health care are reproductive health and pregnancy (AHRQ, 2011; Klein & Adelman, 2008; Martins & Benicio., 2011). This paper will now take a closer look at the women accessing the MHS.

Active Duty Women

Women comprise approximately 15% of the 2.2 million active duty service members (DoD, 2017; DoD, 2012; Krulewitch, 2016) and 17% of the 833,700 reservists and National Guard members (Bean-Mayberry, et al., 2008; DoD, 2012; Krulewitch, 2016; Waterhouse & O'Bryant, 2008). Approximately 97% of active duty military women are of childbearing age

(Grindlay, Yanow, Jelinska, Gomperts, & Grossman, 2011; Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016). In addition to active duty women, the MHS serves spouses/partners and children of active duty members.

Women Dependents in the MHS

Roughly 92% of the military spouses of active duty members are women, and nearly 90% seek care at local military treatment facilities and civilian health clinics utilizing TRICARE as their sole insurance (Crawford III, Wu, Park, Barbour, 2007; Weststat, 2011). TRICARE dependents are an understudied population since military members, minors, and pregnant women are deemed vulnerable populations. This limits the research performed among military members and TRICARE beneficiaries (Shivayogi, 2013). If dependents are not treated within the MHS or utilizing TRICARE as their sole insurer, researchers have limited information about them as a population (Grindlay, Yanow, Jelinska, Gomperts, & Grossman, 2011; Harriott, Williams, & Peterson, 2005; Klein & Adelman, 2008; TRICARE, 2016; TRICARE Management Activity, 2010). Though spouses or partners have been noted to be an understudied population, it is estimated that approximately 80% of spouses are 40 years old or younger (DoD, 2012). Additionally, an estimated 43% to 70% of married service members and their spouses have one or more children (Chandra et al., 2008; DoD, 2012; Park et al., 2011). Thus, pregnancy is a regular occurrence in the MHS.

Pregnancy among Active Duty Women and Dependents

Pregnancy is common in the MHS (Harriott, Williams, & Peterson, 2005; Klein & Adelman, 2008). Approximately 8.5% of active duty women are pregnant at any given time, compared to only 1.2% of civilian women (Centers for Disease Control and Prevention, 2010; Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016). In addition, nearly one third of

active duty women have their first child before age 21 (Centers for Disease Control and Prevention, 2010; Klein & Adelman, 2008; Military Health System, 2015; TRICARE, 2016).

The MHS provides reproductive health care for active duty members, retirees, and their beneficiaries (Grindlay, Yanow, Jelinska, Gomperts, & Grossman, 2011). An estimated 119,000 births occur in military and network facilities per year. Active duty women give birth to approximately 14,000 to 17,000 of these babies each year while over 96,000 of these infants are born to a spouse or partner of an active duty member (Centers for Disease Control and Prevention, 2010; Klein & Adelman, 2008; Military Health System, 2015; Rychnovsky & Beck, 2006; TRICARE, 2016). Adolescent or teenage pregnancy, defined as pregnancy occurring between the ages of 15 and 19 years, is encountered in the military at a rate of 15.8 per 1,000 adolescent girls (Burr, Roberts,& Bucci, 2013). Each year an average of 3,700 infants are born to TRICARE dependents, age 13-19 years (Klein, Gildengorin, Mosher, and Adelman, 2010). Thus, given the age of military members and their families, pregnancy is frequently encountered in the MHS and provides an important opportunity to optimize health for women, infants, and more generally, military families.

Circumstances of Pregnancy in the Military

A key to optimizing health and health care during pregnancy is to understand the general and unique military factors that may contribute to adverse outcomes and factors that serve as protective factors in a military population. Examples of these factors include deployment, temporary duties, living on-base, frequent moves, occupational stress, comprehensive health care, and military family resources (Cozza, Goldenberg, & Ursano, 2014). Deployments and temporary duties often take military members away from their support system and may cause additional stress on members and their families (Drummet, Coleman, & Cable, 2003). Additional

stressors such as the type of relationship, living situation, and even whether the pregnancy was planned or unplanned may affect healthcare, maternal health, birth outcomes, and military readiness (Klein & Adelman, 2008; Robbins, Chao, Frost, & Fonseca, 2001). Promoting overall physical and psychological health, including discussing weight gain during pregnancy is important for maternal and infant health as well as for military readiness.

The MHS provides care for women of different beneficiary status (e.g., spouse/partner, child, active duty member), in a range of potential relationships and living situations (e.g., deployed, base housing, off-base housing, temporary duty locations). Changes in relationships and living situations (e.g., being separated for deployment or temporary duties, frequent moves, extra job duties) can create extra stress for military members compared to civilians (Drummet, Coleman, & Cable, 2003). In addition, pregnancies can be planned or unintended. Unintended pregnancies are associated with more stress and risks to maternal and infant outcomes including low birth weight, excessive gestational weight gain, and psychosocial stressors including juggling childcare and work demands (Ertel, Koenen, & Berkman, 2008; Gaydos, Howell, Quinn, McKee, & Gaydos, 2003; Grindlay & Grossman, 2013; Grindlay & Grossman, 2015; Lindberg, 2011; Robbins, Chao, Frost, & Fonseca, 2001). All of these factors may contribute to health risks experienced during the pregnancy and the postpartum period.

Unintended Pregnancies

Unintended pregnancies are associated with increased negative maternal and birth outcomes (Centers for Disease Control and Prevention, 2015; Curtin, Abma, & Kost, 2015). Unintended pregnancies also affect military readiness (e.g., physical fitness, deployment status, temporary duty requirements, and ability to be considered world-wide qualified) (Armitage & Smart, 2012: Burr, Roberts, & Bucci, 2013; Klein & Adelman, 2008).

The reasons for increased risk vary and include suboptimal health, risky behaviors (e.g., alcohol consumption), and delayed prenatal care (Centers for Disease Control and Prevention, 2015; Curtin, Abma, & Kost, 2015). In the United States, unintended pregnancies account for approximately 37-50% of all pregnancies (Grindlay & Grossman, 2013; Mosher, Jones, & Abma, 2010). Researchers have reported that rate of unintended pregnancies among the total population of active duty military women (deployed as well as not deployed) are similar but with a wider range than the civilian sector (Grindlay & Grossman, 2013; Grindlay & Grossman, 2015; Lindberg, 2011; Robbins, Chao, Frost, & Fonseca, 2001). Unintended pregnancies have been reported to be between 12% to 55% (Gaydos, Howell, Quinn, McKee, & Gaydos, 2003; Grindlay & Grossman, 2013; Grindlay & Grossman, 2015; Lindberg, 2011; Rabie & Magann, 2013; Robbins, Chao, Frost, & Fonseca, 2001). Therefore, it is important to specifically understand studies that examine unintended pregnancies in a military population.

Researchers have considered several factors that are associated with unintended pregnancies in the military. In the civilian population, married or cohabitating women, younger women, nonwhite women, and women with less education also had higher rates of unintended pregnancy (Grindlay & Grossman, 2013; Rabie & Magann, 2013). Alternatively, Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, (2016) compared unintended pregnancies among 1,211 participants differing by marital and active duty status. They found that single female service members reported the highest number of unintended pregnancies (229 per 1,000 women), followed by married female military members (70 per 1,000 women), and dependent spouses (i.e., TRICARE beneficiaries) (30 per 1,000 women) (Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016). In contrast, adolescent pregnancies occur in the military at the rate of 15.8 pregnancies per 1,000 women, significantly less than the U.S. population (Burr, Roberts, &

Bucci, 2013; Klein & Adelman, 2008). Since over 90% of active duty members are in the prime of their reproductive years, there may be a higher likelihood of increased rates of unintended pregnancies in a military population than the civilian population (Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016; Klein & Adelman, 2008).

Furthermore, factors such as deployment and service branch may be associated with higher rates of unintended pregnancies. In the military, 13% of pregnancies occur while female military members are deployed (Grindlay & Grossman, 2015; TRICARE Management Activity, 2010). Approximately 10% of pregnancies that occur while military members are deployed are unintended and occur among young (age 18 to 25), enlisted service members (Custer, Waller, Vernon, & O'Rourke, 2008; Grindlay & Grossman, 2015; TRICARE Management Activity, 2010). Women in the Air Force had a lower rate of unintended pregnancies as compared to women in the Marine Corps, Navy, and Army (Grindlay & Grossman, 2013; Rabie & Magann, 2013). In addition to unintended pregnancies impacting maternal and infant health in the MHS, adolescent pregnancy is also associated with adverse health consequences.

Adolescent Pregnancy in the Military

Although investigating risk factors solely associated with adolescent pregnancies in the MHS is beyond the scope of this study, it is important to understand the frequency and complications associated with adolescent pregnancies, because this study will include some pregnant active duty participants ages 18 to 21 that are considered adolescents. Infants born to adolescent mothers have a higher risk of negative health and psychosocial outcomes. Infants are more likely to have low birth weight, be small for their gestational age, and be born prematurely (Menacker, Martin, MacDorman, Klein & Adelman, 2008). Additionally, they are at a higher risk of poor educational achievement, poverty, and future incarceration (Klein & Adelman,

2008). Children born to adolescent parents have an increased risk of becoming adolescent parents themselves (Jaffee, Caspi, Moffitt, Belsky, & Silva, 2001; Klein & Adelman, 2008).

Adolescent pregnancy in military dependents, age 15 to 19 years, occurs significantly less than the U.S. population. The rate of adolescent pregnancy in the U.S. population is 71.5 pregnancies per 1,000 women (Burr, Roberts, & Bucci, 2013) compared to adolescent pregnancies in the military, which occur at the rate of 15.8 pregnancies per 1,000 women (Burr, Roberts & Bucci, 2013; Klein & Adelman, 2008). Almost 90% of adolescent pregnancies are unplanned and occur outside of marriage (Guttmacher Institute, 2016; Klein & Adelman, 2008).

As stated above, examining risk factors solely associated with adolescent pregnancies in the MHS is beyond the scope of this study. However, some pregnant active duty participants ages 18 to 21 years are considered adolescents. Consequently, it is important to mention the frequency of adolescent pregnancies in order to understand the overall characteristics of pregnancy care within the MHS.

Summary of Pregnancy in the Military Population

In summary, pregnancies are common in the military, and at any time approximately 8.5% of active duty women are pregnant. In addition, active duty women as well as TRICARE dependents of military members often become pregnant in their early 20s. Pregnancy occurs in the military population within a range of relationships and living situations (e.g., deployed status). Overall, pregnancy and postpartum concerns are significant health factors for the MHS to address. They provide an opportunity to positively impact pregnancy health by encouraging healthy weight gain guidelines and addressing demographic, psychosocial, biologic and behavioral, and work factors relevant to the well-being of the mother and the fetus.

PREGNANCY WEIGHT GAIN AND POSTPARTUM WEIGHT RETENTION

Overview

Pregnancy, from conception to birth, is a time when it is healthy for women to gain weight (Romano, Cacciatore, Giordano, & La Rosa, 2010). Women in their reproductive years, ranging from age 25-44 years old, gain weight faster than at any other time in their lives (Bello et al., 2016). This rapid weight gain is often due to changes in women's lifestyle and metabolic rate. Pregnancy also leads to weight gain for many women, placing them at risk for overweight and obesity when they have excessive gestational weight gain (EGWG) and postpartum weight retention (PPWR) (Bello et al., 2016). Excessive weight gain during pregnancy and PPWR also impact maternal and infant health outcomes and military readiness (Krukowski et al., 2016).

Excessive Weight Gain During Pregnancy

In a healthy pregnancy, women gain weight in accordance with the 2009 Institute of Medicine (IOM) guidelines represented in Table 1 (Institute of Medicine, 2009). The guidelines are divided by pre-pregnancy weight status. Excessive gestational weight gain occurs when pregnant women gain more than the recommended amount of weight during pregnancy according to the IOM guidelines set for her pre-pregnancy body mass index. Gaining excess weight during pregnancy is common and occurs in 41-74% of all pregnancies (Davis, Hofferth, & Shenass, 2014; Deputy et al., 2015; Hunt et al., 2013; Institute of Medicine, 2009; & Restall et al., 2014). The military population is not immune to this phenomenon.

Over 40% of military women and TRICARE beneficiaries gain excess weight during pregnancy affecting maternal and infant outcomes and military readiness (Krukowski et al., 2016). Women are frequently unaware of the IOM standards (Mcphie et al., 2015). Approximately 67% of women overestimate the amount of weight gain necessary for a healthy pregnancy. Both of these factors have been associated with EGWG in women (Mcphie et al.,

2015). Many factors may place women at a higher risk for EGWG including demographic factors, work and home demands, mental health diagnoses, service branch and work factors, area of residence/TRICARE service region, delivery type, and high risk health conditions such as preeclampsia, which will be discussed later in the paper (Brawarsky et al., 2005; Herring et al., 2012; Krukowski et al., 2013; Restall et al., 2014).

Gaining weight within the 2009 IOM recommended guidelines is critical to the health of the mother and the fetus. Pregnant women are also at risk for adverse maternal and infant outcomes if they gain less than the recommended amount of weight per their pre-pregnancy class (Institute of Medicine, 2009).

Inadequate Weight Gain During Pregnancy

Inadequate weight gain during pregnancy is associated with negative maternal and infant outcomes (Chen, Feresu, Fernandez, & Rogan, 2009; Davis & Hofferth, 2012; Dietz et al., 2006; Yekta, Porali, & Aiatollahi, 2005). Inadequate weight gain occurs when pregnant women gain less than the recommended amount of weight according to the IOM standards (Institute of Medicine, 2009). Although less common than EGWG, inadequate weight gain occurs during pregnancy occurs in 14 to 30% of pregnancies (Brawarsky et al., 2005; Davis & Hofferth, 2012). Inadequate weight gain places the fetus at an increased risk for preterm birth (Dietz et al., 2006) and low birth weight (Chen, Feresu, Fernandez, & Rogan, 2009; Davis & Hofferth, 2012; Yekta, Porali, & Aiatollahi, 2005). Gaining the appropriate amount of weight during pregnancy is important as it is directly associated with maternal and infant outcomes and military readiness.

Table 1. Institute of Medicine Guidelines for Weight Gain During Pregnancy (Adapted from the Institute of Medicine, 2009)

Classification based on Pre-pregnancy Body Mass Index	IOM weight gain recommendations during pregnancy
Underweight (BMI <18.5 kg/m^2)	28-40 pounds (approximately 1 pound/week)
Normal weight (BMI 18.5-24.9 kg/m^2)	25-35 pounds (approximately 1 pound/week)
Overweight (BMI 25.0-29.9 kg/m^2)	15-25 pounds (approximately 0.6 pounds/week)
Obese (BMI ≥ 30.0 kg/m^2)	11-20 pounds (approximately 0.5 pounds/week)

Consequences of Excessive and Inadequate Gestational Weight Gain

Appropriate weight gain is important for a healthy pregnancy (Institute of Medicine, 2009). A healthy pregnancy benefits not only the health of women and infants but also the military mission (Cofell, 2011; Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016; Spieker et al., 2015; TRICARE Management Activity, 2010). Gaining in excess or less than the 2009 IOM guidelines during pregnancy can lead to pregnancy-specific and lifelong consequences for both the mother and child. In military members, it also impacts military readiness (Armitage & Smart, 2012; Chauhan et al., 2013; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006).

Women that have EGWG are at a higher risk for several adverse health consequences. Excessive weight gain during pregnancy can have negative effects on the mother's and child's cardiovascular and metabolic health (Davis et al., 2012; Fraser et al., 2012). Maternal health complications and outcomes include the likelihood of pregnancy-associated hypertension, gestational diabetes, and postpartum weight retention (PPWR) (Catalano & Ehrenberg, 2006; Guelinckx, Devlieger, Beckers, & Vansant, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). Excessive gestational weight gain puts women at a higher risk for requiring a cesarean

delivery, complications during delivery, gestational hypertension, preeclampsia, gestational diabetes, and stillbirth (Catalano & Ehrenberg, 2006; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). Overweight and obese women have a higher likelihood of preterm delivery (<37 weeks gestation) and very preterm delivery (≤ 32 weeks gestation) compared to normal weight women (Baeten, Bukusi, & Lambe, 2001; Black et al., 2013; Cedergren, 2004; McDonald et al., 2010; Rode et al., 2005). Excessive gestational weight gain is also an indicator of maternal weight gain and BMI in the year following birth and 15-20 years in the future (Amorim et al., 2007; Linné, Barkeling, & Rössner, 2002; Mamun et al., 2010; Mannan, Doi, & Mamun, 2013; Nehring et al., 2011; Rong et al., 2015; Rooney, Schauberger, & Mathiason, 2005). Excessive gestational weight gain puts women at a higher risk of retaining weight three to 24 months postpartum (Endres et al., 2015; Margerison-Zilko, Rehkopf, & Abrams, 2010; Rooney & Schauberger, 2002; Siega-Riz et al., 2010). Due to physical and mental health standards in the military, inappropriate weight gain during pregnancy and the negative health consequences thereafter adversely affect military readiness (Armitage & Smart, 2012; Chauhan et al., 2013; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006).

Excessive gestational weight gain and PPWR negatively impact military readiness. The health conditions described cost extra time away from work and school for active duty members (Armitage & Smart, 2012; Chauhan et al., 2013; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). They cost the military money for the additional health care required and may impact an individual's ability to remain world-wide qualified. Excessive gestational weight gain and PPWR frequently lead to lower women's fitness levels, negative health consequences for the women and their infants, and inability to maintain worldwide

qualification (Armitage & Smart, 2012; Chauhan et al., 2013; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006).

Weight gain during pregnancy affects the size of offspring at birth (Baer et al., 2016; Walker, 2007). Excessive gestational weight gain is associated with infants that are large for their gestational age (Walker, 2007). On the other side of the spectrum, weight gain during pregnancy that is less than the IOM's recommendations is associated with infants that are small for their gestational age. Compared to healthy-weight infants, infants that are small for their gestational age (SGA) (i.e., <10th percentile) or large for their gestational age (LGA) (i.e., >90th percentile) are at an increased risk for death within the first year of life. When combined with preterm birth (i.e., <37 weeks gestation), infants that are SGA are also placed at a higher risk for disease, illness, or injury (Baer et al., 2016).

Excessive weight gain and higher BMI during pregnancy also affects offspring's health and their weight into adulthood (Catalano & Ehrenberg, 2006; Villamor & Cnattingius, 2006). Lau et al. (2014) conducted a systematic review of 23 studies. They found that EGWG had a significant relationship with higher offspring BMI and risk of overweight or obesity in follow-ups two to 18.9 years later (Lau et al., 2014). One cohort study examined 1400 individuals born to mothers with high maternal pre-pregnancy BMI (>26.4 kg/m^2) and gestational weight gain of over 30 pounds. Compared to individuals born to mothers with a normal pre-pregnancy BMI, individuals born to mothers with a high pre-pregnancy BMI and EGWG were at a significantly higher risk for negative health consequences 32 years post birth (Hochner et al., 2012). These men and women were found to have higher BMI and waist circumference at 32 years of age. They also had higher triglycerides, lower HDL cholesterol, and higher systolic and diastolic blood pressures compared to individuals born to mothers with a normal pre-pregnancy BMI

(Hochner et al., 2012). Excessive gestational weight gain and higher BMI are significantly associated with adverse health outcomes for offspring even several years after birth. In addition to gestational weight gain, PPWR also affects maternal and infant health and military readiness.

Postpartum Weight Retention

Postpartum weight retention is significantly impacted by the amount of weight gained during pregnancy. Women who have EGWG are at a higher risk of retaining more weight during postpartum periods. Postpartum periods are defined in the short-term as from the birth of the infant up to six to twelve months post-childbirth and in the long-term, in excess of one year after birth (Amorim et al., 2007; Endres et al., 2015; Margerison-Zilko, Rehkopf, & Abrams, 2010; Romano, Cacciatore, Giordano, & La Rosa, 2010). Postpartum weight retention is weight that is retained after birth that is in excess of weight prior to pregnancy (Bello et al., 2016).

Consequences of Postpartum Weight Retention

Postpartum weight retention may lead to overweight and obesity in women (Rooney & Schauberger, 2002; Villamor & Cnattingius, 2006; Walker, 2007). Women with EGWG and weight retention six months post childbirth are more likely to become overweight or obese (Schmitt, Nicholson, & Schmitt, 2007). Postpartum weight retention of 5 kg or more occurs in approximately 14 to 20% of women (Walker, 2007). In one study of 795 women, even 8 to 10 years post childbirth, women with EGWG and PPWR were significantly heavier than women with appropriate weight gain and no PPWR (Rooney & Schauberger, 2002). After childbirth, many women retain weight gained during pregnancy and move into a higher BMI category. Retaining the weight gained during pregnancy puts them at risk for negative health consequences including cardiovascular disease, metabolic disease, diabetes, and hypertension (Endres et al., 2015; Linné, Barkeling, & Rössner, 2002; Sattar & Greer, 2002; Walker, 2007). Obesity alone

increases the likelihood of stroke, sleep apnea, hypertension, type 2 diabetes, dyslipidemia, coronary heart disease, osteoarthritis, certain cancers, infertility, and all causes of death (Bhaskaran et al., 2014; U.S. Department of Health and Human Services, National Institutes of Health, & National Heart, Lung, and Blood Institute, 2013). In addition to all the negative health consequences described, PPWR also affects physical fitness and military readiness in active duty women (Armitage & Smart, 2012).

Postpartum weight retention often affects physical fitness and military readiness in active duty women (Armitage & Smart, 2012; Chauhan et al., 2013; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). At six months postpartum, active duty women frequently weigh more and have significantly larger abdominal circumferences than pre-pregnancy (Armitage & Smart, 2012). After pregnancy, active duty women commonly score lower on physical fitness tests compared to those prior to pregnancy (Armitage & Smart, 2012; Kominiarek & Chauhan., 2016). This affects their ability to be worldwide-qualified impacting deployment opportunities, special duty assignments, and temporary duties (Armitage & Smart, 2012; Kominiarek & Chauhan, 2016; Christopher, 2007). Maintaining physical fitness is an important requirement of military members. Postpartum weight retention affects women's ability to maintain physical fitness and may affect their ability to be worldwide-qualified, impacting military readiness (Armitage & Smart, 2012; Kominiarek & Chauhan, 2016; Christopher, 2007).

Many factors have been found to be associated with pregnancy weight gain and PPWR (Bello et al., 2016). Demographic factors, work and home demands, service branch and work factors, area of residence/TRICARE service region, and mental health may also impact pregnancy weight gain and PPWR (Behrman & Stith, 2006; Beydoun & Saftlas, 2008; Cozza, Goldenberg, & Ursano, 2014; De Weerth & Buitelaar, 2005; Dunkel-Schetter & Tanner, 2012;

Huizink, Mulder, & Buitelaar, 2004; Endres et al., 2015; Kinsella & Monk, 2009; Kulkarni, 2004; Luppino et al., 2010; VanDenBergh, Mulder, Mennes, & Glover, 2005; Weinstock, 2008). To optimize maternal and infant health and ensure military readiness, it is crucial to understand how these factors intersect and affect weight gain during pregnancy and PPWR.

Summary of Gestational Weight Gain and Postpartum Weight Retention

In summary, it is normal for women to gain weight in pregnancy. However, appropriate weight gain is important because there are several health risks to both women and infants that occur with EGWG and low gestational weight gain. Unfortunately, EGWG is common. It not only affects women during pregnancy but is also in indicator of PPWR. Excessive weight gain is also associated with BMI in women and offspring the year following birth and 15-20 years in the future. Based on the prevalence of EGWG and PPWR, the harmful effects of EGWG on women and offspring, and the threats to military readiness, it is important to understand how the factors intersect and affect EGWG and PPWR.

With the rising number of women entering the military, there is a greater need for health care resources for active duty women and TRICARE dependents, including during pregnancy. A healthy pregnancy, with pregnancy weight gain within IOM guidelines for pre-pregnancy weight class, directly impacts the health of women and infants and military readiness. The proposed study expands the current literature by examining the association of demographic factors, work and home demands, and service branch and work factors, and pregnancy weight gain and PPWR in active duty women. It is also investigating the relationship between region of residence/TRICARE service region, and mental health diagnoses and pregnancy weight gain and PPWR among pregnant and postpartum active duty members in the MHS.

INFANT MORBIDITY AND MORTALITY

The issue of weight gain during pregnancy is important to study for several reasons. Low birth weight, preterm birth in infants, and EGWG in mothers are associated with infant morbidity and mortality (Johnsson, Haglund, Ahlsson, & Gustafsson, 2015). Given the high rates of pregnancy in the military (Heitmann, Solheimsnes., Havnen, Nordeng, & Holst, 2016), it is important to examine factors impacting infant health. This is crucial for infant health as well as military readiness, as parents of ill children are less available for training and other readiness requirements (Zellman, Gates, Moini, & Suttorp, 2009).

To preface this discussion on morbidity and mortality, a brief definition of terms is important. Morbidity describes a population's rate of disease, illness, or injury (Fanaroff et al., 2007; Teune et al., 2011). Morbidity for infants often takes the form of breathing problems, feeding issues, cerebral palsy, developmental delays, or vision and hearing impairment (Centers of Disease Control and Prevention, 2013). Infants born preterm or of low birth weight are at particular risk for these forms of morbidity. Infants born with high birth weights are at reduced risk of these forms of morbidity, but they may be at increased risk for later obesity and type 2 diabetes (Johnsson, Haglund, Ahlsson, & Gustafsson, 2015).

The word mortality is synonymous with death. Mortality data specifies the numbers of death by time, place, and cause (World Health Organization, 2016). Infant mortality is defined as the death of infants before their first birthday, which occurs at a rate of 6.05 per 1,000 births in the United States (Centers for Disease Control and Prevention, 2013; Hoyert & Xu, 2012). Infant mortality occurs in two distinct time periods: neonatal, referring to the period from birth to 27 days, and postneonatal, from 28 days to 364 days (Callaghan, MacDorman, Rasmussen, Quin, & Lackritz, 2006; Hoyert & Xu, 2012). Approximately two-thirds of infant deaths occur during the

neonatal period while one-third occurs during the postneonatal period (Centers for Disease Control and Prevention, 2013; Hoyert & Xu, 2012).

Preterm birth, low birth weight (LBW), and EGWG are associated with infant morbidity and mortality. Preterm birth is divided into three categories: preterm birth (i.e., <37 weeks gestation), late preterm birth (i.e., 32 to 36 weeks gestation), and moderate preterm birth (i.e., <32 weeks gestation) (McDonald et al., 2010). Alternatively, the World Health Organization defines preterm birth as moderated to late preterm (i.e., 32 to <37 weeks gestation), very preterm (i.e., 28 to <32 weeks gestation), and extremely preterm (<28 weeks gestation) (World Health Organization, 2016). Preterm birth is directly associated with LBW. Low birth weight is defined as birth weight of 2,499 grams or less, regardless of gestational age (Ehrenkranz et al., 2006; Deter, Levytska, Melamed, Lee, & Kingdom, 2016).

Preterm birth occurs at a higher rate in the U.S., at approximately 10-13%, compared to 5-9% of births in other developed nations (Beck et al., 2010; Goldenberg, Culhane, Iams, & Romero, 2008). Preterm birth is the second largest cause of mortality in children under the age of five years (Blencowe et al., 2012). Preterm births are frequently associated with a multiples pregnancy and inadequate fetal growth, including low birth weight (Steer, 2005). Risk factors for poor fetal growth include poor dietary intake, psychological stress, and heavy physical work (Feune et al., 2011; Steer, 2005).

Excessive gestational weight gain affects infant morbidity and mortality. Infants that are small for their gestational age (SGA) (i.e., <10^{th} percentile) or large for their gestational age (LGA) (i.e., >90^{th} percentile) are at a 1.2 to 3.5-fold increased risk of death within a year from birth when compared with infants that are born within weight standards (Baer et al., 2016). Compared with all infants, SGA infants are also at a higher risk of preterm birth morbidity when

born between 28 to 36 weeks while LGA infants were at a decreased risk (Baer et al., 2016). Shapiro-Mendoza et al. (2006) performed a population-based cohort study of preterm infants who were otherwise classified as healthy. They found that 4.8 percent were readmitted as inpatients, and 1.3 percent were admitted for observation. These morbidities were associated with labor and delivery complications, infants who were firstborn, were breastfed, had a mother of Asian/Pacific Island descent, or were financially supported by public funds (Shapiro-Mendoza et al., 2006). Additionally, some researchers have found that non-Hispanic African American infants die at almost two times the rate of non-Hispanic White infants (MacDorman & Matthews, 2011; Spong, Iams, Goldenberg, Hauck, & Willinger, 2011). Due to the aforementioned risk factors for newborn infants, clinical practice guidelines in the Department of Defense dictate standard of care for pregnancy in the MHS. These guidelines are implemented to address IOM weight gain guidelines and decrease adverse health outcomes for both the mother and the infant, including infant morbidity and mortality (Department of Veteran Affairs, & Department of Defense, 2009).

RISK FACTORS AFFECTING MATERNAL AND INFANT OUTCOMES

Many factors affect the health outcomes for mothers and children in turn impacting military readiness. Figure 1, proposed by Rasmussen & Yaktine (2009), displays several of the risk factors that are associated with pregnancy weight gain. The proposed study will examine some of these risk factors affecting the amount of weight gain during pregnancy and PPWR in pregnant active duty military members. Specifically, the proposed study will examine the association of demographic factors, work and home demands, service branch and work factors, TRICARE service region, and mental health diagnoses and pregnancy weight gain and PPWR.

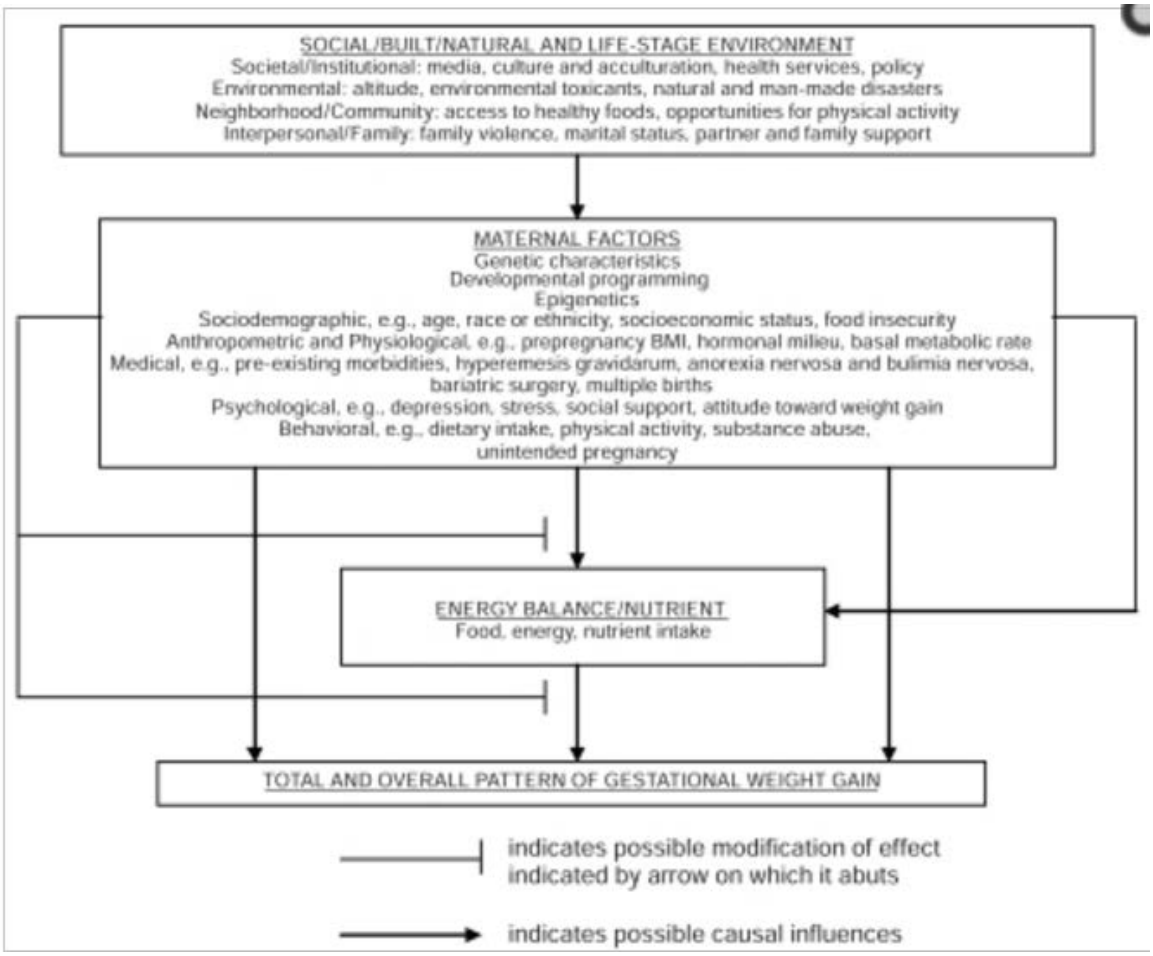

Figure 1. A model of risk factors affecting gestational weight gain (Rasmussen & Yaktine, 2009)

Demographic Risk Factors

Demographic factors affect pregnancy weight gain and PPWR. Demographic factors significantly related to EGWG, PPWR, and maternal and child outcomes include age, race, parity, socioeconomic status (SES), and marital status (Endres et al., 2015; Luppino et al., 2010).

Age

Overall, weight increases as women grow older (Baum & Ruhm, 2009). Active duty military members over the age of 26 are at the highest risk to be overweight or obese (Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015). Pregnancy also contributes to weight gain

and overweight status in women (Gore, Brown, & West, 2003). From their 20s to their 40s, women gain weight more readily than any other time in their lives (Bello et al., 2016). This may be due to a variety of factors including metabolic changes and pregnancy (Bello et al., 2016; Gore, Brown, & West, 2003). On average, PPWR accounts for an approximate weight gain of 0.5 to 3.0 kg (Walker, 2007). In addition to age, race also plays a part in gestational weight gain and PPWR.

Race

Women of diverse racial groups gain different amounts of weight during pregnancy. This paper will briefly review some of the racial disparities researchers have previously reported. For example, Asian women are more likely to only gain 0-20 pounds as compared with Hispanic and non-Hispanic White women. Non-Hispanic Black women are at risk for not gaining enough weight during pregnancy (<15 pounds) (Chu et al., 2009; Hunt et al., 2013; Rasmussen & Yaktine, 2009; Stein, Ellis, Savitz, Vichinsky, & Perl, 2009). Low pregnancy weight gain is associated with adverse maternal and infant outcomes, including increased infant morbidity and mortality previously discussed (Luppino, et al., 2010; MacDorman & Matthews, 2011; Shapiro-Mendoza et al., 2006; Spong, Iams, Goldenberg, Hauck, & Willinger, 2011). Race also is significantly associated with PPWR. African American women are particularly at risk for PPWR six to twelve months post-birth (Whitaker, Young-Hyman, Vernon M, & Wilcox, 2014). African American women (22%) are at three times more likely to have postpartum weight retention than white women (7-8%) (Hunt et al., 2013; Siega-Riz et al., 2009). Postpartum weight retention place women at a higher risk for adverse health consequences in the future and may affect military readiness (Armitage & Smart, 2012; Christopher, 2007; Sattar & Greer, 2002; Villamor & Cnattingius, 2006; Walker, 2007).

Parity

With regards to gestational weight gain and PPWR, parity is an area where there have been inconsistent findings (Chu, Callaghan, Bish, & D'Angelo, 2009; Hill et al., 2017; Nohr et al., 2009). A recent systematic review of the relationship between parity, pre-pregnancy BMI, weight gain during pregnancy, and postpartum weight retention reported that the relationship between parity and gestational weight gain was unclear (Hill et al., 2017). The researchers found that parity was positively correlated with pre-pregnancy BMI. However, they concluded that the relationship between parity and gestational weight gain was not clear, and further research in this area was needed (Hill et al., 2017). Additionally, the association of parity and PPWR was also unclear. The researchers reported that the relationship between parity and PPWR was likely indirect and warranted further research (Hill et al., 2017). Other researchers have found that parity is associated with offspring adiposity (Reynolds, Osmond, Phillips, & Godfrey, 2010). They reported that primiparous women often have offspring with a higher percentage of body fat, and this was associated with higher pregnancy weight gain (Reynolds, Osmond, Phillips, & Godfrey, 2010). Researchers have also reported that women who become pregnant within 12 months of giving birth or those that have more than one child within five years are most likely to have excess weight increases. Pregnancies that are closely spaced may promote greater maternal weight increases (Gunderson and Abrams, 1999; Nohr et al., 2009). Pregnancy-related weight changes at specific postpartum intervals is limited. Among women with two consecutive pregnancies, women gained more weight on average (Nohr et al., 2009). This research indicates that it is not clear as to whether parity plays a role in EGWG and PPWR. Due to the inconsistent findings, this study will examine the association of parity and EGWG and PPWR, specifically in an active duty population.

Socioeconomic Status

Socioeconomic status (SES) affects the health of individuals (Morales, Lara, Kington, Valdez, & Escarce, 2002). Socioeconomic status is the social standing of an individual or group as compared to others. It can also indicate the class an individual or group fits in. Variables such as income, education, wealth, place of residence, and occupation help measure SES (American Psychological Association, 2007). In civilians, SES is frequently related to the overall health of an individual (Morales, Lara, Kington, Valdez, & Escarce, 2002). Socioeconomic status is often associated with health because it affects health activities such as an individual's ability to afford health food and costs associated with exercise (Morales, Lara, Kington, Valdez, & Escarce, 2002). Thus, it affects pregnancy weight gain and PPWR. In the military, rank or grade are frequently used as a proxy to determine SES. Junior enlisted members earn less money than officers and therefore, have a lower SES (Schoenfeld, McCriskin, Hsiao, & Burks, 2011; Tarman et al., 2000). Military rank is associated with health independent of education and race (MacLean & Edwards, 2010). While officers and enlisted are given the same benefits (e.g., access to a gym, comprehensive equal access healthcare), officers have the ability to afford more in way of services (e.g., childcare) due to being paid more. The relationship between health and SES is evident even after service members have left the military. Military veterans who were officers have generally been found to be in better health than those who were enlisted (MacLean & Edwards, 2010; Tarman et al., 2000). Thus, in this study, this study will assess the association of SES utilizing rank as a proxy variable and EGWG and PPWR, specifically in an active duty population.

Marital status

Marital status also affects health and weight status (Schoenborn, 2004). Married adults are generally healthier than their single, divorced, or widowed counterparts regardless of age, sex, race, ethnicity, education level, or SES) (Schoenborn, 2004). However, they have higher body weights and increased rates of being overweight or obese compared to adults in other marital statuses (Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015). Even married military members have a higher rate of overweight and obesity compared to their single counterparts (Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015). Overall, single adults who have never been married have the lowest risk of being overweight or obese (Hanson, Sobal, & Frongillo, 2007; Klos & Sobal, 2013; Schoenborn, 2004). However, differences among racial groups and ethnicities have been found in women. For example, African American women that were separated had higher odds of being overweight. On the other hand, Hispanic women who had never been married had lower odds of being overweight while it did not differ for Caucasian women (Sobal, Hanson, & Fongillo, 2009). Due to these inconsistencies, this study will examine the association of marital status, pregnancy weight gain, and postpartum weight retention in active duty women.

Sex

Women are a minority in the military workplace, which may cause additional stress, leading to EGWG and PPWR (Appolonio & Fingerhut, 2008; Cofell, 2011; O'Boyle, Magann, Ricks, Doyle, & Morrison, 2005). Stress, as discussed later, is associated with negative maternal and infant outcomes. Some of the stress women may encounter may be caused by increased work and home demands (Ertel, Koenen, & Berkman, 2008). This will be discussed in further detail later in this paper. While pregnant, women may experience harassment and discrimination in

their place of work causing additional stress, which may put them at risk for EGWG and PPWR (Bushell, 2007; Griffin, Hart, & Wilson-Evered, 2000; Hunter, Bedell, & Mumford, 2007; Rafferty & Rose, 2001; Rose, Douglas, & Griffin, 2002; Rose & Griffin, 2002; Rose & Waterhouse, 2004). Additional risk factors placing mothers and infants at a higher risk for negative health consequences during pregnancy and postpartum are biological, behavioral, and cultural risk factors.

Biological, Behavioral, and Cultural Risk Factors

Biological Risk Factors

When women who are overweight or obese, it frequently puts them at a higher risk for exceeding the 2009 IOM guidelines of weight gain during pregnancy (Brawarsky et al., 2005; Herring et al., 2012; Krukowski et al., 2013; Restall et al., 2014). Women who are overweight and obese are at a higher likelihood for EGWG (Amorim et al., 2007; Begum et al., 2012; Brawarsky et al., 2005; Davis et al., 2012; Endres et al., 2015; Fraser et al., 2012; Gould et al, 2011; Institute of Medicine, 2009; Kirkegaard et al., 2015; Mcphie et al., 2015; Restall et al., 2014).

One of the biggest risk factors for EGWG is entering pregnancy overweight or obese (Brawarsky et al., 2005; Herring et al., 2012; Krukowski et al., 2013; Restall et al., 2014). Large percentages of women gain more than the IOM's recommendations, particularly if they are overweight or obese (53.1% of overweight and 66.7% of obese women) compared to only 29.8% of normal weight women. In women who were underweight prior to pregnancy, 26.7% had inadequate weight (Popa, Oleniuc, & Graur, 2011). Excessive gestational weight gain and inadequate weight gain can negatively affect the health of the mother and child (Davis et al., 2012; Fraser et al., 2012).

Behavioral Habits

Biological and behavioral factors affect EGWG, PPWR, maternal and infant outcomes and military readiness. Health habits including increased ingestion of unhealthy foods, increased caloric intake, decreased exercise, and quitting smoking increase the probability of pregnant and postpartum women gaining and retaining excess weight. Exercise buffers this possible outcome (Gaillard et al., 2013; Martins & Benicio, 2011; Olson & Strawderman, 2003; Rooney & Schauberger, 2002).

Physical activity is an important piece of physical health for the mother and fetus that is often impacted by the work demands. Women who work more hours commonly fail to reduce the number of hours they worked during their pregnancy (Rasmussen et al., 2010). Many women believe that they cannot work less during pregnancy as it will demonstrate that they are not committed to the organization (Rasmussen et al., 2010). Pregnant women who work more hours are inherently less active before pregnancy. Pregnant women were less active before pregnancy, and reported lack of childcare as a barrier to exercise, had more gestational weight gain. Additionally, those with a higher gestational weight gain were at an increased likelihood to be insufficiently active (<150 minutes per week of total physical activity) at six months postpartum (Rasmussen, et al., 2010). Key modifiers of weight gain during pregnancy impacts both maternal and fetal health inclusive of pre-pregnancy weight. Weight at the beginning of pregnancy is measured in accordance to BMI while other moderating factors include the lack of available childcare (Rasmussen et al., 2010). Lack of child care (Rasmussen et al., 2010) and fatigue (Goodrich, Cregger, Wilcox, & Liu, 2013) were reported as barriers by which exercising and other physical activity were hindered thereby contributing to an increase in gestational weight gain.

Gaining weight within the recommended guidelines can be difficult for pregnant women. In many situations, women are unaware of the IOM guidelines and believe common myths such as that they are eating for two. Some cultures do not believe that being lean equates to beauty and may encourage excessive weight gain during pregnancy as an indication of the beauty of a pregnant woman (Goodrich, Cregger, Wilcox, & Liu, 2013; Tovar, Chasan-Taber, Bermudez, Hyatt, & Must, 2010).

Cultural Risk Factors

Culture is defined as customs, beliefs, habits, and knowledge that a group of people share (Kulkarni, 2004). Even within the United States, there are different cultures which affect dietary and exercise habits. The prevalence of obesity and chronic disease is unevenly distributed in the United States (Myers et al., 2015). According to self-report, a higher number of men and women living in the Southeastern United States are deemed obese as compared to the rest of the United States (Le et al., 2014). Individuals may identify with several cultures. For example, many Americans living in the southern United States eat what is casually called, “soul food” (Kulkarni, 2004). Soul food was traditionally part of the diet of African Americans living in the southern United States (Kulkarni, 2004). It includes corn, starchy vegetables, cornbread and yeast rolls, whole milk and buttermilk. Due to their high fat and calorie content, these foods can lead to increased weights and health problems including cardiovascular disease and diabetes (Kulkarni, 2004). Diets like this found in the southern region of the United States may contribute to the south being deemed a geographic area with a high prevalence of obesity (Myers et al., 2015).

On the other hand, the Northeast and West have been found to have a low prevalence of obesity (Myers et al., 2015). Regional and cultural characteristics may lead to the variation of obesity prevalence seen in the U.S. (Myers et al., 2015). The military is unique in that its

members come from the general population of the United States. Additionally, military members frequently move (Redmond et al., 2015). Therefore, it is possible that active duty military members may also be susceptible to higher BMIs and higher likelihood of overweight and obesity due to the region and culture in which they reside.

While many men and women partake in the food culture around them, it is not known whether this is true in the active duty population. Furthermore, it is not known if living in the southern United States poses a risk to increased weight gain and PPWR for pregnant active duty women. Therefore, the proposed study seeks to examine the association between cultural factors such as region of residence/region of TRICARE service and EGWG and PPWR.

Summary

Several demographic, biological, behavioral, and cultural factors are associated with negative health outcomes for the mother and infant. These factors affect the rates of infant morbidity and mortality and lead to future concerns for the mother and offspring including weight and metabolic consequences for both and negative cognitive, behavioral, emotional, and physical impairments for the infant. In addition to the risk factors just described, psychosocial risk factors are associated with maternal and infant outcomes.

Psychosocial Risk Factors

Negative affective states during pregnancy are adversely related to certain pregnancy conditions and maternal and infant outcomes (Behrman & Stith, 2006; Beydoun & Saftlas, 2008; De Weerth & Buitelaar, 2005; Dunkel-Schetter & Tanner, 2012; Huizink, Mulder, & Buitelaar, 2004; Kinsella & Monk, 2009; VanDenBergh, Mulder, Mennes, & Glover, 2005; Weinstock, 2008). Psychosocial determinants put individuals at a higher risk for EGWG and PPWR. These risk factors include lower levels of social support, higher stress levels, shorter sleep duration,

body image dissatisfaction, and social desirability (Cofell, 2011; Cohen, Finch, Bower, & Sastry, 2006; Hartley et al., 2015; Xiao et al., 2014). Negative affective states including depression, anxiety, and stress are also important because of the effects to the infant. Depression, anxiety, and stress are all associated with preterm birth and low birthweight (Ibanez et al., 2012; Liou, Wang, & Cheng, 2016).

Depression

Some research demonstrates that depression is a negative psychosocial factor affecting pregnancy (Ibanez et al., 2012; Liou, Wang, & Cheng, 2016; Luppino et al., 2010), although results are mixed (Smith, Huber, Issel, & Warren-Findlow, 2015). Frequently, researchers have found that depression symptoms are associated with negative perinatal and maternal health outcomes (Appolonio & Fingerhut, 2008; Dunkel-Schetter & Tanner, 2012; Goedhart et al., 2010; Luppino et al., 2010). Infants born to mothers with depression are at a higher risk for preterm birth, lower birth weight, fetal growth concerns, and infant abnormalities (Goedhart et al., 2010; Ibanez et al., 2012; Nascimento, Pudwell, Surita, Adamo, & Smith, 2014). Higher levels of depression have been significantly associated with PPWR (Whitaker, Young-Hyman, Vernon, & Wilcox, 2014). Depression severity has also been associated with negative metabolic consequences including diabetes, increased risk of overweight and obesity, and hypertension in the mother and the offspring up to 20 years later (Dunkel-Schetter & Tanner, 2012). Similarly, researchers found that depression was significantly associated with Body Mass Index (BMI) increase and detrimental eating attitudes at 4-months and 14-months postpartum (Carter, Wood Baker, & Brownell, 2000). The increase in BMI led to adverse health consequences for the mother. Researchers reported that participants with higher BMIs also reported more anxiety and depression symptoms (Carter, Wood Baker, & Brownell, 2000). Depression symptoms increase

the risk for adverse health outcomes for the mother and infant and may also be related to PPWR (Poyatos-Leon et al., 2017). Depression is associated with an increased BMI among the mother during pregnancy and postpartum (Dunkel-Schetter, & Tanner, 2012). Another affective state that places mothers and infants at a higher risk for negative perinatal consequences is anxiety.

Anxiety

Elevated anxiety levels in women who are pregnant are associated with adverse birth outcomes and pregnancy complications (Ibanez et al., 2012; Littleton, Radecki Breitkopf, & Berenson, 2007). Anxiety has also been found to be correlated with EGWG and PPWR (Appolonio & Fingerhut, 2008; Carter, Wood Baker, & Brownell, 2000; Cohen, Finch, Bower, & Sastry, 2006; Hartley et al., 2015). Anxiety, including state anxiety and pregnancy-specific anxiety, is correlated with preterm birth (i.e., <37 weeks gestation) which negatively impacts neurodevelopment in the fetus while in utero and results in lower birth weight (Davidoff et al., 2006; Dunkel-Schetter and Glynn, 2011; Dunkel-Schetter, 2011; McDonald, Kingston, Bayrampour, Dolan, & Tough, 2014). Researchers utilizing animal models found that maternal distress results in adverse outcomes for the offspring and influences behavior, physical development, coordination, and the ability to learn new information (DiPietro, Hilton, Hawkins, Costigan, 2002; Schneider & Moore, 2000). Researchers hypothesize that maternal stress and negative affective states alter the ability of the maternal and fetal hypothalamic pituitary adrenal (HPA) axes to function properly (Charil, Laplante, Vaillancourt, & King, 2010; Glover, Bergman, Sarkar, & O'Connor, 2009). This change is associated with cognitive, motor, behavioral, and emotional infant outcomes (Buss et al., 2010; Davis & Sandman, 2010; Kashan et al., 2008; Mennes, Stiers, Lagae, & VanDenBergh, 2006). Examples include attention regulation, negative reactivity to novel stimulus during the infant's first year, decreased gray

matter, delayed processing speed, impulsivity, and negative affective states (Buss et al., 2010; Davis & Sandman, 2010; Kashan et al., 2008; Mennes, Stiers, Lagae, & VanDenBergh, 2006).

Researchers have recently found a significant correlation between anxiety and higher BMI levels and weight retention during the postpartum period (Appolonio & Fingerhut, 2008; Carter, Wood Baker, & Brownell, 2000; Cohen, Finch, Bower, & Sastry, 2006; Hartley et al., 2015). Additionally, women with a higher than normal BMI are at an increased risk for developing depression and anxiety (Appolonio & Fingerhut, 2008; Cohen, Finch, Bower, & Sastry, 2006; Hartley et al., 2015). Anxiety is correlated with negative cognitive, behavioral, physical, and emotional infant birth outcomes. It is also associated with adverse maternal health consequences including pregnancy complications and higher BMI levels. An additional psychological factor that is associated with perinatal outcomes is social support.

Social Support

Researchers have found that having social support is a protective factor for women during pregnancy. It promotes health of the woman and offspring, reduces adverse effects of stress on health and well-being, and decreases infant mortality risk (Sarason, Sarason, & Gurung, 2001). Pregnant women reporting low social support endorse more depressive symptoms and lower quality of life. Pregnancy complications and preterm deliveries are significantly higher in women with low support as compared to those with high support (Elsenbrunch et al., 2007). Cumulative psychosocial stress in women with low levels of social support significantly increases the risk for preterm birth (McDonald, Kingston, Bayrampour, Dolan, & Tough, 2014). Ghosh, Wilhelm, Dunkel-Schetter, Lombardi, & Ritz (2010) conducted a study to determine if psychosocial support from the father of the infant would decrease preterm birth and lessen chronic stress and anxiety in pregnant women. Mothers without support from the father and with

moderate-to-high stress were at an increased risk of delivering a preterm infant. Alternatively, even with moderate-to-high chronic stress, increased social support from the father of the baby was associated with decreased risk of preterm birth (Ghosh, Wilhelm, Dunkel-Schetter, Lombardi, & Ritz, 2010). Psychosocial support from a pregnant woman's partner is related to birth outcomes and can mitigate some of the stress women may experience during pregnancy. Psychosocial from a pregnant woman's workplace is also important for a healthy pregnancy.

The workplace is another area of social support that has been found to be associated with maternal and birth outcomes. Women with moderate job strain, psychosocial stress, high levels depression, and high levels of anxiety have an increased risk of babies born with low birth weight (Loomans et al., 2012). Occupational strain also affects the physical health of the mother and the fetus. Psychosocial factors in the workplace influence health-related outcomes among pregnant and postpartum women. Such factors include lack of social support among co-workers and supervisors, work overload, stress, possible physical danger, job dissatisfaction and lack of commitment (Isaksen et al., 2007; Michie, 2002).

Salihu, Myers, & August (2012) completed a systematic review examining pregnancy in the workplace and found that pregnancy directly impacted women's psychosocial health in their work environment. Co-workers often believe that pregnancy adds stress to work relationships. A common belief is that pregnant women are a liability to the company because they are not focused upon the goals of the company. If women are not supported during pregnancy and members of the workplace have a negative attitude regarding the pregnancy, pregnant women experience a higher level of job dissatisfaction which increases the risk for negative birth outcomes including preterm delivery (Henrich, Schmider, Fuchs, Schmidt, Dudenhausen, 2003; Salihu, Myers, & August, 2012).

On the other side of the spectrum, a supportive work environment decreases job strain. Social support in the workplace has been found to buffer some of the negative health consequences of occupational stress (Elsenbrunch et al., 2007; Evans & Rosen, 1996; Evans & Rosen, 1997; Salihu, Myers, & August, 2012; Sarason, Sarason, & Gurung, 2001). During pregnancy if co-workers and supervisors have a positive attitude about the pregnancy, pregnant women report increased job commitment, occupational satisfaction, and companies have lower rates of loss of talented and trained employees (Equal Opportunity Commission, 2004; Greenberg, Ladge, & Clair, 2009; Salihu, Myers, & August, 2012). Work environments that support pregnant women are vital to assuage any fears of negative repercussions and ensure the health of the mother and fetus (Greenberg, Ladge, & Clair, 2009).

Stress

Stress, especially chronic stress, during pregnancy negatively affects maternal and infant outcomes. Stress is a process in which an organism faces a threat or challenge to its homeostasis and the organism's response to the stimulus (Baum, Gatchel, & Krantz, 1997; Faraday, Blakeman, & Grunberg, 2005). Stress has physical, social, and psychological factors that affect the response of an organism to a stressor. Response to stress relative to feelings, behaviors, and attitudes produce an onset of physical symptoms ranging from acute to chronic. In the short-term, acute stress responses are typically adaptive while chronic stress adversely affects the health of an organism (Faraday, Blakeman, & Grunberg, 2005). Acute stress-related responses may minimally influence feelings and attitudes inclusive of anxiety, fatigue, and irritability while more chronic feelings lead to the development of postpartum depression. Negative emotional states are frequently associated with emotional eating and concomitant weight gain (Strien, Konttinen, Homberg, Engels, & Winkens, 2016). Thus, as previously discussed, stress also

affects behavioral habits and lifestyle such as eating, exercise, and cultural activities (Isaksen et al., 2007; Michie, 2002).

Stress and Pregnancy

An estimated 25% of pregnant women report stress during pregnancy (Dunkel-Schetter & Tanner, 2012; Littleton, Bye, Buck, & Amacker, 2010). Littleton, Bye, Buck, & Amacker (2010) recently conducted a meta-analysis of 35 studies examining psychosocial stress, pregnancy, and perinatal outcomes and found small, but significant, associations between psychosocial stress and negative perinatal outcomes including an increased the risk of infants being born with low birth weight. Research indicates that job strain and unfavorable work environments including those that are not supportive of pregnancy profiles have a negative effect on stress levels and overall health during pregnancy (Bushell, 2007; Griffin, Hart, & Wilson-Evered, 2000; Hunter, Bedell, & Mumford, 2007; Rafferty & Rose, 2001; Rose & Waterhouse, 2004).

There are many stressors during pregnancy. Increased family and household responsibilities, psychosocial stress, and conflict with intimate partners are some of the stressors that women encounter during pregnancy (Dunkel-Schetter & Tanner, 2012; Littleton, Bye, Buck, & Amacker, 2010). Low material resources, unfavorable employment environments, and job strain also affect maternal and infant health outcomes. Pregnancy-specific stressors such as financial concerns, childcare concerns, pregnancy complications, low confidence of having a normal birth, anxiety about the health of the fetus adversely impact maternal and fetal health. Additionally, any combination of these stressors may affect the health of the mother and infant (Appolonio & Fingerhut, 2008; Dunkel-Schetter & Tanner, 2012; Littleton, Bye, Buck, & Amacker, 2010).

Demographic changes from past generations may affect stress levels in women. Some of these stressors include more women working, an increase of dual-earner couples, the rise of single-parent homes, and a higher number of mothers with young children working outside the home. Additionally, many families are considered the "sandwich generation" meaning that they are caring for their children and their parents (Ertel, Koenen, & Berkman, 2008). Further stressors include poor marital satisfaction, childcare stress, and low social support. Stressors such as these have been associated with higher rates of postpartum depression and anxiety (Appolonio & Fingerhut, 2008).

Psychosocial factors influence health-related outcomes among pregnant and postpartum women. Such factors stem from conflicts between individuals within the organization or with other organizations, work overload, inequity of pay, lack of job security, potential physical danger, stress, negative relationships with management (Isaksen et al., 2007; Michie, 2002).

On the other hand, work-life balance initiatives have been successful at decreasing stress and increasing women's commitment to their job. Women who felt their employer supported their pregnancy worked later into their pregnancy, returned to work sooner, and had less absences (Hobson, Delunas, & Kesic, 2001; Lyness, Thompson, Francesco, & Judiesch, 1999).

Home and Family Demands

Factors that affect stress in working women are home and family demands. Researchers have frequently used having the presence of a child under the age of 18 in the household as a proxy for home demands (Ertel, Koenen, & Berkman, 2008). Home demands frequently add to the stress men and women experience. While working women are now considered the norm, working women are still often performing many of the same roles as stay-at-home mothers. In addition, advances in technology (e.g., e-mail, cell phones, computers), have made it more

difficult to separate work and home life (Kodz, Harper, & Dench, 2002). This means that their attention may be divided as they try to balance both roles. This may cause women additional stress (Jones & Bright, 2001; Kodz, Harper, & Dench, 2002).

Literature is mixed on the relationship between home demands and health of both men and women. Some researchers have found that home and family demands did not impact the health and well-being of men and women. However, they did find that work characteristics, including job resources and job demands, were directly associated with their well-being (Hakanen, Schaufeli, & Ahola, 2008). On the other hand, many researchers have found that individuals experiencing home demands in addition to job strain have poorer health outcomes and at particularly at risk for mental health conditions such as depression and stress (Ertel, Koenen, & Berkman, 2008; Luecken et al., 1997). Women with at least one child at home reported significantly more home strain (i.e., stress at home related to taking care of a child under the age of 18) (Ertel, Koenen, & Berkman, 2008). They also excreted significantly more cortisol than women without children regardless of marital status (Luecken et al., 1997). This research indicates that women with children at home experience significantly higher levels of stress, which may be due to parenting stress (Whitaker, Young-Hyman, Vernon, & Wilcox, 2014). This additional stress may impact their physical and psychological health, including PPWR (Luecken et al., 1997; Whitaker, Young-Hyman, Vernon, & Wilcox, 2014). Therefore, it is important to further examine if there is a significant difference in pregnancy weight gain and postpartum weight retention for active duty women with children already in the home.

Stress and Work

Michie (2002) proclaims that stress within an individuals' work environment adversely affects their behavior. Stress in the work environment is characterized by environmental

pressure; however, other studies and research literature define stress as the physical and psychological state and level of strain inherent within a given individual. Level of strain is therefore based on interactions between the individual and a given situation (Michie, 2002). If stress continues to persist over a significant period of time, an individual tends to undergo autonomic, cardiovascular, immunological, and neuroendocrine changes that adversely affects an individuals' mental and physical health including anxiety, cardiovascular disease, depression, weight, fatigue, high cholesterol, increased heart rate, impaired neurological functioning (Michie, 2002; Reich et al., 2017) as well as sleep deprivation and mood disturbances (Beck, Hansen, & Gold, 2015). Figure 2 displays a model of stress caused from the work environment adapted from Michie (2002). It displays how some work stressors may lead to adverse health outcomes for the employee.

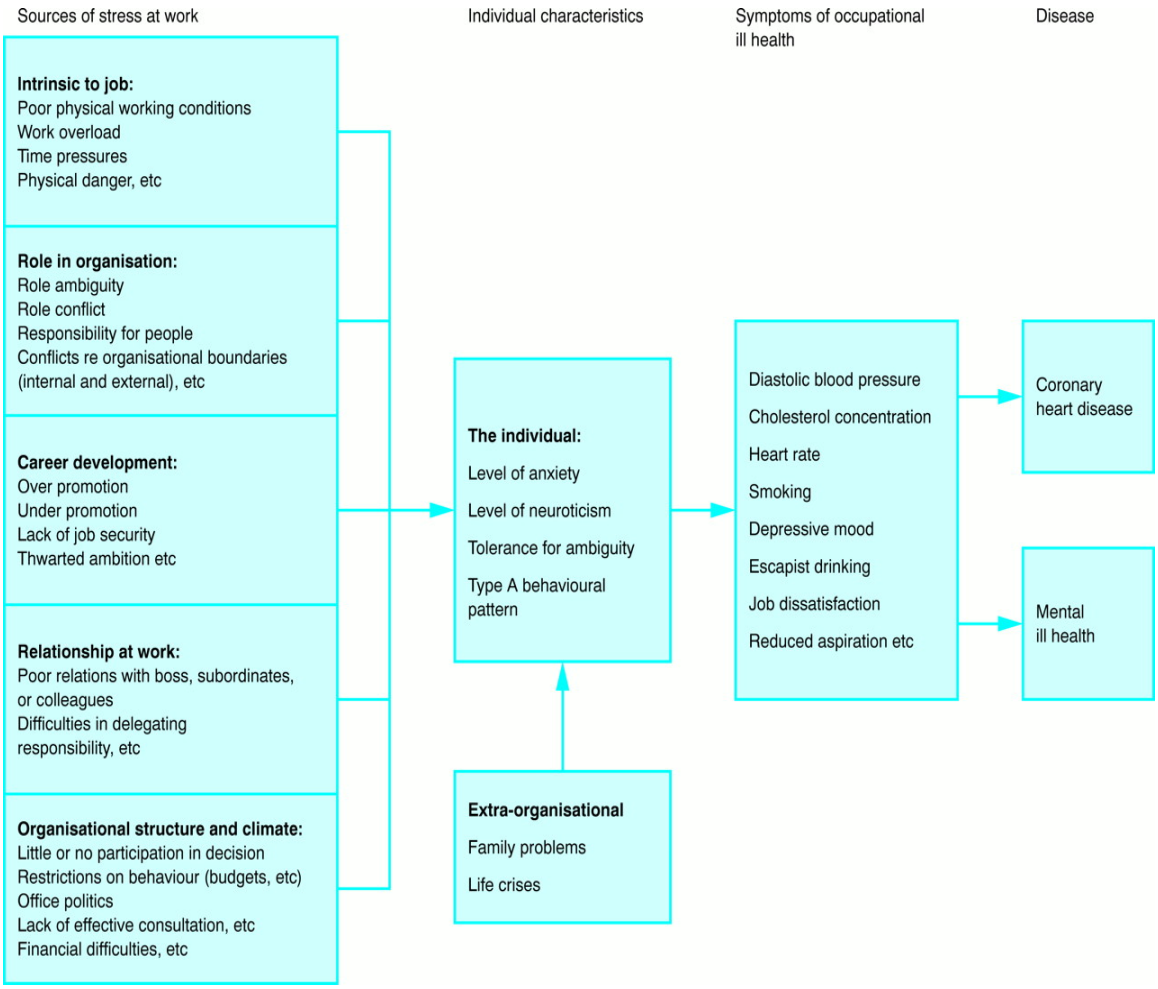

Figure 2. A model of work environment: Signs and symptoms of stress (Adapted from Michie, 2002).

Job Strain

One factor that affects stress levels and overall health in both working men and women is job strain. Several models have been used to describe job strain (Bunker et al., 2003; Karasek, 1979; Landsbergis & Hatch, 1996; Vagg & Spielberger, 1998). According to all of the models, job strain is multi-faceted. Common factors affecting job strain include high work demands and low control. Additionally, stressful job characteristics include work-related psychological stress, which is defined as work that has high levels of psychosocial demands and limited decision-

making control in response to these demands (Landsbergis & Hatch, 1996). Active duty women may be at higher risk for stressful job characteristics since they limited control in the military.

The model that seems most appropriate to this dissertation is Karasek (1979). According to Karasek (1979), job strain is defined as low decision latitude and high job demands. Low decision latitude and heavy job demands leads to mental strain, or stress, in individuals because they believe they have little decision authority and/or skill level to complete their jobs. This lack of control and/or skill level combined with heavy job demands leads to job strain (Karasek, 1979). Examples of individuals at risk for high job strain include workers with demanding jobs, low workplace flexibility, low wage jobs, limited sick and vacation leave, and difficult schedules requiring them to be available 24/7 (Ertel, Koenen, & Berkman, 2008).

Job strain affects the health of men and women. Individuals with high job strain are more prone to coronary heart disease, diabetes, overweight/obesity, headaches, high blood pressure, and mental health concerns including depression and anxiety (Ertel, Koenen, & Berkman, 2008; Hobson, Delunas, & Kesic, 2001; Kuper & Marmot, 2003; Van der Doef & Maes, 1998). Work overload is directly related to job strain.

Work Overload

Similar to job strain, another area of stress for pregnant women in the work environment is work overload. Work overload is defined as quantitatively having too much work to complete or qualitatively perceiving that the level of difficulty of the work is beyond what an individual can complete (Michie, 2002). Both of these factors are detrimental to the developing fetus. Job overload is strongly correlated with cigarette smoking, lower self-esteem, decreased motivation at work, escapist drinking, and other stress-related symptoms (Michie, 2002). Aggressiveness, being withdrawn, feelings of embarrassment, job dissatisfaction and tension, lacking motivation,

and tearfulness are behaviors that transpire within a given work environment that may contribute to the onset of health-related concerns such as headaches, nausea, and palpitations (Michie, 2002). During pregnancy, this is especially dangerous as stress and being burdened by work have been associated with maternal and infant health outcomes up to 20 years after birth (Davis et al., 2012; Fraser et al., 2012; Hochner et al., 2012). Hence, both quantitative and qualitative work overload produce varying degrees of physical and psychological strain (Elsenbrunch et al., 2007; Salihu, Myers, & August, 2012; Sarason, Sarason, & Gurung, 2001).

Work Requirements

Environmental stress, specifically workplace stress, affects maternal and infant outcomes. Workplace stress is frequently caused by occupational factors including being exposed to chemical agents, pesticides, ergonomic factors, psychosocial factors, job strain, heavy physical labor, and irregular work schedules (Figa-Talamanca, 2006). In non-pregnant employees, job strain and work hours have been associated with weight gain (Fujishiro et al., 2015). It is logical, then, to hypothesize that increased work and home demands may also be associated with weight gain during pregnancy. Another area of work that has been found to be related to weight gain is shift work.

Shift Work

Irregular work schedules, specifically shift work, are associated with worse health outcomes than consistent daytime work schedules (Canuto et al., 2013; Chen, Lin, & Hsiao, 2010; Kubo et al., 2010). Shift work (i.e., shifts outside of 0700-1800) decreases optimal work performance (Caruso, 2013). Researchers also report that evidence points to an adverse relationship between shift work and health (Wang, Armstrong, Cairns, Key, & Travis, 2011). According to some research, it increases the risk of chronic conditions such as obesity (Caruso,

2013; Chen, Lin, & Hsiao, 2010; Kubo et al., 2010). Among men and women who worked shift work, there was a significant increase in the risk of obesity (Caruso, 2013; Chen, Lin, & Hsiao, 2010; Kubo et al., 2010). Women who worked night shift have a higher risk for central obesity and high blood pressure (Canuto et al., 2013; Chen, Lin, & Hsiao, 2010). Even after 10 years, shift work significantly increases the risk that employees will become obese (Kubo et al., 2010). In these studies, researchers adjusted for education, duration of work, age, smoking, and drinking. Even after these adjustments, men and women who worked shift work were found to be at a significantly higher risk for obesity and poor health outcomes than those who worked consistent hours and daytime office jobs (Canuto et al., 2013; Chen, Lin, & Hsiao, 2010; Kubo et al., 2010).

There is limited research on the work environment and weight gain during pregnancy as the association of job strain and shift work on weight gain have yet to be studied jointly. However, research investigating job strain and changes in BMI (Fujishiro et al., 2015) has informed the hypotheses for this study (i.e., if job strain is related to BMI increase in non-pregnant women, it is logical to hypothesize that it would be related to EGWG for pregnant women). Job strain is defined as a high job demand with low job control (Karasek et al., 1998). Among shift workers, the association between job strain and delayed and concurrent weight gain was examined. Findings demonstrate that previous and concurrent job strain and rotating shift work were independently associated with BMI change for previous exposure (-0.02 to 0.09 kg/m^2) and concurrent exposure (ranging from 0.01 to 0.14 kg/m2) over the course of the four years of the study (Fujishiro et al., 2016). Results revealed no evidence related to effect modification associated with job strain (Fujishiro, Lividoti, Schernhammer, & Rich-Edwards, 2016). Hence, if the trend toward obesity is observed in civilians, the military should also

consider if job strain and shift work are significantly associated with obesity. Due to the association of obesity, job strain, and shift work after these adjustments, it is important to consider if certain work factors, such as shift work, affect pregnancy weight gain and postpartum weight retention.

Stress, Work, Weight Gain During Pregnancy, And Postpartum Weight Retention

As discussed, work factors have been associated increased weight gain in women, and they are believed to be associated with gestational weight gain and PPWR. Many factors affect whether women are able to follow the 2009 IOM guidelines for weight gain during pregnancy, which also affects their ability to attain weight standards postpartum. Key factors among work and home demands that are prominent factors associated with pregnancy weight fluctuation in the civilian population are stress and workload. Longer work hours have also been linked to decreased physical activity during pregnancy and postpartum (Pereira et al., 2007) leading to excess weight gain and retention (Pedersen et al, 2011). Additionally, researchers studying the effects of pregnancy in the civilian work place have found that pregnant women are often devalued, considered less competent, and received lower performance appraisals than men and nonpregnant women (Henrich, Schmider, Fuchs, Schmidt, Dudenhausen, 2003; Salihu, Myers, & August, 2012). This is another indication that pregnancy is a time in women's lives that may lead to adverse consequences for their careers and their health. A prospective study conducted by Fujishiro et al. (2015) examined the correlation between job strain and weight gain among women. Increased job strain once during the course of a 4-year period demonstrated a significantly higher BMI (0.06-0.12, $p<0.05$) compared to women who failed to report high job strain. Findings showed that the correlation between changes in exposure to job strain and changes in BMI are dependent on a woman's BMI level at baseline ($p=0.015$) (Fujishiro et al.,

2015). Increased BMI at baseline is associated with higher BMI gains despite significantly high job-related strain. Women with higher BMI are at increased risk of BMI gain following consistent exposure to job strain and work stress. Exposure to job strain and chronic stress contributes to unhealthy patterns and behaviors such as a heightened level of cortisol production, higher BMI, increased intra-abdominal fat, larger waist circumference, and neuroendocrine dysregulation (Fujishiro et al, 2015). Therefore, if non-pregnant women experiencing stress in the workplace have changes in their BMI, it is important to consider if this phenomenon is also true with pregnant women.

Being employed outside of the home is associated with PPWR (Endres et al., 2015). Women employed outside of the home are at a higher risk to retain 20+ pounds during the postpartum period (Endres et al., 2015). Cline and Decker (2012) examined the effects of weight gain during pregnancy and postpartum depression. Research findings demonstrate the inverse relationship between weight gain and postpartum depression for obese women during pregnancy. Among obese pregnant women, less weight gain was attributed to an increased risk of developing postpartum depression. Additionally, feeling burdened by work can lead to PPWR (Pedersen et al, 2011). Military women may be exposed to these same effects.

Many factors affect whether civilian and military women are able to follow the 2009 IOM guidelines for weight gain during pregnancy, which also affects women's ability to attain weight standards postpartum. Key factors among work and home demands that are prominent factors associated with pregnancy weight fluctuation in the civilian population are stress and workload. Longer work hours have also been linked to decreased physical activity during pregnancy and postpartum (Pereira et al., 2007) leading to excess weight gain and retention (Pedersen et al, 2011). Military stressors such as deployment, temporary duty, physical fitness

requirements, and permanent change of station differentiate a career in the military from one as a civilian. Very few studies have examined the effects of these work requirements in the military community and how they affect pregnancy weight gain and retention (Chauhan et al., 2013; Evans & Rosen, 1997; Krukowski et al., 2016; Rasmussen & Yaktine, 2009).

Summary

Psychosocial factors are associated with maternal and infant outcomes during pregnancy and postpartum. Specifically, depression and anxiety are related to women having higher BMIs before and after pregnancy. Depression has been associated with higher risk for preterm birth, lower birth weight, and fetal growth concern. Depression was associated with negative maternal metabolic consequences. Anxiety is related to preterm birth and lower infant birth weight. Social support may negate some of the risks depression and anxiety pose to a pregnancy. Stress affects a pregnancy in several ways and may increase the risk of negative psychosocial and maternal and infant outcomes. Stress, specifically work and home demands are associated with EGWG and PPWR. A specific workplace of interest in the proposed study is the military.

Military Culture and Its Relevance to Pregnancy Outcomes

The military is a unique culture in and of itself. The military is distinct from civilian culture in several ways (Redmond et al., 2015). Many aspects of the military culture are potentially relevant to the health of service members. More specifically aspects of the military culture are relevant to women's health and potentially to pregnancy outcomes.

One of the primary ways in which the military is different from civilian culture is organizational citizenship behavior (OCB). Organizational citizenship behavior is also referred to as the good soldier syndrome and indicates involuntary, expected behavior that exceeds job requirements and positively contributes to an organization (Smith, Organ, & Near, 1983).

Examples of OCB are helping coworkers with tasks, working overtime without commensurate pay, and flexing work hours to accommodate others. While these behaviors may be discretionary in civilian culture, they are expected and even required of military members (Rose, Herd, & Palacio, 2017; Smith, Organ, & Near, 1983; Vigoda-Gadot, 2007). The military, as a whole, seeks to utilize structure and training to minimize individual differences (Redmond et al., 2015). Included in this training are laws codified in the Uniform Code of Military Justice (UCMJ) specifically for military members, DoD and service branch regulations, military traditions, and military missions (Lee & Allen, 2002; Redmond et al., 2015; Rose, Herd, & Palacio, 2017). These laws, regulations, traditions, and missions create a unique culture from the civilian workplace (Redmond et al., 2015).

Even within the military, the different service branches have subcultures due to their different histories and unique purposes (Murray, 1999; Redmond et al., 2015). The service branches appeal to different people in part due to the expectations and requirements of their members. For example, the Marine Corps focus on maintaining a younger, non-career force than the other three branches with over 60% at or under the age of 25 (Headquarters, Marine Corps, 2012). On the other hand, the Air Force is often viewed as a business or organization and places a higher priority on technological advancement (Murray, 1999). Each service branch also has its own purpose and mission. For example, the purpose of the Air Force is to provide security to the United States through providing air support to ground forces. The purpose and missions of the separate branches lead them to having different regulations and physical fitness requirements (DoD, 2017).

United States Army Subculture

The United States Army is the largest service branch. Its mission is to "Fight and win our Nation's wars by providing prompt, sustained land dominance across the full range of military operation and spectrum of conflict in support of combatant commanders" (DoD, 2017; Redmond et al., 2015). While its mission includes transporting military members via air and sea, it is primarily used as the nation's chief land force (Cozza, Goldenberg, & Ursano, 2014; DoD, 2017; Redmond et al., 2015). On average, the Army has the most members engaged in combat operations and has a high operational tempo. Army members are called soldiers. In general, soldiers deploy for six months to over a year in a two to three-year cycle (Cozza, Goldenberg, & Ursano, 2014).

United States Navy Subculture

The Navy's mission is to "Maintain, train and equip combat-ready Naval forces capable of winning wars, deterring aggression and maintaining freedom of the seas" (DoD, 2017; Redmond et al., 2015). Navy members are referred to as sailors. As sailors, Navy members may be exposed to sea, air, submarine, and land missions. On the sea, many sailors are stationed on aircraft carriers, which function as their own city on the sea. Aboard the ship, there are cooks, carpenters, firefighters, pilots, and doctors. Due to the number of career fields aboard, some sailors may not know what other personnel on the ship do. Therefore, even among sailors, unique subcultures arise within the different military occupations. The Navy also directly support the Marine Corps through providing health care providers, chaplains, and support corps to the Marines. Additionally, the Navy may transport supplies and personnel for the Marine Corps (Cozza, Goldenberg, & Ursano, 2014; Redmond et al., 2015).

United States Marine Corps Subculture

The Marine Corps' mission is to "Train, organize, and equip Marines for offensive amphibious employment and as a force in readiness" (DoD, 2017; Redmond et al., 2015). Members in the Marine Corps are called Marines. They have the smallest service branch in number but are the branch with the highest number of military members exposed to combat. Marines perform ground and air missions that are organized through a Marine Air-Ground Task Force. The Marine Air-Ground Task Force is responsible for overseeing the ground, air, and combat mission command and support elements. Marines are expected to be expeditionary in nature, always ready to deploy and conduct expeditionary and amphibious missions. These missions may involve crisis response and close air support to military members on the ground (Cozza, Goldenberg, & Ursano, 2014).

United States Air Force Subculture

The Air Force was created in 1947 and is the newest service branch. It was previously part of the Army. Air Force members are called airmen. The Air Force's mission is to "Fly, fight, and win in air, space, and cyberspace" (DoD, 2017; Redmond et al., 2015). In line with their mission, many of the career fields in the Air Force support the flying mission. The flying missions are used for surveillance and reconnaissance missions, air defense, search and rescue, and satellite delivery to outer space (Cozza, Goldenberg, & Ursano, 2014). The Air Force is expected to be able to travel anywhere in the world on extremely short notice to answer the priorities of the United States. In addition to air crew deployments, Air Force members including explosive ordnance disposal (EOD), security forces, and medical and chaplain support members deploy in support of the Air Force's mission (Cozza, Goldenberg, & Ursano, 2014).

Military Branches and the Proposed Study

All of the services work together to accomplish the larger mission of safety and security of the United States. The unique subcultures found within service branches and within the officer and enlisted corps affect the "image" the branches wish to portray. For example, Marine service members have been found to be the leanest service while also having the smallest increase of active duty members being obese and overweight (RTI International, 2006). This may be due to the fact that Marines serve as ready force for expeditionary missions (Cozza, Goldenberg, & Ursano, 2014). Active duty Marines are expected to be ready at any time to deploy, and their fitness level factors into whether Marines are deemed world-wide qualified and deployable. Therefore, they may enter pregnancy at a lower weight and lose more weight faster during the postpartum due to their operational tempo. Due to their unique subcultures, the proposed study seeks to examine if there are differences in pregnancy weight gain and PPWR between the branches of the military.

Military Culture and Rank

Officers and enlisted members have different roles and responsibilities in the military. Officers in the military have, at minimum, a bachelor level degree (Redmond et al., 2015). They earn more money than enlisted personnel, thus putting them into a different SES (Schoenfeld, McCriskin, Hsiao, & Burks, 2011).

Meanwhile, approximately 83% of the military is made up of enlisted members (Defense Manpower Data Center, 2017). For several years, enlisted military service members have ranked in the top three most stressful jobs in the United States (CareerCast, 2014; CareerCast 2015; Forbes, 2017). According to Forbes (2017), enlisted military personnel have the most stressful job in 2016. A range of factors impacted the ranking in 2016 including physical demands, risks

to an individual's life, travel required, deadlines, interactions with the public, public scrutiny, environmental conditions, and hazards (CareerCast, 2014; CareerCast 2015; Forbes, 2017).

The division of labor between enlisted, warrant officers, and officers are different between the service branches and dictated by their distinct missions (Cozza, Goldenberg, & Ursano, 2014; Defense Manpower Data Center, 2017). However, across all service branches, officers are held accountable for all aspects of their unit in the military. They give orders and are responsible for everything that happens in their unit (i.e., work-related or personal concerns) (Cozza, Goldenberg, & Ursano, 2014). Officers and enlisted members are granted different privileges based on their rank and career field. However, since enlisted and officers have distinct rank structures, officers outrank even the highest-ranking enlisted members (Cozza, Goldenberg, & Ursano, 2014). Due to the distinct differences among enlisted and officers, the proposed study will examine the differences in gestational weight gain and PPWR between enlisted members and officers.

Military Specific Differences in Stress, Anxiety, and Depression

Due to these additional stressors placed upon military members and their dependents, affective states in pregnant and postpartum military members differ from those in the general civilian population. A report written in 2006 by RTI International, found that women in the Marine Corps had the highest rates of stress (49.3%) followed by women in the Army (40.0%), Navy (35%), and Air Force (30.3%). This makes sense due to the high operational tempo of the Marine Corps and Army. One study found reports of depressive symptoms in active duty Navy and Marine women at 12 months postpartum were two to three times higher than those typically reported for civilian women (Cofell, 2011). Assessed in the first two months postpartum, anxiety levels in military women are approximately 33%, compared to civilian rates of 30.7%

(Appolonio & Fingerhut, 2008; Yin et al., 2008). This number is estimated to be even higher in the military due to many service members being reluctant to report mental health problems due to mental health stigma (Eaton et al., 2008). Many military members fear reporting mental health concerns will negatively impact their career. They may even ask their partner not to report physical or mental health concerns due to it potentially reflecting adversely on their career opportunities (Eaton et al., 2008; Greene-Shortridge, Britt, & Castro, 2007; Hoge et al., 2004).

Affective states and birth outcomes are impacted by military factors such as geographic separations including deployment. Compared with women whose spouses are not deployed, women who have partners deployed during or subsequent to pregnancy have a 2.75-fold increased risk of having symptoms of depression as identified on the Edinburgh Postnatal Depression Scale. They also report significantly higher levels of depression than women who partners did not deploy (Robrectht, Millegan, Leventis, Crescitelli, & McLay, 2008). A significant association between depression and preterm birth in spouses whose partner deployed during pregnancy and returned following delivery has also been documented (Levine, Bukowinski, Sevick, Mehlhaff, & Conlin, 2015; Tarney et al., 2015). There are many factors within the military that may cause additional stress to pregnant active duty members.

Military-specific Work Factors

Active duty military women face some of the same stressors as employed civilian women, but they also experience some different ones. Additional unique risk factors active duty military women experience are temporary and long-term separations from their support system (e.g., significant other, extended family, and friends), separation and stress from deployments and temporary duties, and the inability to leave their job due to an active duty service commitment (Tarney et al., 2015). Active duty military women have stressful, full-time careers

with yearly performance reports, promotion testing, and eligibility requirements for promotion. They are required to complete a physical fitness test every six months to a year (Appolonio & Fingerhut, 2008; O'Boyle, Magann, Ricks, Doyle, & Morrison, 2005). Stressful job characteristics significantly impact adverse health events. Stressful job characteristics include work-related psychological stress, which is defined as work that has high levels of psychosocial demands and limited decision-making control in response to these demands (Chauhan et al., 2013; Linné, Barkeling, & Rössner, 2002). Additionally, researchers have found that women who were pregnant were treated with more hostility than their non-pregnant counterparts (Hebl, King, Glick, Singletary, & Kazama, 2007). Active duty women in the military tend to have less control of their duties and assignments compared to civilians. Spouses and TRICARE dependents may experience this same stress as they have very little control of their sponsor or partner's duties and assignments. Limited control over duties and assignments significantly increase job-related stress and psychosocial stress in relationships indicating that active duty women may be at higher risk for stressful job characteristics compared to civilians. Ensuring that military women return to their pre-pregnancy weight is key to future health outcomes and prevents the likelihood of potential consequences. These stressful job characteristics may also affect health-related outcomes such as weight change during pregnancy (Linné, Barkeling, & Rössner, 2002) and weight retention during postpartum (Chauhan et al., 2013; Linné, Barkeling, & Rössner, 2002).

Deployment and Operational Tempo

Deployments are frequently stressful for military members and their families. Deployments may be for a variety of reasons including combat, peacekeeping, and humanitarian (Newby et al., 2005). Many military members report a higher rate of mental health problems

postdeployment as opposed to predeployment. Military members with exposure to combat were more likely to report mental health problems (Hoge, Auchterlonie, & Milliken, 2006). Additionally, military members who deploy were referred for and utilized mental health services more frequently than prior to deployment. They were also more likely to separate from the military (Hoge, Auchterlonie, & Milliken, 2006).

Deployments and operational tempo are considered stressors for military members, their families, and their support system. Married service members were more likely to report negative consequences than single military members (Newby et al., 2005). Military members must adjust to the requirements of the deployment while many military spouses also encounter new roles and responsibilities when their spouse was deployed (Eaton et al., 2008). The health of military spouses is significant to the family unit and to the military unit. A spouse's perception of the military is linked to their physical and mental health (Hoge et al., 2004). Compared to military members who spouses are satisfied with the military lifestyle, military members with spouses that are unsatisfied with the military lifestyle are more likely to leave the military (Hoge et al., 2004).

Some military members have reported positive consequences of deployment. Single military members were more likely to report positive consequences than married service members (Newby et al., 2005). Positive experiences included made more money, worked on self-improvement, and had time to think. Additionally, married military members reported an improvement in their level of satisfaction with their significant other (Newby et al., 2005).

The most stringent U.S. military branches regarding deployments for new mothers are the U.S. Marine Corps and U.S. Army. Mothers in the U.S. Marine Corps and U.S. Army may be deployed six months from the date of delivery (Breastfeeding in Combat Boots, 2017; DoD

Instruction 6490.07, 2010). U.S. Air Force and U.S. Navy mothers are not required to deploy prior to one year from the date of delivery (Breastfeeding in Combat Boots, 2017; DoD Instruction 6490.07, 2010). As mentioned previously, a report written in 2006 by RTI International found that women in the Marine Corps had the highest rates of stress (49.3%) followed by women in the Army (40.0%), Navy (35%), and Air Force (30.3%). Due to the high operational tempos and combat exposure of the Marine Corps and Army, it is expected that their stress levels would be the highest. However, many Marines join with the expectation of deploying often, and they may enjoy deployments. In addition, Marines must maintain strict physical standards. For these reasons, it is expected that women in the Marine Corps will gain less weight during pregnancy and retain less weight during postpartum as compared to women in other branches of the military.

Women and Military Culture

The number of women joining the military is growing, and women currently make up over 15% of the military (DoD, 2017). Among the branches, the Air Force has the highest percentage of females within its ranks, at 20%, while the Navy and Army have 15% and 14%, respectively, and the Marine Corps have 6% (Defense Manpower Data Center, 2017). In the past, women were not allowed to serve in all occupations in the military. Due to women being ineligible to serve in combat roles meant that women were excluded from 38% of Marine Corps jobs, 10% of Navy and Army jobs, and 1% of Air Force occupations (Kelly, Kleykamp, & Segal, 2010). This impacted women's ability to reach rank as fast and as high as men. Oftentimes due to limitations on their career progression and for family reasons, women leave active duty status earlier than their male counterparts (Kelly, Kleykamp, & Segal, 2010). As of January 2016,

women are now allowed to serve in all roles in the military (Southwell & MacDermid Wadsworth, 2016).

Of the women in the military, 8-9% are pregnant at any time (Department of Defense Statistical Information Analysis Division website, 2014). Pregnancy affects military readiness as women who are pregnant are placed on profiles that limit their mobility, exempt them from physical fit tests and weight standards, and restrict work activities (Armitage & Smart, 2012; Evans & Rosen, 1997). Researchers have also linked pregnancy and postpartum to periods of increased weight gain and retention, further affecting an individual's health and military readiness (Carter, Wood Baker, & Brownell, 2000; Chauhan et al., 2013; Cofell, 2011).

Career Implications of Pregnancy in the Military

Previously, active duty women who became pregnant during deployment were discharged (Christopher, 2007). Currently, women who are deployed will be sent home with potential negative consequences to her career. Women who become pregnant can voluntarily request to leave the military, but they are no longer required to leave solely based on pregnancy (Christopher, 2007).

Pregnancy not only affects the woman, it also affects the military. The loss of personnel affects military readiness for deployed and non-deployed units (Christopher, 2007). When service members get pregnant, there can be a great cost to their unit due to the time and money invested in military service members' training, deployment, and health care (Albright, 2007; Belmont, 2010; Segal & Lane, 2016). Women who are pregnant are not worldwide-qualified, meaning they cannot deploy for one year from the time of diagnosis, change their military base (i.e., permanent change of station), complete certain training duties (e.g., field exercises, marksmanship, fly in aircraft, or ride in tactical vehicles), or fill certain assignments due to their

pregnancy status, impacting military readiness (Christopher, 2007; Klein & Adelman, 2008). Additionally, women are expected to gain weight during pregnancy, and this may affect their fitness status post-pregnancy (Armitage & Smart, 2012; Christopher, 2007). Researchers have found that many women after pregnancy do not return to their pre-pregnancy level of fitness. On fitness tests required every six months to one year (depending on the military service branch), women frequently do not complete as many push-ups, sit-ups, and have slower run times than their fitness test prior to pregnancy, which could negatively impact their career including assignments and promotion potential (AFPC/DPS, 2015; Armitage & Smart, 2012; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; Chief of Naval Operations, 2007; The Surgeon General, 2012; US Department of the Army, 2007; US Department of the Army, 2007; US Department of the Army, 2012). The military also has height and weight standards service members are required to maintain. Women service members must meet these weight standards six months to a year following the birth of the infant (AFPC/DPS, 2015; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; Chief of Naval Operations, 2007; The Surgeon General, 2012; US Department of the Army, 2007; US Department of the Army, 2007; US Department of the Army, 2012). Pregnancy is a time when women gain weight, and it impacts their ability to meet weight standards post-pregnancy if they retain the excess weight (Armitage & Smart, 2012; Christopher, 2007).

Attrition from the Military

Women are underrepresented in the military service with only approximately 15% of the military being female (DoD, 2017; DoD, 2012; Krulewitch, 2016). Compared with their representation at lower ranks, women are underrepresented in the military's senior leadership

(Defense Advisory Committee on Women in the Services, 2017). Currently, women make up 20.6% of the Air Force officer corps. It is even less in the other service branches. Most women separate after their second enlistment, and only 37% of female officers that are not pilots stay in the service over 10 years compared to 55% of male officers (Lundquist & Xu, 2014; Maucione, 2018; Teachman, Tedrow, & Anderson, 2015). Many factors impact women's decision to separate from the military.

One of the reasons women choose to separate from the military is family and personal life concerns. For example, women are concerned about how pregnancy and having children impact their careers and their priorities may shift once they become pregnant and have children (Maucione, 2018; Teachman, Tedrow, & Anderson, 2015). Child care is a consistent issue of concern for military parents. Many parents believe the Defense Department does not provide enough support to aid children in coping with the unique challenges of military lifestyle (Blue Star, 2017).

Women have made the decision to separate from the military due to career path flexibility, ability to cross train, and civilian opportunities. Many women currently struggle with flexibility in their current career trajectory with long hours and high demands (Figa-Talamanca, 2006; Fujishiro et al., 2015; Maucione, 2018). Having the flexibility to seamlessly transfer into the Reserves, to cross train to a new career field/MOS, or to complete a civilian intermission program without impacting women's careers is important to them and is associated with higher retention rates (Defense Advisory Committee on Women in the Services, 2017; Maucione, 2018; Teachman, Tedrow, & Anderson, 2015).

Furthermore, women chose to separate due to work environment issues including leadership, role models who are women, mentoring, sexual harassment and assault, gender

composition of the work place, and long work hours or shift work. Women state that work-life balance impacts their retention rates. They have little control over the long hours they work and what the mission dictates. Additionally, women iterated that they would like to see more activities focusing on women and their roles in the military. For example, having women-based panels or forums may increase the retention of women in the military (Defense Advisory Committee on Women in the Services, 2017; Maucione, 2018).

More broadly, women choose to leave the military due to military benefits, permanent change of station, deployment, and force reduction. Women have indicated that they prefer to have fewer permanent change of station moves and a better ability to control their future assignments (Defense Advisory Committee on Women in the Services, 2017). Furthermore, some women believe morale in the military is currently low. Lower levels of readiness, lower levels of manpower, higher operational tempo, and "less people, less parts on the shelves" has led to reduced morale in the military (Haskell, 2018). Unit and squadron leadership are part of the issue, but the issue is broader and includes having a culture that values the mission at the expense of an individual (Haskell, 2018). Mandatory budget cuts caused by sequestration have not helped. Sequestration cost the Air Force over 30,000 individuals and 10 squadrons, even though the mission demands have increased (Losey, 2018). Thus, many women have chosen or been chosen to separate from the military.

Many factors impact women's decision to stay in the military or separate from it. Overall, the rate of attrition is much higher among women than men. Many changes are currently being suggested, and the military is becoming more "family friendly" with new policies such as extended maternity leave and changes to the civilian intermission programs with the hope of being to retain more women in the military. However, as it presently stands, many women

choose to separate from the military after their second assignment (Defense Advisory Committee on Women in the Services, 2017; Maucione, 2018).

Protective Factors in the Military

Despite the additional risk military members may have, there may be some protective factors in the military. Military members have comprehensive health care for military members and their families. Being able to access care in the MHS may provide a protective factor to which civilian women do not have access (Appolonio & Fingerhut, 2008). Babies born preterm can greatly benefit from the new mother's utilization of these services. Additionally, there are supportive programs offered through a military branch's Family Advocacy Program such as the New Parent Support Program that are provided for new military parents and TRICARE dependents. The programs are designed to help mothers and families adjust to a new member in the household and provide support individually or through a group setting. Providers from the programs will even meet families at their home to help them with common issues such as breastfeeding and child-proofing the home (Family Advocacy Program, 2017; New Parent Support Program, 2017). Furthermore, there are programs (e.g., Military One Source, Operation We Are Here) offered in the community for military families and groups for military spouses to provide additional support to military families (Koeman, 2017; Military One Source, 2017). Although there are several protective factors in the military community, the military members may be at risk for EGWG and PPWR due to the unique work factors they are exposed to.

Active Duty Factors Affecting Weight

Due to several factors present in a military work environment, many active duty military women are at risk for gaining and retaining excess weight during and after pregnancy (Carter, Wood Baker, & Brownell, 2000; Endres et al., 2015; Pedersen et al, 2011). Requirements for

military women are different from civilian women. Active duty women's work performance and appraisal in the military may be affected due to pregnancy status. Both civilian and active duty military women gain weight during pregnancy, however, until recently, six months post childbirth military women were required to meet strict military weight standards (AFPC/DPS, 2015; Armitage & Smart, 2012; Cofell, 2011; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; Chief of Naval Operations, 2007; The Surgeon General, 2012; US Department of the Army, 2007; US Department of the Army, 2007; US Department of the Army, 2012). Maintaining a normal body weight is a significant criterion of military readiness (Armitage & Smart, 2012; Cofell, 2011). If postpartum women do not meet these standards, their command may require them to participate in military physical fitness programs, weight management programs, and body composition programs (AFPC/DPS, 2015; Chief of Naval Operations, 2007; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; The Surgeon General, 2012; US Department of the Army, 2012). The service branches have cultures that expect them to be fit and worldwide qualified. If members are deemed ineligible for any reason, they may fear stigma and discrimination (Redmond et al., 2015). In one study of active duty Soldiers, 39% of Soldiers reported feeling stigmatized or discriminated against by their peers for being overweight or obese. In the same group of soldiers, over 49% felt that their supervisors discriminated against them for being overweight or obese (Piche, Stankorb, & Salgueiro, 2014).

Pregnant service members do not deploy and their work duties may change due to pregnancy. Additionally, during pregnancy, women are not required to maintain the same physical fitness standards required of other military members, which may give rise to a

difference in their yearly evaluation (Armitage & Smart, 2012; Evans and Rosen, 1997). Differences in yearly performance evaluations may contribute to psychosocial factors such as depression and anxiety levels affecting adverse health outcomes including weight gain and retention during pregnancy and postpartum (Armitage, 2013; Carter, Wood Baker, & Brownell, 2000; Endres et al., 2015; Evans & Rosen, 1997; Pedersen et al., 2011; Toups, et al., 2013). Military members face many challenges during pregnancy and the postpartum period that may affect maternal and infant health.

Summary

Many factors in the military make it a unique workplace. Each branch and rank has its own subculture which may be associated with EGWG and PPWR. Additionally, there appear to be higher levels of psychosocial distress in the military even with the protective factors it offers. Therefore, it is important to consider what military-specific factors may be associated with pregnancy weight gain and PPWR in order to develop interventions tailored for military members.

Standards of Care of Pregnancy and Birth in Civilian and in the Military Health System

Optimizing health during pregnancy and postpartum promotes the health of the mother and mitigates adverse birth outcomes for the infant. Strategies designed to promote antepartum health include regular prenatal visits, genetic screening, and ultrasounds measuring the anatomy and size of the fetus (Kirkham, Harris, & Grzybowski, 2005). Additionally, ensuring the health of the mother and infant through height and weight measurements of the mother, promoting healthy weight gain, and monitoring vital signs including blood pressure and heart rate help promote a healthy pregnancy. Furthermore, certain psychological and lab screenings are

implemented as standard of care including screening for symptoms of depression and testing glucose tolerance (Department of Veteran Affairs, & Department of Defense, 2009; Kirkham, Harris, & Grzybowski, 2005). The Department of Defense and Veterans Administration developed clinical practice guidelines during pregnancy and the postpartum period to mitigate risks of negative outcomes for pregnant and postpartum women and their offspring (Department of Veteran Affairs, & Department of Defense, 2009). These guidelines are in line with evidence-based prenatal care recommended by the American Academy of Family Physicians (Kirkham, Harris, & Grzybowski, 2005).

Standard of care for postpartum care includes a follow-up visit six weeks after birth. During this visit, a full regular postpartum doctor visits assess the height, weight retention, vital signs, and psychosocial health of the mother (Department of Veteran Affairs, & Department of Defense 2009). The MHS adheres to standards of care and encourages active duty members and all TRICARE beneficiaries to take part in the services offered (Department of Veteran Affairs, & Department of Defense 2009).

Despite following the standard of care in the MHS, including regular weight measurements, nearly two-thirds of women do not adhere to the IOM guidelines (Olson, 2008). It is vital to consider what factors, including work and home strain, may be affecting women's ability to follow IOM guidelines.

Healthcare System Organization

Regional issues

Comprehensive healthcare is provided to active duty women. In the civilian population, it has been found that areas where there are a higher number of physicians, there have been lower rates of obesity (Myers et al., 2015). Approximately 70% of active duty military members are

stationed in 11 states in the U.S. (Defense Manpower Data Center, 2016). The states that have the highest number of active duty members are California, Texas, North Carolina, Virginia, Florida, Georgia, Washington, New York, South Carolina, Hawaii, and Maryland (Defense Manpower Data Center, 2017). The military places the highest number of healthcare resources in these areas (TRICARE, 2017). Therefore, while there is comprehensive prenatal and postpartum care for military members across the board, there may be healthcare disparities among states such as Alabama, Mississippi, South Dakota, and North Dakota. These states also have military members (Defense Manpower Data Center, 2017). However, the active duty members may not have equal access to healthcare due to the geographic locations of the large healthcare facilities being located in areas where more active duty members are stationed (i.e., California, Texas, Hawaii). The proposed study seeks to examine regional differences in trends of EGWG and PPWR.

Summary

It is important for the military to optimizing health during pregnancy and postpartum for active duty women. The military provides comprehensive healthcare for women and infants during pregnancy and postpartum periods. However, regional issues may create healthcare disparities for women and children during pregnancy and postpartum. It is hypothesized that these regional healthcare disparities may be related to EGWG and PPWR.

CONCEPTUAL MODEL

Adapted from Hill et al., 2013, the conceptual model proposed identifies demographic, work, cultural, and psychological factors that may be associated with EGWG and PPWR.

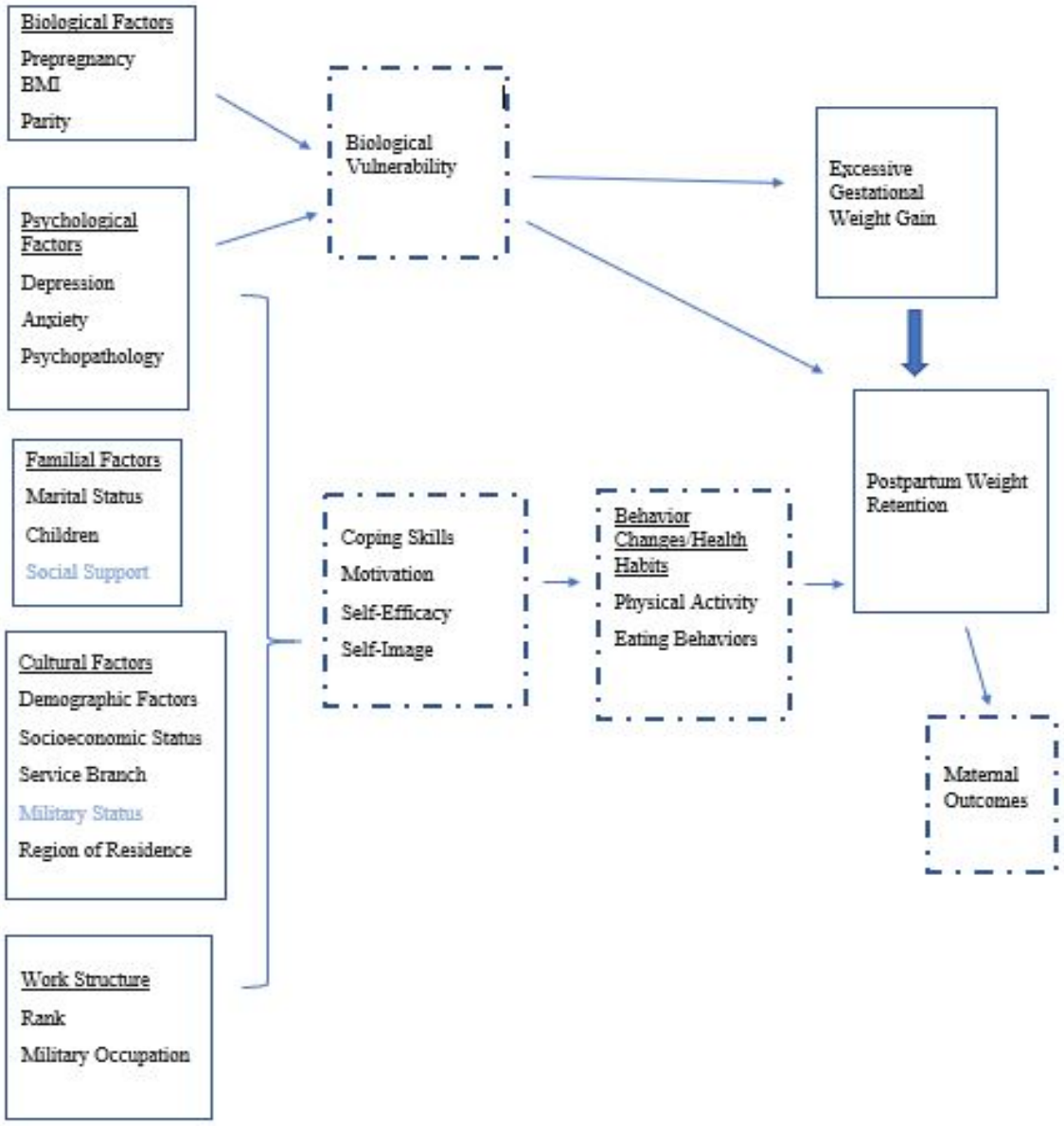

Figure 3. Conceptual Model for Demographic Factors, Work Factors, Cultural Factors, Psychological Factors, and Excessive Gestational Weight Gain and Postpartum Weight Retention (Adapted from Hill et al., 2013).

Study Rationale and Overview

Pregnancy is an important topic for the MHS because the majority of women receiving healthcare in this system are of childbearing age. Pregnancy is common in the MHS, with nearly eight times the number of active duty women pregnant at any given time compared to the civilian population. This means that the most common reasons for which women in the military seek healthcare include reproductive health and pregnancy (AHRQ, 2011; Klein & Adelman, 2008; Martins & Benicio, 2011). Pregnancy affects both the physical and mental health of women and their families, and this can impact their readiness. One of the most important concerns during pregnancy is weight gain due to its association with maternal and fetal health and military readiness.

Pregnancy is a time when women naturally gain weight, but it is crucial that this weight gain occur within healthy parameters in order to avoid detrimental outcomes to the mother and the developing fetus. Additionally, for active duty women, it is important that they can be able to return to optimum fitness and a healthy and optimal weight postpartum. Women who are serving in the military may experience additional unique stressors beyond those that non-military associated women may undergo during pregnancy. These include deployment of self or partner/spouse, temporary duties, living on-base, frequent moves, and occupational or scholastic stress. These stressors may lead to behaviors that increase weight gain beyond that which is recommended for a healthy pregnancy.

Increased weight gain during pregnancy can lead to high rates of infant morbidity and mortality. Risk factors that can affect maternal and infant outcomes during pregnancy or postpartum include demographic factors such as sex, age, or ethnicity/race, unintended or adolescent pregnancy, psychosocial factors such as negative affective states, social support from peers and superiors, and certain military-specific work factors. There are also biological and

behavioral risk factors such as health habits, work requirements, and other military-specific factors that can affect maternal weight gain during pregnancy.

Weight gained during pregnancy also affects PPWR, health of the mother, and military readiness. Stress, specifically job and home demands, contributes to pregnancy weight gain and PPWR. Given the importance of work and home demands on overall stress, and the importance of stress on birth outcomes, it is important to understand the relationship between work and home demands, and weight gain during pregnancy and postpartum. Currently, there is a paucity of research on the relationship between these factors. It is not known how military work factors including work and home demands impact pregnancy weight gain and PPWR.

Proposed Study Overview

The purpose of the proposed study will examine the impact of demographic factors (i.e., marital status, parity, entering pregnancy overweight and/or obese), military service branch, rank of active duty member, region of TRICARE service, and mental health diagnoses on pregnancy weight gain and postpartum weight retention. The present study will examine job and home demands, shift work, and deployment and operational tempo, as a proxy to stress/demand. In doing this, the proposed study will examine how stress affects weight fluctuation of active duty women during pregnancy and postpartum. Understanding the factors that are associated with weight fluctuation during pregnancy and postpartum in active duty women are critical. Once understood, interventions can be implemented to prevent active duty military women from becoming overweight or obese after pregnancy. The proposed study will examine the factors affecting pregnancy weight gain and postpartum weight retention in active duty women accessing the MHS from January 1, 2010 - December 31, 2014.

The Comparative Effectiveness and Provider Induced Demand Collaboration Project

The proposed study will make use of the Military Healthcare Data Repository (MDR) under the Comparative Effectiveness and Provider Induced Demand Collaboration (EPIC) project core of women's health. The MDR contains all TRICARE claims data for TRICARE beneficiaries including active duty military members, activated Reservists and National Guard members, and TRICARE dependents (Bagchi et al., 2011; Stewart et al., 2010; Zogg et al., 2016). The MDR does not include data from military members in combat zones or for healthcare obtained through the Veterans Administration facilities. Active duty members account for only 20% of the TRICARE beneficiaries (Schoenfeld et al., 2017; Zogg et al., 2016). The MDR utilized clinical procedure codes (CPT) for all care provided and International Classification of Diseases, 9th revision, Clinical Modification (ICD-9 CM codes) to document the diagnoses given for each visit billed to TRICARE. The MDR does not contain self-report questionnaires, specifically those related to psychological health. However, it does contain variables such as a beneficiary's service branch, rank, and demographic factors. For these reasons, the focus of the proposed study is to assess the relationship between demographic, mental health diagnoses, service branch and work factors, region of TRICARE service, delivery type, and preeclampsia health diagnoses and EGWG and PPWR within the MDR. These foci lead to five specific aims, and nine main hypotheses. These aims and hypotheses are as follows.

Specific Aims

Specific Aim 1

To determine the relationship between demographic factors and variables affecting home demands, and weight change during pregnancy and postpartum.

Hypothesis 1a. Women who are married will gain more weight during pregnancy and retain more weight during postpartum compared to women who are single, divorced, or widowed.

Hypothesis 1b. Women who have at least one child will gain less weight during pregnancy and retain less weight during postpartum compared to women in their first pregnancy.

Hypothesis 1c. Women who enter pregnancy overweight or obese will gain more weight during pregnancy and retain more weight during postpartum compared to women categorized as having a normal body mass index.

Specific Aim 2

To determine the relationship between a mental health diagnosis (anxiety, depression, PTSD, and adjustment disorder) and weight change during pregnancy and postpartum in active duty.

Hypothesis 2. Women with a mental health diagnosis will gain more weight during pregnancy and retain more weight during postpartum than women without a mental health diagnosis.

Specific Aim 3

To examine the service branch and work factors, including service branch and rank, that affect weight change during pregnancy and postpartum.

Hypothesis 3a. Active duty Marine women will gain less weight during pregnancy and retain less weight during postpartum compared to Army, Air Force, or Navy women.

Hypothesis 3b. Active duty enlisted women will gain more weight during pregnancy and retain more weight during postpartum compared to active duty officers.

Specific Aim 4

To examine the impact of region of TRICARE service on maternal weight change during pregnancy and postpartum.

Hypothesis 4. Women living in and treated in the TRICARE south region will gain more weight during pregnancy and retain more weight during postpartum than women in the other TRICARE regions.

Specific Aim 5

To examine the impact of delivery type (vaginal birth vs. cesarean delivery), and the development of preeclampsia on maternal weight change during pregnancy and postpartum.

Hypothesis 5a. Women who have cesarean deliveries will gain more weight during pregnancy and retain more weight during postpartum than women who have a vaginal delivery.

Hypothesis 5b. Women who develop preeclampsia will gain more weight during pregnancy and retain more weight during postpartum than women who did not develop preeclampsia.

CHAPTER 2: METHODS

STUDY DESIGN AND OVERVIEW

The proposed study was a retrospective data analysis that examined the association of several factors and pregnancy weight gain and postpartum weight retention (PPWR) in pregnant active duty women who deliver in the Military Health System (MHS).

STUDY POPULATION

The study used data from TRICARE medical claims (January 1, 2010 – December 31, 2014) from the MHS Data Repository. The sample chosen for the proposed study was pregnant

women who meet the inclusion and exclusion criteria listed below. Eligibility for the studies and procedures for identifying the sample population will be discussed in the following paragraphs.

Inclusion Criteria

Women were included in the study if the following criteria were met:

1. Pregnant women in their first trimester with pre-pregnancy baseline weight, third trimester pregnancy weight, and at least one postpartum weight available
2. Age 18-40
3. Pre-pregnancy BMI between 18.5 - 34.9 kg/m^2
4. Active duty status
5. Eligible for direct care within the Military Health System (MHS)

Exclusion Criteria

Women were excluded from the study if any of the following criteria were met:

1. Presence of underlying medical conditions that would place the pregnancy in the high-risk category (e.g., hypertension, pre-existing diabetes mellitus, thyroid disease, multiple gestations)
2. Planned surgeries, medical interventions, or other procedures that would place the participants in the high-risk pregnancy category
3. Presence of an eating disorder
4. Second pregnancy within 18 months of incident event

PROCEDURES

The Comparative Effectiveness and Provider Induced Demand Collaboration (EPIC) Project

The EPIC Project (Schoenfeld et al., 2017; Zogg et al., 2016) utilized an interdisciplinary team to examine health services research (HSR). The team was a partnership between the Uniformed Services University (USU) and the Brigham and Women's Hospital (BWH). In addition to HSR, the team was focused on health policy analysis and health economics. It also sought to use HSR to establish USU collaboration with clinicians in military treatment facilities and research areas that are important to the Military Health System (MHS). The EPIC study had six project cores. These core projects were surgery, trauma, policy, wounded warrior, pediatrics, and women's health. Within these project cores, the EPIC study sought to investigate "epidemiology, comparative effectiveness/outcome, quality/practice improvements, health care disparities, provider induced demand, and geographic variation" (Koehlmoos, 2017).

The EPIC Project utilized data from TRICARE insurance claims recorded in the Military Health System Data Repository (MDR) (Chaudhary et al., 2017). The Department of Defense (DoD) provided TRICARE insurance to 9.5 million active and retired US military personnel and their dependents worldwide (Chaudhary et al., 2017; DoD, 2016). The MDR does not contain claim information from care received in combat zones or at Veterans Administration facilities. Within the MDR, only 20% of claim information was from active duty military members (Bagchi et al., 2011; Zogg et al., 2016). The proposed study sample consisted of MDR data gathered from active duty women that are pregnant.

Proposed Study

The proposed study used TRICARE claims data from the MDR under the Comparative Effectiveness and Provider Induced Demand Collaboration (EPIC) project core of women's health. The proposed study examined the association of demographic factors (i.e., marital status, parity, entering pregnancy overweight and/or obese), mental health diagnoses, military service

branch, rank of active duty member, region of TRICARE service, delivery type, and diagnosis of preeclampsia on pregnancy weight gain and postpartum weight retention.

The proposed study design was a retrospective data analysis of the target population (i.e., all pregnant women in the MDR meeting the inclusion and exclusion criteria from January 1, 2010 to December 31, 2014). These dates were chosen because the Institute of Medicine (IOM) pregnancy weight gain guidelines for each body mass index (BMI) category changed in 2009. Selecting data beginning in 2010 allows for all individuals in the study to have the same pregnancy weight gain guidelines based on their pre-pregnancy BMI. Maternity leave policies changed for the Navy and Marine Corps in 2015 (DoD, 2016). Therefore, the proposed study only included data up to December 31, 2014. The study included all pregnant women meeting the inclusion and exclusion criteria.

Variables

Marital Status

Marital status was defined as married, single, divorced, or widowed.

Gravida

Gravida denoted the number of times a woman has been pregnant, including any current pregnancy (Cunningham, 2005).

Parity

Parity signified how many pregnancies reach the gestational age such that the fetus is able to survive outside of the uterus (Moore & Persaud, 2003).

Delivery Type

Delivery type denoted the type of delivery women had (i.e., vaginal birth or cesarean delivery).

Mental Health Diagnosis

Mental health diagnosis was defined as any International Classification of Diseases-9 (ICD-9) code for a mental health diagnoses of depressive disorders (29383, 29620-29626, 29630-29636, 3004, 29682, 29690, 29699, & 311) anxiety disorders (29384, 30000, 30001, 30002, & 30009), posttraumatic stress disorder (PTSD) (30981), or adjustment disorder (3090, 3091, 30924, 30928, 30929, 3093, 3094, 30982, 30983, 30989, & 3099).

Military Service Branch

Military service branch was classified as Army, Navy, Air Force, and Marine Corps.

Active Duty

Active duty service referred to the status of being full-time employed in one of the military branches (i.e., Marine Corps, Army, Air Force, or Navy). National Guard, active duty reserve, and Coast Guard members were not examined in this study.

Military Rank

Military rank was defined as Senior Officers (Field Grade Officers O4-O6), Junior Officers (Company Grade Officers O1-O3), Senior Enlisted (i.e., non-commissioned officers E5-E9), Junior Enlisted (i.e., lowest four military ranks of any service branch E1-E4). Military rank was utilized as a proxy for socioeconomic status (SES). Enlisted, specifically, junior Enlisted personnel, were considered representative of individuals from lower SES (Schoenfeld, McCriskin, Hsiao, & Burks, 2011; Tarman et al., 2000).

Region of TRICARE service

The region of TRICARE service was defined as the region in which individuals received care. The regions were divided into the North, South, West, Alaska, and OCONUS.

Covariates

Covariates included age and race. Age was defined in the following groups: 18-24, 25-29, 30-34, and 35-40. Race was defined as White, Black, Asian, American Indian/Alaska Native, "Other," and Unknown based on their self-reported race listed in the MDR.

Anthropometric Measures

Bodyweight

Body weight was measured in pounds (lbs.) to the nearest pound. Weight was measured at baseline (i.e., as close to 40 weeks prior to delivery as available), third trimester, and at least one postpartum weight (i.e., 6 weeks postpartum, 5-11 months postpartum, or 12-18 months postpartum) with the closest weight to six months postpartum being chosen. Pregnancy weight gain and postpartum weight retention were measured as change in weight from baseline to third trimester and baseline to the six months postpartum. In order to find the pregnancy weight gain score, baseline weight was subtracted from third trimester weight. Postpartum weight retention will be measured by subtracting the baseline weight from six months postpartum weight. Weight change score was using the weight measurement at six months postpartum and subtracting the third trimester weight measurement.

Height

Height was measured in inches to the nearest inch at baseline (i.e., within 6 months prior to pregnancy), third trimester, six weeks postpartum, five to eleven months postpartum, and twelve to eighteen months postpartum.

Body Mass Index

Body mass index (BMI) is the weight of a person in kilogram divided by the square of the individual's height in meters (Centers for Disease Control and Prevention, 2016). It was calculated using the following formula. Weight in pounds was divided by height in inches squared. The number derived from that calculation was then be multiplied by 703 (i.e., weight (lb.) / [height (in)]^2 x 703 = BMI) to obtain the BMI (Centers for Disease Control, 2017). It was calculated at each of the following time points: baseline (i.e., within 12 months prior to pregnancy), third trimester, and at least one time postpartum (i.e., 6 weeks postpartum, 5-11 months postpartum, or 12-18 months postpartum). Individuals were placed in one of the following four categories based on their BMI: underweight (<18.5 kg/m^2), normal/healthy weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2), obese (≥ 30.0 kg/m^2) (Institute of Medicine, 2009).

Heart Rate

Resting heart rate was defined as the speed of the heartbeat and was measured via the number of contractions, or beats, of the heart per minute while the heart was at rest. For the present study, normal resting heart rate was 60-100 beats per minute (bpm). Bradycardia was defined as <60 bpm, and tachycardia was defined as >100 bpm (Spodick, Raju, Bishop, & Rifkin, 1992).

Blood Pressure

For the purposes of this study, blood pressure was defined as normal and hypertensive (includes both prehypertensive and hypertensive measurements) measured in millimeters per mercury (mm Hg). Normal blood pressure was defined as a systolic blood pressure of less than 120 mm Hg and a diastolic blood pressure less than 80 mm Hg. Prehypertension was defined as a

systolic blood pressure of 120-139 mm Hg or a diastolic blood pressure of 80-89 mm Hg. Hypertension was divided into three categories. In high blood pressure, Stage 1, individuals had a systolic blood pressure of 140-159 mm Hg or a diastolic blood pressure of 90-99 mm Hg. High blood pressure, Stage 2, was defined as a systolic blood pressure of 160-179 mm Hg or a diastolic blood pressure from 100-109 mm Hg. A hypertensive crisis was defined as a systolic blood pressure higher than 180 mm Hg or a diastolic blood pressure greater than 110 mm Hg. For the purpose of this study, individuals were considered hypertensive if they had a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure higher than 90 mm Hg (Resperate, 2013).

Preeclampsia

Preeclampsia is a complication of pregnancy that originates in the placenta after 20 weeks gestation. It is characterized by high blood pressure, a leakage of large amounts of the albumin protein into urine, and edema of the hands, feet, and face (Redman & Sargent, 2005). In the present study, the presence of preeclampsia was indicated as a diagnosis in the medical records utilizing ICD-9 code 64261.

Chapter 3: PROPOSED ANALYSES AND EXPECTED RESULTS

DATA ANALYTIC PLAN

Overview

All analyses were performed using SAS 9.4 and SPSS 22.0. Tests were two tailed. The alpha was set at .05 and the tables present the Bonferroni-adjusted p-levels.

If weight, the outcome variable, was not normally distributed, it was transformed to achieved normality and meet the assumptions of all tests performed. The mean weight gained during pregnancy and retained during postpartum was tabulated. Women were classified into

four BMI categories based on their pre-pregnancy weight: underweight, normal weight, overweight, and obese according to the World Health Organization's definition of BMI (World Health Organization, 2017). As part of the demographic results section, the total number of women in the proposed study and the percent of women failing to meeting IOM guidelines are reported for each hypothesis.

For all the study aims, analyses of weight at each time point were performed using linear regressions. Weight was examined as a continuous variable at each of the following time points: baseline (i.e., as close to 40 weeks prior to delivery as available), third trimester, six months postpartum. Analyses examined group differences in pregnancy weight gain, weight retention at 6 months postpartum, and weight changes after third trimester. The following time points were compared using linear regressions using Bonferroni correction for multiple comparisons: baseline differences between groups, baseline to third trimester, baseline to 6 months postpartum, third trimester to 6 months postpartum. The model assumed a random effect for participant, and time points were treated as a within subject's factor. The analyses included age and race as covariates. The between subjects' variables for each analysis were based on the specific study hypothesis being tested. Weight gain during pregnancy compared weights at baseline and during third trimester. Weight retention during postpartum involved comparing baseline weight to six months postpartum. To examine weight change from pregnancy to postpartum, third trimester weight was compared to weight at six months postpartum.

To further determine whether or not pregnancy weight gain exceeded guidelines for desirable values, after gestational weight gain was analyzed as a continuous variable, the weights were categorized into IOM pre-pregnancy BMI groups. For all aims, logistic regression was used to model the odds of meeting IOM gestational weight gain guidelines for each independent

variable found in the hypotheses. One model incorporated all the predictor variables except for a diagnosis of preeclampsia, which was run as a separate model due to the inclusion and exclusion criteria of the study aims. Women were placed in BMI categories according to their baseline weight as close to 40 weeks prior to their delivery date. A change score, calculated from subtracting baseline weight from third trimester weight, was used, to determine if the women met the IOM gestational weight gain guidelines according to their pre-pregnancy BMI. The women were then dichotomously classified in their pre-pregnancy BMI category as to yes, they met IOM gestational weight gain guidelines, or no, they did not meet guidelines.

Predictor variables were marital status, parity, pre-pregnancy body mass index (BMI), mental health diagnosis, military service branch, military rank, regions of TRICARE service, type of delivery, and development of preeclampsia. Dependent variables were body weight change in pregnancy, weight change from third trimester to six months postpartum, and postpartum weight retention (i.e., weight change from baseline to six months postpartum). Differences between conditions were reported using estimates (B), chi squares, odds ratios, and p values.

For the outcome of weight gain during pregnancy, a multiple linear regression model was used. For the outcome of weight gain during pregnancy according to the IOM guidelines, a multiple logistic regression was utilized. For the outcome of weight retention during postpartum, a multiple linear regression model was utilized. For the outcome of weight change from pregnancy (third trimester to six months postpartum), a multiple linear regression was used. All analyses controlled for age and race.

Due to the fact that not all women visit the doctor after they deliver, there was missing data for some women. In order to minimize the effect of missing data, only women with

baseline, third trimester, and at least one postpartum weight (e.g., 6 week, 6 month, 12 month postpartum weight) available were included in this study.

Power Analysis

A post hoc power analysis was calculated to determine the power using an estimated 58,097 total sample size, small effect size of 0.1, alpha of 0.05, and number of groups as 20 (i.e., 20 represents a 4 category variable across 5 time points equaling 20 groups). The critical F was 1.49, and power greater than 0.99. The proposed study utilized beneficiary medical claims from the MDR (the population, N), and this study did not be collecting data for a new sample.

CHAPTER 4: Results

SAMPLE CHARACTERISTICS

The sample for Aims 1-5a utilized consisted of 28,771 participants. Figure 4, the CONSORT diagram, below represents the number of individuals with matched delivery codes who were assessed for exclusion criteria, including exclusion diagnosis codes, a subsequent pregnancy within 18 months of the prior delivery, having a pre-pregnancy, third trimester, and at least one postpartum weight, and had all demographic information available. A total of 42,914 individuals matched the delivery codes and did not have an exclusion diagnosis code. Of those, 1,157 were excluded due to having a subsequent pregnancy within 18 months of the prior delivery. Of the remaining 41,757, another 11,853 were excluded due to not having a pre-pregnancy, 3rd trimester, and at least one postpartum weight. Of the remaining 29,904, 265 were excluded due to serving in the Coast Guard or “Other”, or missing rank or region. After removing 868 women with extreme outliers in weight measurements the final sample consisted of 28,771.

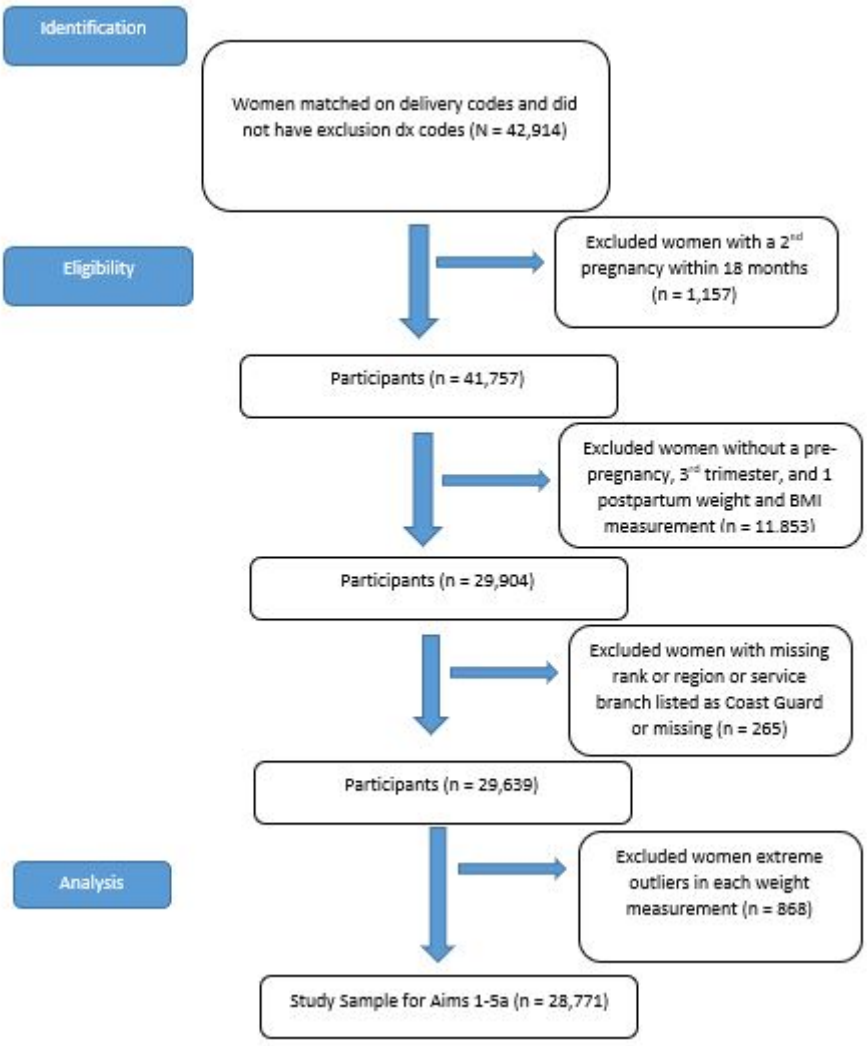

Figure 4. CONSORT Diagram of Study Sample for Aims 1-5a

The sample for Aim 5, Hypothesis 5b utilized a different population due to including women with preeclampsia. Preeclampsia was part of the exclusion criteria for Hypotheses 1-5a. The CONSORT diagram represented in Figure 5, indicates the number of women who matched on delivery and preeclampsia diagnosis codes and did not match on any exclusion diagnosis codes. Women were excluded if they had a subsequent pregnancy within 18 months of the prior delivery, did not have a pre-pregnancy, third trimester, and at least one postpartum weight, and if

they were missing any demographic information. A total of 2,935 individuals matched the delivery and preeclampsia codes and did not have an exclusion diagnosis code. Of those, 313 women were excluded due to having a subsequent pregnancy within 18 months of the prior delivery. Of the remaining 2,622, another 769 were excluded due to not having a pre-pregnancy, 3rd trimester, and at least one postpartum weight. A total of 18 women serving in the Coast Guard or "Other," or missing rank or region were excluded. Of the remaining 1,835 women, 43 were excluded due to extreme outliers in weight measurements. The final Aim 5, Hypothesis 5b sample consisted of 1,792 women.

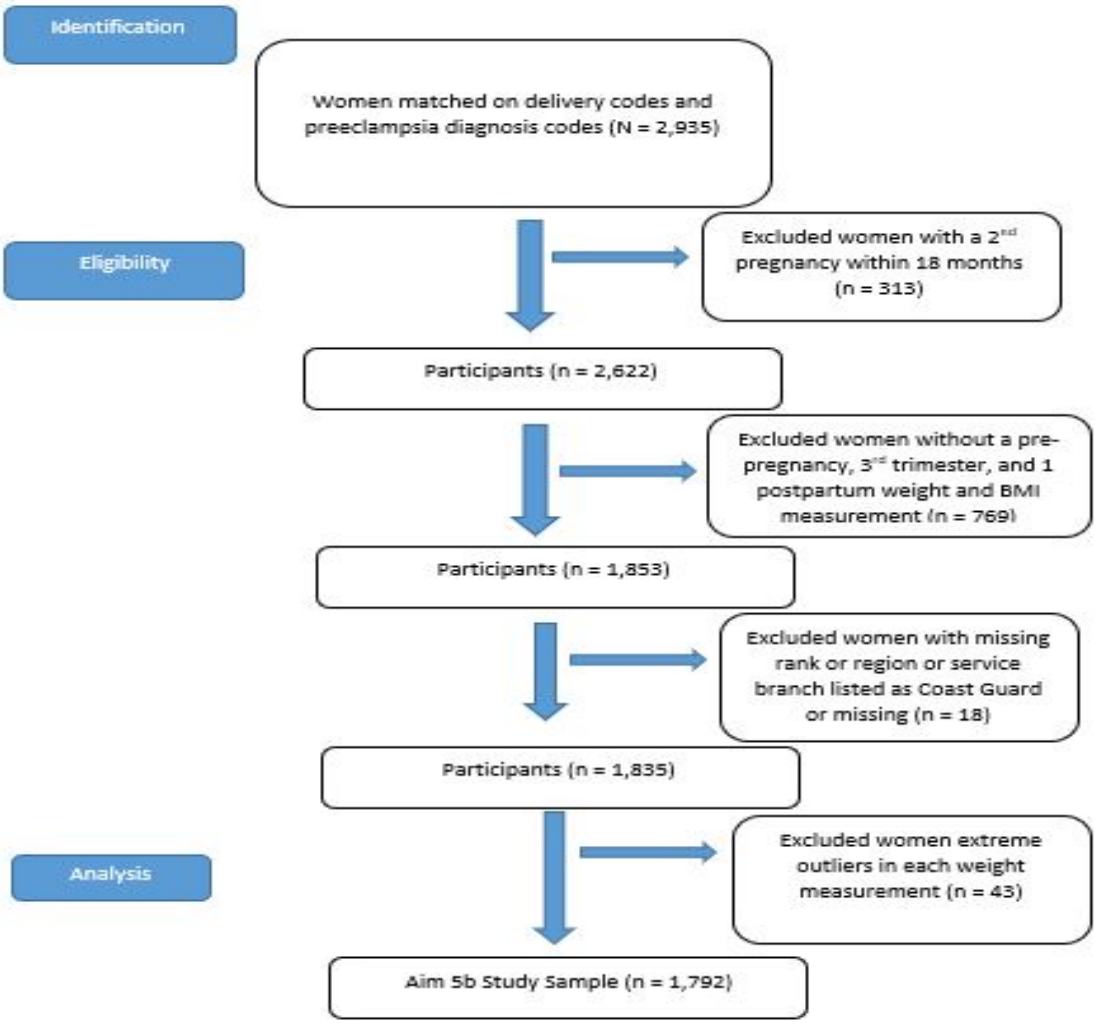

Figure 5. CONSORT Diagram of Study Sample for Aim 5b

All individuals in the sample for Aims 1-5a were females. Table 2 presents demographic characteristics of the sample. There were 15,226 (52.92%) Caucasians, 8,001 (27.81%) African Americans, 1,779 (6.18%) Asians, 606 (2.11%) Native American/Alaskan Natives, 2,901 (10.08%) individuals identifying as "Other," and 258 (0.9%) Unknown in the sample. The average age of individuals was 26.4 years with 54.10% of individuals being married, 37.95% single, 6.67% divorced, 0.07% widowed, and 1.22% of unknown marital status. Nearly half the individuals in the sample (45.94%) were in the Army, 26.69% were in the Navy, 18.52% in the Air Force, and 8.85% were in the Marine Corps. The majority of individuals were enlisted (86.86%) with 61.87% being junior enlisted and 24.99% being senior enlisted at the time of the sample. Junior officers accounted for 12.40% of the individuals in the sample, and 0.14% of the individuals were senior officers. The sample consisted of only 0.39% warrant officers and also consisted of 0.39% of individuals with "Other" rank. The sample demographics and key regional variables are presented in Table 2. Table 3 describes important health characteristics of the women. Of the total sample, 52.31% of women entered pregnancy with a normal, or healthy, baseline BMI. Conversely, 39.03% had a baseline BMI placing them in the overweight category, and 8.66% of individuals were classified as obese at baseline. In the sample, 81.25% had a normal resting heart rate, 14.99% had bradycardia (heart rate <60 beats per minute), and 3.76% had tachycardia (heart rate >100 beats per minute). Resting blood pressure numbers were reported as recorded in the women's charts. Based on their blood pressure measurements (i.e., systolic and diastolic readings), the same individuals can be represented in more than one diagnostic category (e.g., Prehypertensive and High, Stage 1). For this reason, all blood pressure diagnostic categories are reported in Table 3, and the ends may add up to more than the total

study sample. In the study sample, 57.28% of women had a normal, resting blood pressure, 36.20% were prehypertensive, 4.27% had high blood pressure (i.e., High, Stage 1; High, Stage 2; Crisis), and 5.11% were missing a resting blood pressure (See Table 3).

Table 2. Demographic Characteristics of Sample Used for Aims 1-5a[a]

Demographic Variables	
Variable	Number (Percent)
Gender	
Female	28,771 (100%)
Age (years)	Mean = 26.4 SD =4.92
18-24	12,211 (42.44%)
25-29	9,263 (32.20%)
30-34	5,013 (17.42%)
35-40	2,284 (7.94%)
Marital Status	
Married	15,564 (54.10%)
Single	10,919 (37.95%)
Divorced	1,918 (6.67%)
Widow	20 (0.07%)
Unknown	350 (1.22%)
Race	
White	15,226 (52.92%)
Black	8,001 (27.81%)
Asian	1,779 (6.18%)
Native American/Alaskan Native	606 (2.11%)
Other	2,901 (10.08%)
Unknown	258 (0.90%)
Branch of Service	
Army	13,216 (45.94%)
Navy	7,679 (26.69%)
Air Force	5,329 (18.52%)
Marine Corps	2,547 (8.85%)
Rank	
Junior Enlisted	17,802 (61.87%)
Senior Enlisted	7,191 (24.99%)
Warrant Officer	113 (0.39%)
Junior Officer	3,567 (12.40%)
Senior Officer	41 (0.14%)
Other	113 (0.39%)
Region of Residence	
North	9,268 (32.21%)
South	8,730 (30.34%)
West	8,899 (30.93%)
Alaska	532 (1.85%)
OCONUS	1,341 (4.66%)
Missing	1 (0.00%)

a. The sample utilized for Aims 1-5a found in this table are different from the sample used for Hypothesis 5b because they have different inclusion/exclusion criteria.

Table 3. Baseline Health Characteristics of Sample Aims 1-5a[a]

Health Variables	
Variable	Number (Percent)
BMI	
Normal/Healthy Weight	15,049 (52.31%)
Overweight	11,229 (39.03%)
Obese	2,493 (8.66%)
Resting Heart Rate	
Normal	23,377 (81.25%)
Bradycardic	4,313 (14.99%)
Tachycardic	1,081 (3.76%)
Resting Blood Pressure[b]	
Normal	16,479 (57.28%)
Prehypertensive	10,414 (36.20%)
High, Stage 1	1,123 (3.90%)
High, Stage 2	85 (0.30%)
Crisis	19 (0.07%)
Missing	1,469 (5.11%)

a. The sample utilized for Aims 1-5a found in this table are different from the sample used for Hypothesis 5b because they have different inclusion/exclusion criteria.
Note. BMI = Body Mass Index.
Resting systolic and diastolic numbers were reported separately. Individuals are considered hypertensive if they have a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure higher than 90 mm Hg. For this reason, both diagnostic categories are reported. Because of overlapping criteria for prehypertensive, High Stage 1, High Stage 2, and Crisis, individuals may be represented in more than one blood pressure category.

All individuals in the sample for Hypothesis 5b were females. Table 4 presents demographic characteristics of the sample from 5b. There were 867 (48.38%) Caucasians, 616 (34.38%) African Americans, 91 (5.08%) Asians, 40 (2.23%) Native American/Alaskan Natives, 161 (8.98%) individuals identifying as “Other,” and 17 (0.95%) Unknown in the sample. The average age of individuals was 26.3 years with 49.55% of individuals being married, 42.91% single, 6.58% divorced, 0.11% widowed, and 0.84% of unknown marital status. In the sample, 43.14% were in the Army, 29.80% were in the Navy, 19.92% in the Air Force, and 7.14% were

in the Marine Corps. The majority of individuals were enlisted (88.89%) with 62.72% being junior enlisted and 26.17% being senior enlisted at the time of the sample. Junior officers accounted for 10.60% of the individuals in the sample, and 0.11% of the individuals were senior officers. The sample consisted of only 0.28% warrant officers. The sample demographics and key regional variables are presented in Table 4. Table 5 describes important health characteristics of the women. Of the total sample, 41.91% of women entered pregnancy with a normal, or healthy, baseline BMI. Conversely, 45.03% had a baseline BMI placing them in the overweight category, and 13.06% of individuals were classified as obese at baseline. In the sample, 81.64% had a normal resting heart rate, 14.12% had bradycardia (heart rate <60 beats per minute), and 4.24% had tachycardia (heart rate >100 beats per minute). Resting blood pressure numbers were reported as recorded in the women's charts. Based on their blood pressure measurements (i.e., systolic and diastolic readings), the same individuals can be represented in more than one diagnostic category (e.g., Prehypertensive and High, Stage 1). For this reason, all blood pressure diagnostic categories are reported in Table 5, and the ends may add up to more than the total study sample. In the study sample, 39.29% of women had a normal, resting blood pressure, 51.17% were prehypertensive, 11.55% had high blood pressure (i.e., High, Stage 1; High, Stage 2; Crisis), and 5.80% were missing a resting blood pressure (See Table 5).

Table 4. Demographic Characteristics of Sample Used for Hypothesis 5b[a]

Demographic Variables	
Variable	Number (Percent)
Gender	
Female	1,792 (100%)
Age (years)	Mean = 26.3 SD =5.12
18-24	808 (45.09%)
25-29	530 (29.58%)
30-34	301 (16.80%)
35-40	153 (8.54%)
Marital Status	
Married	888 (49.55%)
Single	769 (42.91%)
Divorced	118 (6.58%)
Widow	2 (0.11%)
Unknown	15 (0.84%)
Race	
White	867 (48.38%)
Black	616 (34.38%)
Asian	91 (5.08%)
Native American/Alaskan Native	40 (2.23%)
Other	161 (8.98%)
Unknown	17 (0.95%)
Branch of Service	
Army	773 (43.14%)
Navy	534 (29.80%)
Air Force	357 (19.92%)
Marine Corps	128 (7.14%)
Rank	
Junior Enlisted	1,124 (62.72%)
Senior Enlisted	469 (26.17%)
Warrant Officer	5 (0.28%)
Junior Officer	190 (10.60%)
Senior Officer	2 (0.11%)
Region of Residence	
North	602 (33.59%)
South	546 (30.47%)
West	536 (29.91%)
Alaska	34 (1.90%)
OCONUS	74 (4.13%)

a. The sample utilized for Hypothesis 5b found in this table are different from the sample used for Aims 1-5a because they have different inclusion/exclusion criteria.

Table 5. Baseline Health Characteristics of Sample Hypothesis 5b[a]

Health Variables	
Variable	Number (Percent)
BMI	
Normal/Healthy Weight	751 (41.91%)
Overweight	807 (45.03%)
Obese	234 (13.06%)
Resting Heart Rate	
Normal	1,463 (81.64%)
Bradycardic	253 (14.12%)
Tachycardic	76 (4.24%)
Resting Blood Pressure[b]	
Normal	704 (39.29%)
Prehypertensive	917 (51.17%)
High, Stage 1	179 (9.99%)
High, Stage 2	23 (1.28%)
Crisis	5 (0.28%)
Missing	104 (5.80%)

a. The sample utilized for Hypothesis 5b found in this table are different from the sample used for Aims 1-5a because they have different inclusion/exclusion criteria.
Note. BMI = Body Mass Index.
Resting systolic and diastolic numbers were reported separately. Individuals are considered hypertensive if they have a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure higher than 90 mm Hg. For this reason, both diagnostic categories are reported. Because of overlapping criteria for prehypertensive, High Stage 1, High Stage 2, and Crisis, individuals may be represented in more than one blood pressure category.

BASELINE GROUP CHARACTERISTICS

The means and standard deviations of weight for all aims and hypotheses are presented in Tables 6 - 13 on pages 117 - 124. To assess the differences between groups at baseline in weight, a multiple linear regression model was utilized. Data presented in tables represent comparisons between groups in baseline weight. For this section and following sections, significant differences will be reported in the text, and detailed regression statistics can be found in

accompanying tables. Analyses of baseline differences in weight are presented in Table 14 on page 125.

Baseline Weight

Baseline weight (pounds) and BMI categories for the various groups are presented in Tables 6 - 13 on pages 117-124. The overall baseline regression model indicating differences in baseline weight was significant ($F(25, 28{,}744) = 1660.29$, $p < 0.0001$). The model explained 59.08% of the variance. In the model, a marital category of single, baseline body mass index (BMI), diagnosis of a mental health condition, service branch, delivery type, diagnosis of preeclampsia, race, and age were significant predictors of baseline differences in weight. For the parameter estimates and p-values, please see Table 14 on page 125.

Using ages 25-29 as a reference category as described in Table 14, results revealed women who were ages 30-34 and 35-40 weighed significantly more at baseline than women who were ages 25-29 (30-34 B = 1.92, $t(28744) = 7.24$, Bonferroni-adjusted $P < 0.0001$) or 35-40 (35-40 B = 2.58, $t(28744) = 7.17$, Bonferroni-adjusted $P < 0.0001$). Women who were 25-29 weighed significantly more than women age 18-24 (18-24 B = -1.83, $t(28744) = -8.57$, Bonferroni-adjusted $P < 0.0001$).

As indicated in Table 14, women who were African American weighed significantly more at baseline then women who were Caucasian (African American B = 0.74, $t(28744) = 3.52$, Bonferroni-adjusted $P = 0.004$). Women who were Caucasian weighed significantly more at baseline when compared to women who were Asian, “Other,” or Unknown (Asian B = -6.75, $t(28744) = -18.14$, Bonferroni-adjusted $P < 0.0001$), (Other B = -3.05, $t(28744) = -10.15$, Bonferroni-adjusted $P < 0.0001$), and (Unknown B = -2.77, $t(28744) = -2.96$, Bonferroni-adjusted $P = 0.003$), respectively.

Specifically, results indicated that there are significant differences in baseline weight between women who are married versus single. Single women weighed significantly more than married women (Single B = 0.67, t(28744) = 3.39, Bonferroni-adjusted P = 0.0007). Women who were overweight and obese weighed significantly more than women or normal/healthy weight (Overweight B = 26.18, t(28744) = 139.84, Bonferroni-adjusted P < 0.0001) and (Obese B = 54.10, t(28744) = 166.23, Bonferroni-adjusted P < 0.0001).

Women with a mental health diagnosis had a significantly higher baseline weight compared to those with no mental health diagnosis (No Mental Health Diagnosis B = -0.98, t(28744) = -2.57, Bonferroni-adjusted P = 0.01). Although baseline weight differences between military service branches were small in magnitude, they were significant. Using the Marine Corps as a reference group, women serving in the Army, Navy, and Air Force weighed significantly more than women in the Marine Corps (Army B = 1.48, t(28744) = 4.47, Bonferroni-adjusted P = 0.0001), (Air Force B = 1.79, t(28744) = 4.83, Bonferroni-adjusted P < 0.0001), and (Navy B = 2.11, t(28744) = 6.05, Bonferroni-adjusted P < 0.0001). Women who had a vaginal delivery weighed significantly more at baseline than women who had a cesarean delivery (Vaginal Delivery B = 2.07, t(28744) = 10.54, Bonferroni-adjusted P < 0.0001).

Baseline and Postpartum BMI Categories

The number of women in each BMI category at baseline and postpartum for the Hypotheses 1-5a sample are found in Table 9 on page 120. At baseline, 15,049 women were at a normal/healthy BMI, 11,229 were at an overweight BMI, and 2,493 were at an obese BMI. No women in the sample were included if they were underweight at baseline. However, 130 (0.86%) women that were in the normal baseline BMI moved to an underweight BMI. Of women who were at a normal/healthy baseline BMI, 9,038 (60.06%) remained at a normal/healthy BMI, 393

(2.6%) moved to the overweight BMI category, and 5,488 (36.47%) of women moved to an obese BMI at postpartum. When women started in the overweight baseline BMI category, 789 (7.03%) moved to a normal BMI, 6740 (60.02%) remained in the overweight BMI category, and 3,700 (32.95%) moved to an obese BMI at postpartum. In women with an obese baseline BMI, 7 (0.28%) moved to a normal/healthy BMI, 365 (14.64%) moved to an overweight BMI, and 2121 (85.08%) remained in the obese BMI category postpartum.

The number of women in each BMI category at baseline and postpartum for the Hypothesis 5b sample is found in Table 13 on page 124. At baseline, 751 women were at a normal/healthy BMI, 807 were at an overweight BMI, and 234 were at an obese BMI. No women were included in the sample if they were underweight at baseline. Of women starting at a normal/healthy baseline BMI, 5 (0.67%) moved to an underweight BMI, 403 (53.66%) remained at a normal/healthy BMI, 303 (40.35%) moved to an overweight BMI, and 40 (5.33%) moved to an obese BMI at postpartum. When women started at an overweight baseline BMI, 42 (5.20%) moved to a normal/healthy BMI, 436 (58.06%) remained in an overweight BMI, and 329 (40.77%) moved to an obese BMI at postpartum. Of women who were in the obese baseline BMI category, 32 (13.68%) moved to an overweight BMI and 202 (86.32%) remained in an obese BMI category at postpartum.

WEIGHT GAIN, WEIGHT RETENTION, WEIGHT CHANGE, AND IOM WEIGHT GAIN MODELS

The means and standard deviations of weight gain during pregnancy, weight retention during postpartum, and weight change from third trimester to six months postpartum for the variable groups are presented in Tables 6 - 17 on pages 117-128. The overall linear regression model predicting weight gain was statistically significant ($F(25, 28{,}744) = 35.57$, $P < 0.0001$). The model explained 3.00% of the variance. In the model, age, race, marital status, baseline body

mass index (BMI), service branch, rank, region, and delivery type were each significant predictors of differences in weight gain during pregnancy. For the parameter estimates and p-values, please see Table 15 on page 126. All hypotheses will be discussed in their respective aims starting on page 106.

The overall regression model predicting weight retention during postpartum was significant, $F(25, 28744) = 13.91$, $P < 0.0001$. The model explained 1.20% of the variance. In the model, age, marital status, parity, baseline BMI, service branch, rank, and delivery type were each significant predictors of differences in weight retention during postpartum. For the parameter estimates and p-values, please see Table 16 on page 127. All hypotheses concerning weight retention will be discussed in their respective aims starting on page 106.

The overall linear regression model predicting weight change from third trimester to six months postpartum was statistically significant ($F(25, 28744) = 35.09$, $P < 0.0001$). The model explained 2.96% of the variance. In the model, age, race, marital status, parity, baseline body mass index (BMI), mental health, service branch, rank, region, and delivery type were significant predictors of differences in weight change from third trimester to six months postpartum. For the parameter estimates and p-values, please see Table 17 on page 128.

The overall logistic regression model predicting pregnancy weight gain according to the 2009 IOM weight gain guidelines during pregnancy was statistically significant (X^2 (25) = 921.12, $p < 0.0001$.In the model, the following predictor variables including marital status, baseline BMI, service branch, rank, and type of delivery and covariates of age and race were significant predictors of meeting IOM pregnancy weight gain guidelines. In a separate logistic regression model, a diagnosis of preeclampsia was also a significant predictor of the ability to meet IOM weight gain guidelines during pregnancy (X^2 (9) = 38.67, $p < 0.0001$).

Effects of Age and Race Covariates on Study Variables

Results in Tables 15– 17 on pages 126 - 128 present analyses of weight gain, weight retention, and weight change, respectively, as a function of age and race. Results indicated there were significant differences in weight gain during pregnancy and retention during postpartum in women of different age group categories ($F(3, 28744) = 18.62$, $P < 0.0001$) and ($F(3, 28744) = 14.49$, $P < 0.0001$), respectively. Specifically, women who were 25-29 gained significantly more weight than women who were 18-24 (18-24 B = -1.25, $t(28744) = -5.55$, Bonferroni-adjusted $P < 0.0001$) or 35-40 (35-40 B = -1.26, $t(28744) = -3.32$, Bonferroni-adjusted $P = 0.001$).

Women, ages18-24, retained less weight during postpartum than women ages 25-29 (18-24 B = -0.93, $t(28744) = -4.55$, Bonferroni-adjusted $P < 0.0001$), and women ages 30-34 retained more weight than women ages 25-29 (30-34 B = 0.72, $t(28744) = 2.86$, Bonferroni-adjusted $P = 0.004$. There was a significant difference between weight change in third trimester and six months postpartum in women in distinct age groups. Women in the 35-40 age group lost significantly less weight compared to women ages 25-29 (35-40 B = 1.26, $t(28744) = 4.28$, Bonferroni-adjusted $P < 0.0001$). Results of the logistic regression presented in Table 18 on pages 126 revealed that women who were 35-40 were more likely to meet IOM guidelines compared to women ages 25-29 (X^2 (1) = 10.16, $P = 0.0035$) after adjusting for race, marital status, parity, body mass index, mental health diagnosis, service branch, rank, region of TRICARE service, and type of delivery.

Results indicate there are significant differences in weight gain during pregnancy in women of different races ($F(5, 28744) = 59.83$, $P < 0.0001$). Women who identified as Caucasian gained significantly more weight than women identifying as Asian, African American, “Other,” or Unknown descent (Asian B = -1.64, $t(28744) = -4.20$, Bonferroni-adjusted $P < 0.0001$, African American B = -3.82, $t(28744) = -17.22$, Bonferroni-adjusted $P < 0.0001$, “Other” B = -

1.02, t(28744) = -3.21, Bonferroni-adjusted P = 0.001, and Unknown B = -1.90, t(28744) = -1.93, Bonferroni-adjusted P = 0.05, respectively). There were no significant differences in weight retention during postpartum among women of diverse races.

Results indicated there were significant differences in weight changes from third trimester to six months postpartum in women of diverse races (F(5, 28744) = 86.71, P <0.0001). Caucasian women lost significantly more weight than Asian (Asian B = 1.16, t(28744) = 3.81, Bonferroni-adjusted P = 0.0001), African American (African American B = 3.58, t(28744) = 20.8, Bonferroni-adjusted P < 0.0001), American Indian/Alaska Native B = 1.5, t(28744) = 2.98, Bonferroni-adjusted P = 0.003, women of "Other" (Other B = 1.23, t(28744) = 5.00, Bonferroni-adjusted P < 0.0001), or women of Unknown (Unknown B = 1.48, t(28744) = 1.94, Bonferroni-adjusted P = 0.05) descent. Results of the logistic regression presented in Table 18 on pages 126 revealed that Asian and African American women were more likely to meet IOM guidelines compared to Caucasian women (X^2 (1) = 1.68, P = 0.0165 and X^2 (1) = 3.10, P < 0.0001, respectively) after adjusting for age, marital status, parity, body mass index, mental health diagnosis, service branch, rank, region of TRICARE service, and type of delivery.

AIM 1

For Aim 1 as well as for all aims and hypotheses, linear and logistic regressions were utilized. For the outcomes of weight change during pregnancy, weight retention during postpartum, and weight change from third trimester to six months postpartum, multiple linear regressions were used. For the outcome of weight gain during pregnancy according to the IOM guidelines, a multiple logistic regression was utilized. All analyses controlled for age and race.

Hypothesis 1a

Results for hypothesis 1a are presented in Tables 15 - 20 on pages 126 - 131. Hypothesis 1a proposed that there would be differences between married women and the other marital categories in weight change during pregnancy and weight retention during postpartum. For this hypothesis, women who were married were expected to gain more weight during pregnancy and retain more weight during postpartum when compared to women who were single, divorced, or widowed. All analyses controlled for age and race.

Results did not support the hypothesis that married women would gain the most weight during pregnancy and retain the most weight during postpartum. However, it did indicate marital status significantly impacted weight gain change during pregnancy $F(4, 28744) = 5.62$, $P = 0.0002$). Women who were married gained significantly less weight compared to women who were single (Single $B = 0.63$, $t(28744) = 2.92$, Bonferroni-adjusted $P = 0.04$). Women who were single retained more weight during postpartum compared to women who were married (Single $B = 0.54$, $t(28744) = 2.89$, Bonferroni-adjusted $P = 0.004$). Marital status did not significantly impact weight change from the third trimester of pregnancy to six months postpartum. Regarding the Institute of Medicine (IOM) guidelines, there were no significant differences between married women and all other marital categories in whether women met IOM guidelines for weight gain during pregnancy after adjusting for age, race, parity, body mass index, mental health diagnosis, service branch, rank, region of TRICARE service, and type of delivery.

Hypothesis 1b

Hypothesis 1b examined whether parity would predict weight change during pregnancy and weight retention during postpartum. Hypothesis 1b proposed that women who have at least one child will gain less weight during pregnancy and retain less weight during postpartum

compared to women in their first pregnancy. All analyses controlled for age and race. Results for hypothesis 1b are presented in Tables 15 - 20 on pages 126 - 131.

Results indicated that parity was not a significant factor associated with weight gain during pregnancy. However, parity did impact weight retention during postpartum $F(1, 28744) = 9.30$, $P = 0.002$). Women who had at least one child retained significantly more weight during postpartum than women in their first pregnancy (Parity 1+ child $B = 1.32$, $t(28744) = 3.05$, Bonferroni-adjusted $P= 0.002$). Results indicated that women in their first pregnancy lost significantly more weight from third trimester to six months postpartum compared to women with at least one child (Parity 1+ child $B = 0.91$, $t(28744) = 2.48$, Bonferroni-adjusted $P = 0.01$). Parity was not a significant factor as to whether women met IOM guidelines for weight gain during pregnancy after adjusting for age, race, marital status, body mass index, mental health diagnosis, service branch, rank, region of TRICARE service, and type of delivery.

Hypothesis 1c

Hypothesis 1c proposed that baseline Body Mass Index (BMI) would predict weight change during pregnancy and weight retention during postpartum. Hypothesis 1c proposed that women with a normal, or healthy, BMI would gain less weight during pregnancy and retain less weight during postpartum compared to those who had a baseline BMI that was overweight or obese. All analyses controlled for age and race. Results for hypothesis 1c are presented in Tables 15 - 20 on pages 126 - 131.

The results indicated a significant difference between weight gain in pregnancy in women who were in the obese BMI category at baseline compared to women in normal/healthy baseline BMI and women in overweight baseline BMI categories $F(2, 28744) = 136.04$, $P <0.0001$). However, the direction of these results was contrary to what was hypothesized. Surprisingly,

women in the obese baseline BMI category gained significantly less weight than women in the normal/healthy weight BMI category when controlling for age and race as covariates (Obese B = -5.25, t(28744) = -15.35, Bonferroni-adjusted P < 0.0001). Results also indicated there is a significant difference in weight retention during postpartum among women in different baseline BMI categories F(2, 28744) = 74.82, P <0.0001). As predicted, women in the overweight baseline BMI categories retained significantly more weight than women in the normal/health weight BMI category (Overweight B = 0.48, t(28744) = 2.67, Bonferroni-adjusted P = 0.008). Again, contrary to what was expected, women in the obese baseline BMI category retained significantly less weight than women in the normal/health weight BMI category (Obese B = -3.33, t(28744) = -10.74, Bonferroni-adjusted P < 0.0001). The results indicated that there was a significant difference in weight change from third trimester to six months postpartum in women of different baseline BMI categories F(2, 28744) = 26.73, P <0.0001), and women in the obese baseline BMI category lost significantly less weight compared to women in the normal/healthy weight baseline BMI category (Obese B = 1.92, t(28744) = 7.25 , Bonferroni-adjusted P < 0.0001). In addition, with regard to IOM guidelines for weight gain during pregnancy, women whose baseline BMI categories were overweight or obese were significantly less likely to meet IOM pregnancy weight gain guidelines Overweight (X^2 (1) = 123.06, P < 0.0001) and Obese (X^2 (1) = 46.49, P < .0001), respectively) when adjusting for age, race, marital status, parity, mental health diagnosis, service branch, rank, region of TRICARE service, and type of delivery.

AIM 2

Hypothesis 2

Hypothesis 2 proposed women who had a mental health diagnosis would gain more weight during pregnancy and retain more weight during postpartum when compared to women

who do not have a mental health diagnosis. All analyses controlled for age and race. Results for hypothesis 2 are presented in Tables 15 - 20 on pages 126 - 131.

Results indicated there was no significant effect of presence of mental health diagnosis on weight gain during pregnancy or weight retention during postpartum. There also was not a significant difference in weight change from pregnancy in the third trimester to six months postpartum in women with mental health conditions versus women without mental health conditions. Mental health was not a significant factor as to whether women met IOM guidelines for weight gain during pregnancy after adjusting for age, race, marital status, parity, body mass index, service branch, rank, region of TRICARE service, and type of delivery.

AIM 3

Hypothesis 3a

Hypothesis 3a proposed that service branch would predict weight gain during pregnancy and weight retention during postpartum. This hypothesis stated that active duty women in the Marine Corps would gain less weight during pregnancy and retain less weight during postpartum compared to Army, Air Force, or Navy women. All analyses controlled for age and race. Results for hypothesis 3a are presented in Tables 15 - 20 on pages 126 - 131.

A multiple linear regression was calculated to predict weight gain during pregnancy base on women's service branch. Overall, branch of service was significantly associated with weight gain after adjusting for the other variables in the model ($F(3,28744) = 15.72$, $P < 0.0001$), but these differences were not as predicted. Compared with the Marine Corps, women in the Navy gained 1.89 fewer pounds (Navy $B = -1.89$, $t(28744) = -5.17$, Bonferroni-adjusted $P < 0.0001$), women in the Army gained 0.73 fewer pounds (Army $B = -0.73$, $t(28744) = -2.09$, Bonferroni-

adjusted P = 0.04), and women in the Air Force gained 1.78 fewer pounds (Air Force B = -1.78, t(28744) = -4.57, Bonferroni- adjusted P < 0.0001).

There were also significant differences in weight retention among the military service branches (F(3,28744) = 17.06, P < 0.0001). Again, these differences were not as expected. Women in the Air Force retained less weight than women in the Marine Corps (Air Force B = -1.33, t(28744) = -3.78, Bonferroni-adjusted P = 0.0002). Results indicated that there were also significant differences in weight change from third trimester to six months postpartum among women serving in different branches of the military (F(3,28744) = 32.15, P < 0.0001). Women in the Army and Navy lost significantly less weight than women in the Marine Corps (Army B = 0.94, (t(28744) = 3.49, Bonferroni-adjusted P = 0.0005) and (Navy B = 2.22, (t(28744) = 7.85, Bonferroni-adjusted P < 0.0001). Analyses using the IOM guidelines again yielded unexpected results. Women in the Air Force and Navy were significantly more likely to meet IOM pregnancy weight gain guidelines compared to women in the Marine Corps when adjusting for all other variables (i.e., age, race, marital status, parity, body mass index, mental health diagnosis, rank, region of TRICARE service, and type of delivery) in the model: Air Force (X^2 (1) = 4.89, P = 0.027) and Navy (X^2 (1) = 9.36, P = 0.0022).

Hypothesis 3b

Hypothesis 3b proposed active duty enlisted women would gain more weight during pregnancy and retain more weight during postpartum compared to active duty officers. Again, all analyses controlled for age and race. Results for hypothesis 3b are presented in Tables 15 - 20 on pages 126 - 131.

Results of the linear regression indicated that rank was significantly associated with weight gain and weight retention after adjusting for other variables in the model (F(1,28744) =

47.70, P <0.0001) and (F(1,28744) = 97.49, P < 0.0001). Enlisted women did gain significantly more weight during pregnancy than officers and retain more weight during postpartum. Compared with enlisted members, officers gained 2.10 fewer pounds (Officer B = -2.10, t(28744) = -6.91, Bonferroni-adjusted P < 0.0001) and retained 2.72 less pounds (Officer B = -2.72, t(28744) = -9.87, Bonferroni-adjusted P <0.0001).

Regarding weight changes from third trimester to six months postpartum, enlisted women lost significantly less weight than officers (F(1,28744) = 6.91, P = 0.0086) and (Officer B = -0.62, t(28744) = -2.63, Bonferroni-adjusted P = 0.009). Regarding IOM guidelines, logistic regression indicated that officers were significantly more likely to meet IOM weight gain guidelines compared to enlisted women after adjusting for all other variables (i.e., age, race, marital status, parity, body mass index, mental health diagnosis, service branch, region of TRICARE service, and type of delivery. in the model) Officer (X^2 (1) = 14.45, P = 0.0001).

AIM 4

Hypothesis 4

Hypothesis 4a proposed that women living in and treated in the TRICARE south region will gain more weight during pregnancy and retain more weight during postpartum than women in the other TRICARE regions. All analyses controlled for age and race. Results for hypothesis 4 are presented in Tables 15 - 20 on pages 126 - 131.

Results of the linear regression indicated that region of TRICARE service was significantly associated with weight gain after adjusting for other variables in the model (F(4,28744) = 3.20, P = 0.0123). Women living in the Alaska TRICARE region gained more weight during pregnancy compared to women living in the TRICARE south region (Alaska B = 2.08, t(28744) = 2.99, Bonferroni-adjusted P = 0.003). There were no significant differences in

weight retention among women living in different TRICARE service regions. Results indicated that there were also significant differences in weight change from third trimester to six months postpartum among women living in different TRICARE service regions. Women living in the Alaska TRICARE service region lost more weight compared to women living in the south TRICARE service region (Alaska B = -1.49, t(28744) = -2.76, Bonferroni-adjusted P = 0.006). Region of TRICARE service was not a significant factor as to whether women met IOM guidelines for weight gain during pregnancy after adjusting for age, race, marital status, parity, body mass index, mental health diagnosis, service branch, rank, and type of delivery.

AIM 5

Hypothesis 5a

Hypothesis 5a proposed women who have cesarean deliveries would gain more weight during pregnancy and retain more weight during postpartum than women who have a vaginal delivery. All analyses controlled for age and race. Results for hypothesis 5a are presented in Tables 15 - 20 on pages 126 - 131.

Results revealed that, as hypothesized, women who had a cesarean delivery did gain more significantly more weight during pregnancy (F(1,28744) = 192.97, P <0.0001) and retained more weight at six months postpartum (F(1,28744) = 20.79, P <0.0001) compared to those who have a vaginal delivery. Women who had a vaginal delivery gained 2.87 fewer pounds than those with a cesarean delivery (Vaginal Delivery B = -2.87, t(28744) = -13.89, Bonferroni-adjusted P < 0.0001) and retained 0.85 fewer pounds (Vaginal Delivery B = -0.85, t(28744) = -4.56, Bonferroni-adjusted P < 0.0001). Women who had a cesarean delivery lost significantly more weight from third trimester to six months postpartum than women who had a vaginal delivery (F(1,28744) = 158.55, P <0.0001) and (Vaginal Delivery B = 2.02, t(28744) = 12.59, Bonferroni-

adjusted P < 0.0001). Regarding IOM weight gain guidelines, type of delivery was also a significant factor in weight gain during pregnancy. Specifically, women who had a vaginal delivery were more likely to meet IOM weight gain guidelines than women who had a cesarean delivery, Vaginal delivery (X^2 (1) = 42.63, P < 0.0001) after adjusting for race, marital status, parity, body mass index, mental health diagnosis, service branch, rank, and region of TRICARE service.

Hypothesis 5b

Hypothesis 5b proposed that the presence of a preeclampsia diagnosis would predict weight change during pregnancy and weight retention during postpartum. This hypothesis proposed that women who had preeclampsia would gain more weight during pregnancy and retain more weight during postpartum when compared to women who do not have preeclampsia. Due to the exclusion criteria, Hypothesis 5b utilized a different sample for analyses of preeclampsia than the sample used in Hypotheses 1-5a. All analyses controlled for age and race. Results indicating the number of women meeting IOM guidelines for Hypothesis 5b are displayed in Table 19 on page 130.

Results of preeclampsia analyses indicated that women with a preeclampsia diagnosis gained significantly more weight during pregnancy F(9, 30553) = 53.05, P <0.0001) and lost significantly more weight from third trimester in pregnancy to six months postpartum than women without preeclampsia F(9, 30553) = 64.45, P <0.0001). The linear regression model for weight gain accounted for 1.54% of the variance. The linear regression model for weight change accounted for 1.86% of the variance. Women who were not diagnosed with preeclampsia gained 4.68 fewer pounds during pregnancy compared to women diagnosed with preeclampsia (No Preeclampsia Diagnosis B = -4.68, t(30553) = -12.20, Bonferroni-adjusted P < 0.0001). Women

with preeclampsia lost 2.13 more pounds than women without preeclampsia from third trimester to six months postpartum (No Preeclampsia Diagnosis B = 2.13, t(30553) = 7.18, Bonferroni-adjusted P < 0.0001). Despite these results, women with preeclampsia still retained more weight during postpartum F(9, 30553) = 8.27, P <0.0001) compared to those without preeclampsia. Women without preeclampsia retained 2.55 fewer pounds compared to women diagnosed with preeclampsia (No Preeclampsia Diagnosis B = -2.55, t(30553) = -7.38, Bonferroni-adjusted P < 0.0001). Regarding the IOM weight gain guidelines during pregnancy, women with preeclampsia were significantly less likely to meet the IOM weight gain guidelines during pregnancy when adjusting for age (X^2 (3) = 7.05, P = 0.07) and race (X^2 (5) = 5.01, P = 0.41) in the model (Preeclampsia (X^2 (1) = 26.59, P < 0.0001).

RESULTS TABLES

Table 6. Summary of Means and Standard Deviations of Weight Gain for Aims 1-5a

	N	Mean	Median	Min	Max	Std Dev
Baseline Weight	28771	148.6	146	91	258	23.0
Pregnancy Weight Gain	28771	36.4	36	-24	96	15.7
Postpartum Weight Retention	28771	10.7	10	-44	64	14.1
Weight Change at 6 Months Postpartum	28771	-25.8	-25	-70	20	12.2

Table 7. Summary of Means and Standard Deviations of Baseline Weight, Weight Gain, Weight Retention, and Weight Change for Age and Race Covariates for Aims 1-5a

	N	Baseline Weight		Pregnancy Weight Gain		Postpartum Weight Retention		Weight Change at 6 Months Postpartum	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std
Age Group									
18-24	12210	145.11	22.04	36.18	16.26	10.54	14.90	-25.64	12.49
25-29	9263	149.46	23.02	36.87	15.51	10.87	13.76	-26.00	12.11
30-34	5013	152.54	23.56	36.85	15.12	10.99	13.33	-25.86	11.85
35-40	2284	154.81	23.92	34.98	14.80	9.88	12.78	-25.10	11.52
Race									
White	15225	147.84	22.40	37.64	15.64	10.59	14.12	-27.05	11.95
Asian	1779	141.16	23.21	36.20	15.10	10.40	13.36	-25.81	11.55
Black	8001	152.71	23.76	34.10	15.75	10.75	14.18	-23.35	12.57
American Indian/ Alaskan Native	606	150.68	22.34	36.65	16.50	11.79	14.83	-24.86	12.07
Other	2901	145.24	22.18	36.60	15.72	10.87	14.31	-25.73	11.77
Unknown	258	147.10	22.16	35.48	14.07	9.60	12.40	-25.88	11.65

Table 8. Summary of Means and Standard Deviations of Baseline Weight, Weight Gain, Weight Retention, and Weight Change for each Variable Category for Aims 1-5a

		Baseline Weight		Pregnancy Weight Gain		Postpartum Weight Retention		Weight Change at 6 Months Postpartum	
	N	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Marital Status									
Divorced	1918	150.50	23.06	36.80	15.58	10.87	13.90	-25.93	12.09
Married	15564	149.02	23.29	36.21	15.44	10.42	13.81	-25.79	12.06
Single	10918	147.80	22.64	36.60	16.17	10.98	14.58	-25.63	12.41
Widowed	20	156.80	26.20	34.60	15.40	11.45	16.38	-23.15	14.42
Unknown	350	142.10	19.92	38.29	14.69	11.18	13.27	-27.11	10.81
Parity									
First Pregnancy	27660	148.46	22.96	36.43	15.75	10.63	14.13	-25.79	12.19
1+ Pregnancies	1110	151.43	24.31	36.31	15.01	11.57	13.68	-24.74	11.98
Baseline BMI									
Normal	15048	133.49	14.39	36.74	14.33	10.60	12.55	-26.14	11.34
Obese	2493	188.17	17.52	31.46	17.75	7.81	16.96	-23.65	13.81
Overweight	11229	160.00	15.12	37.10	16.80	11.39	15.27	-25.70	12.83
Mental Health History									
None	27179	148.40	22.90	36.44	15.68	10.66	14.04	-25.78	12.17
Yes	1591	151.62	24.81	36.07	16.36	10.81	15.25	-25.26	12.49
Service									
Army	13216	148.59	22.74	36.62	15.89	10.89	14.31	-25.73	12.32
Air Force	5329	148.47	23.04	36.18	14.77	9.42	12.89	-26.76	11.49
Marines	2547	140.09	19.14	38.18	16.19	10.81	14.40	-27.37	12.19
Navy	7678	151.44	23.95	35.67	15.87	11.11	14.43	-24.55	12.30
Rank									
Officer	3778	146.96	21.74	35.50	13.34	8.78	11.61	-26.71	10.74
Enlisted	24992	148.82	23.20	36.56	16.05	10.96	14.43	-25.61	12.38
Region									
Alaska	532	147.58	23.52	38.79	15.00	10.88	13.38	-27.92	11.63
North	9268	149.37	23.57	36.04	15.70	10.77	14.13	-25.27	12.20
OCONUS	1341	150.43	23.63	36.46	15.91	10.48	13.96	-25.99	11.76
South	8730	148.26	22.69	36.44	15.73	10.68	14.14	-25.76	12.32
West	8899	147.83	22.59	36.66	15.74	10.57	14.13	-26.09	12.10
Delivery Type									
Vaginal	20785	147.77	22.75	35.76	15.47	10.45	14.03	-25.31	12.05
Cesarean	7985	150.68	23.57	38.15	16.23	11.24	14.30	-26.91	12.47

Table 9. Summary of Baseline and Postpartum BMI Categories for Aims 1-5a

Study Population for Hypotheses 1-5a n=28,771					
		Postpartum BMI			
Baseline BMI Total		Underweight	Normal	Overweight	Obese
Normal	15049	130	9038	393	5488
Overweight	11229	0	789	6740	3700
Obese	2493	0	7	365	2121

Table 10. Summary of Means and Standard Deviations of Weight Gain for Hypothesis 5b

	N	Mean	Median	Min	Max	Std Dev
Baseline Weight	1792	153.1	150	92	245	24.2
Pregnancy Weight Gain	1792	40.9	40	-13	103	17.5
Postpartum Weight Retention	1792	13.2	12	-40	70	15.5
Weight Change at 6 Months Postpartum	1792	-27.6	-27	-75	23	13.5

Table 11. Summary of Means and Standard Deviations of Baseline Weight, Weight Gain, Weight Retention, and Weight Change for Age and Race Covariates for Hypothesis 5b

	N	Baseline Weight		Pregnancy Weight Gain		Postpartum Weight Retention		Weight Change at 6 Months Postpartum	
		Mean	Std	Mean	Std	Mean	Std	Mean	Std
Age Group									
18-24	808	149.05	23.50	42.06	17.96	14.29	16.65	-27.77	14.18
25-29	530	153.32	22.81	40.19	16.93	12.51	14.34	-27.69	12.68
30-34	301	158.53	24.87	39.58	16.36	11.87	14.54	-27.71	12.77
35-40	153	163.59	26.61	39.33	18.69	12.58	14.52	-26.75	13.98
Race									
White	867	152.68	22.58	43.07	16.68	13.71	15.34	-29.36	13.06
Asian	91	143.61	26.63	42.59	17.88	13.9	15.38	-28.68	12.53
Black	616	156.58	26.10	37.03	17.23	11.72	15.01	-25.31	13.46
American Indian/Alaskan Native	40	154.55	20.84	47.60	22.53	18.90	20.43	-28.70	17.15
Other	161	147.78	22.63	41.48	19.12	15.18	17.16	-26.30	14.01
Unknown	17	154.41	25.84	39.00	15.48	9.41	13.02	-29.59	14.95

Table 12. Summary of Means and Standard Deviations of Baseline Weight, Weight Gain, Weight Retention, and Weight Change for each Variable Category for Hypothesis 5b

		Baseline Weight		Pregnancy Weight Gain		Postpartum Weight Retention		Weight Change at 6 Months Postpartum	
	N	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Marital Status									
Divorced	118	158.19	24.04	43.19	18.31	14.46	16.89	-28.74	14.00
Married	888	154.02	25.24	40.14	17.39	12.18	15.33	-27.96	12.89
Single	769	151.31	23.00	41.34	17.51	14.26	15.49	-27.09	14.08
Widowed	2	157.00	2.83	25.50	21.92	-3.00	11.31	-28.50	10.61
Unknown	15	155.33	23.56	42.53	12.58	12.87	8.91	-29.67	14.09
Baseline BMI									
Normal	751	133.90	14.49	41.45	16.22	13.00	14.12	-28.45	12.41
Obese	234	188.49	19.45	36.15	18.05	9.58	17.59	-26.57	15.28
Overweight	807	160.81	15.33	41.68	18.24	14.46	15.90	-27.21	13.88
Service									
Army	773	152.07	23.23	41.54	17.25	13.58	15.60	-27.95	13.43
Air Force	357	154.58	26.26	40.37	16.13	11.53	13.26	-28.84	11.75
Marines	128	144.18	21.16	43.64	18.73	12.56	15.23	-31.08	14.83
Navy	534	155.89	24.44	39.54	18.28	13.95	16.69	-25.59	14.06
Rank									
Enlisted	1593	153.31	24.15	40.90	17.94	13.50	15.87	-27.40	13.72
Officer	197	151.89	25.15	40.68	13.34	10.98	11.85	-29.70	11.34
Other	2	145.00	19.80	27.50	3.54	-1.00	4.24	-28.50	7.78
Region									
Alaska	34	156.32	24.20	40.71	17.56	11.62	19.51	-29.09	11.80
North	602	155.88	24.46	39.80	18.31	13.57	16.31	-26.23	13.83
OCONUS	74	150.81	22.70	41.82	16.48	13.35	14.61	-28.47	10.46
South	546	151.42	23.79	42.07	17.02	13.39	15.16	-28.68	13.59
West	536	151.95	24.48	40.69	17.10	12.70	14.74	-27.99	13.39
Delivery Type									
Vaginal	1057	152.58	23.96	40.82	17.30	13.16	15.53	-27.66	13.52
Cesarean	735	153.96	24.65	40.92	17.76	13.28	15.45	-27.64	13.47

Table 13. Summary of Baseline and Postpartum BMI Categories for Hypothesis 5b

Study Population for Hypothesis 5b n=1,792					
		Postpartum BMI			
Baseline BMI Total		Underweight	Normal	Overweight	Obese
Normal	751	5	403	303	40
Overweight	807	0	42	436	329
Obese	234	0	0	32	202

Table 14. Summary of Linear Regression Analyses for Variables Associated with Baseline Weight

Baseline Weight Regression Model				
Variable	**B**	**Std. Error of B**	**t Value**	**Bonferroni-adjusted P-Value**
Age Group (Ages 25-29 Reference Category)				
Ages 18-24	-1.83	0.21	-8.57	<.0001*
Ages 30-34	1.92	0.27	7.24	<.0001*
Ages 35-40	2.58	0.36	7.17	<.0001*
Race (Caucasian Reference Category)				
Asian	-6.75	0.37	-18.14	<.0001*
African American	0.74	0.21	3.52	0.004*
American Indian/Alaska Native	-0.53	0.62	-0.86	0.39
Other	-3.05	0.3	-10.15	<.0001*
Unknown	-2.77	0.94	-2.96	0.003*
Marital Status (Married Reference Category)				
Divorced	-0.35	0.36	-0.96	0.33
Single	0.67	0.20	3.39	0.0007*
Widowed	2.42	3.30	0.73	0.46
Parity (1st Child Reference Category)				
1+ Children	0.76	0.45	1.67	0.095
Baseline Body Mass Index (Normal/Healthy Reference Category)				
Obese Baseline BMI	54.10	0.33	166.23	<.0001*
Overweight Baseline BMI	26.18	0.19	139.84	<.0001*
Mental Health Diagnosis (Mental Health Diagnosis Reference Category				
No Mental Health Diagnosis	-0.98	0.38	-2.57	0.01*
Service Branch (Marine Corps Reference Category)				
Army	1.48	0.33	4.47	<.0001*
Air Force	1.79	0.37	4.83	<.0001*
Navy	2.11	0.34	6.05	<.0001*
Rank (Enlisted Reference Category)				
Officer	0.49	0.29	1.71	0.09
TRICARE Region (South Reference Category)				
Alaska	-1.14	0.66	-1.73	0.08
North	0.32	0.23	1.38	0.17
OCONUS	0.72	0.44	1.65	0.1
West	0.36	0.23	1.55	0.12
Type of Delivery (Cesarean delivery Reference Category)				
Vaginal Delivery	2.07	0.2	10.54	<.0001*

Note. Each variable category is compared to a reference group category. Reference groups are indicated at the top of each variable category. Negative values indicate lower baseline weight compared to reference group.
*$p < .05$

Table 15. Summary of Simple Regression Analyses for Variables Associated with Pregnancy Weight Gain

Weight Gain Regression Model				
Variable	**B**	**Std. Error of B**	**t Value**	**Bonferroni-adjusted P-Value**
Age Group (Ages 25-29 Reference Category)				
Ages 18-24	-1.25	0.22	-5.55	<.0001*
Ages 30-34	0.46	0.28	1.65	0.1
Ages 35-40	-1.26	0.38	-3.32	0.001*
Race (Caucasian Reference Category)				
Asian	-1.64	0.39	-4.2	<.0001*
African American	-3.82	0.22	-17.22	<.0001*
American Indian/Alaska Native	-0.85	0.65	-1.31	0.19
Other	-1.02	0.32	-3.21	0.001*
Unknown	-1.9	0.98	-1.93	0.05*
Marital Status (Married Reference Category)				
Divorced	0.47	0.4	1.24	0.21
Single	0.86	0.21	4.17	<.0001*
Widowed	-1.38	3.46	-0.4	0.69
Parity				
Parity 1+	0.4	0.48	0.84	0.4
Baseline Body Mass Index (Normal/Healthy Reference Category)				
Obese BMI	-5.25	0.34	-15.35	<.0001*
Overweight BMI	0.31	0.20	1.58	0.12
Mental Health Diagnosis (Mental Health Diagnosis Reference Category				
No Mental Health Dx	0.54	0.4	1.35	0.18
Service Branch (Marine Corps Reference Category)				
Army	-0.73	0.35	-2.09	0.04*
Air Force	-1.78	0.39	-4.57	<.0001*
Navy	-1.89	0.37	-5.17	<.0001*
Rank (Enlisted Reference Category)				
Officer	-2.1	0.3	-6.91	<.0001*
TRICARE Region (South Reference Category)				
Alaska	2.08	0.7	2.99	0.003*
North	-0.35	0.24	-1.45	0.15
OCONUS	-0.27	0.46	-0.59	0.56
West	0.08	0.24	-0.32	0.75
Type of Delivery (Cesarean delivery Reference Category)				
Vaginal Delivery	-2.87	0.21	-13.89	<.0001*

Note. Each variable category is compared to a reference group category. Reference groups are indicated at the top of each variable category. Negative values indicate lower weight gain compared to reference group.
*p < .05

Table 16. Summary of Simple Regression Analyses for Variables Associated with Postpartum Weight Retention

Weight Retention Regression Model				
Variable	**B**	**Std. Error of B**	**t Value**	**Bonferroni-adjusted P-Value**
Age Group (Ages 25-29 Reference Category)				
Ages 18-24	-0.93	0.2	-4.55	<.0001*
Ages 30-34	0.72	0.25	2.86	0.004*
Ages 35-40	-0.002	0.34	-0.01	1.00
Race (Caucasian Reference Category)				
Asian	-0.49	0.35	-1.37	0.17
African American	-0.24	0.2	-1.21	0.23
American Indian/Alaska Native	0.65	0.59	1.1	0.27
Other	0.21	0.29	0.74	0.46
Unknown	-0.42	0.89	-0.47	0.64
Marital Status (Married Reference Category)				
Divorced	0.12	0.34	0.35	0.73
Single	0.54	0.19	2.89	0.004*
Widowed	0.29	3.14	0.09	0.93
Parity (1st Child Reference Category)				
1+ Children	1.32	0.43	3.05	0.002*
Baseline Body Mass Index (Normal/Healthy Reference Category)				
Obese Baseline BMI	-3.33	0.31	-10.74	<.0001*
Overweight Baseline BMI	0.48	0.18	2.67	0.008*
Mental Health Diagnosis (Mental Health Diagnosis Reference Category				
No Mental Health Diagnosis	-0.04	0.36	-0.12	0.9
Service Branch (Marine Corps Reference Category)				
Army	0.21	0.32	0.68	0.5
Air Force	-1.33	0.35	-3.78	0.0002*
Navy	0.33	0.33	1.01	0.31
Rank (Enlisted Reference Category)				
Officer	-2.72	0.28	-9.87	<.0001*
TRICARE Region (South Reference Category)				
Alaska	0.59	0.63	0.94	0.35
North	-0.08	0.22	-0.35	0.72
OCONUS	-0.33	0.42	-0.8	0.43
West	-0.22	0.22	-1.03	0.3
Type of Delivery (Cesarean delivery Reference Category)				
Vaginal Delivery	-0.85	0.19	-4.56	<.0001*

Note. Each variable category is compared to a reference group category. Reference groups are indicated at the top of each variable category. Positive values indicate more weight retained compared to reference group.
*p < .05

Table 17. Summary of Simple Regression Analyses for Variables Associated with Pregnancy Weight Change from Third Trimester to Six Month Postpartum

Weight Change Regression Model				
Variable	**B**	**Std. Error of B**	**t Value**	**Bonferroni-adjusted P-Value**
Age Group (Ages 25-29 Reference Category)				
Ages 18-24	0.32	0.17	1.84	0.07
Ages 30-34	0.26	0.22	1.21	0.23
Ages 35-40	1.26	0.29	4.28	<.0001*
Race (Caucasian Reference Category)				
Asian	1.16	0.3	3.81	0.0001*
African American	3.58	0.17	20.8	<.0001*
American Indian/Alaska Native	1.5	0.50	2.98	0.003*
Other	1.23	0.25	5.00	<.0001*
Unknown	1.48	0.76	1.94	0.05*
Marital Status (Married Reference Category)				
Divorced	-0.35	0.3	-1.19	0.23
Single	-0.32	0.16	-2.01	0.04*
Widowed	1.66	2.69	0.62	0.54
Parity (1st Child Reference Category)				
1+ Children	0.91	0.37	2.48	0.01*
Baseline Body Mass Index (Normal/Healthy Reference Category)				
Obese Baseline BMI	1.92	0.27	7.25	<.0001*
Overweight Baseline BMI	0.17	0.15	1.09	0.28
Mental Health Diagnosis (Mental Health Diagnosis Reference Category				
No Mental Health Diagnosis	-0.59	0.31	-1.89	0.06
Service Branch (Marine Corps Reference Category)				
Army	0.94	0.27	3.49	0.0005*
Air Force	0.44	0.3	1.47	0.14
Navy	2.22	0.28	7.85	<.0001*
Rank (Enlisted Reference Category)				
Officer	-0.62	0.24	-2.63	0.009*
TRICARE Region (South Reference Category)				
Alaska	-1.49	0.54	-2.76	0.006*
North	0.28	0.19	1.46	0.14
OCONUS	-0.06	0.36	-0.17	0.86
West	-0.15	0.19	-0.8	0.43
Type of Delivery (Cesarean delivery Reference Category)				
Vaginal Delivery	2.02	0.16	12.59	<.0001*

Note. Each variable category is compared to a reference group category. Reference groups are indicated at the top of each variable category. Negative values indicate higher weight change compared to reference group.
*$p < .05$.

Table 18. Age and Race Covariates of Study Sample Indicating the Number of Women Meeting IOM Weight Gain Guidelines During Pregnancy

	Met IOM Guidelines, Study Pop n=28,771		Met IOM Guidelines, Preeclampsia Pop n=1,792	
	Yes n(col %)	No n(col %)	Yes n(col %)	No n(col %)
Age Group				
18-24	2870 (23.50)	9341 (76.50)	154 (19.06)	654 (80.94)
25-29	2161 (23.33)	7102 (76.67)	96 (18.11)	434 (81.89)
30-34	1162 (23.18)	3851 (76.82)	51 (16.94)	250 (83.06)
35-40	592 (25.92)	1692 (74.08)	26 (16.99)	127 (83.01)
Race				
White	3573 (23.47)	11653 (76.53)	146 (16.84)	721 (83.16)
Asian	456 (25.63)	1323 (74.37)	17 (18.68)	74 (81.32)
Black	1862 (23.27)	6139 (76.73)	125 (20.29)	491 (79.71)
Native American/Alaskan Native	138 (22.77)	468 (77.23)	7 (17.50)	33 (82.50)
Other	691 (23.82)	2210 (76.18)	30 (18.63)	131 (81.37)
Unknown	65 (25.19)	193 (74.81)	2 (11.76)	15 (88.24)

Table 19. Variables of Interest in Study Sample Indicating the Number of Women Meeting IOM Weight Gain Guidelines During Pregnancy

	Met IOM Guidelines, Study Pop n=28,771		Met IOM Guidelines, Preeclampsia Pop n=1,792	
	Yes n(col %)	No n(col %)	Yes n(col %)	No n(col %)
Marital Status				
Divorced	426 (22.21)	1492 (77.79)	16 (13.56)	102 (86.44)
Married	3758 (24.15)	11806 (75.85)	168 (18.92)	720 (81.08)
Single	2509 (22.98)	8410 (77.02)	140 (18.21)	629 (81.79)
Widowed	5 (25.00)	15 (75.00)	0 (0.00)	2 (100)
Unknown	87 (32.57)	263 (67.43)	3 (20.00)	12 (80.00)
Parity				
First Pregnancy	6542 (23.65)	21119 (76.35)	-	-
1+ Pregnancies	243 (21.89)	867 (78.11)	-	-
Baseline BMI				
Normal	4579 (30.43)	10470 (69.57)	198 (26.36)	553 (73.64)
Obese	409 (16.41)	2084 (83.59)	34 (14.53)	200 (85.47)
Overweight	1797 (16.00)	9432 (84.00)	95 (11.77)	712 (88.23)
Mental Health History				
None	6409 (23.58)	20771 (76.42)	-	-
Yes	376 (23.63)	1215 (76.37)	-	-
Service				
Army	2958 (22.38)	10258 (77.62)	116 (15.00)	657 (85.00)
Air Force	1344 (25.22)	3985 (74.78)	74 (20.73)	283 (79.27)
Marines	617 (24.22)	1930 (75.78)	27 (21.09)	101 (78.91)
Navy	1866 (24.30)	5813 (75.70)	110 (20.60)	424 (79.40)
Rank				
Officer	1063 (28.14)	2715 (71.86)	35 (17.77)	162 (82.23)
Enlisted	5722 (22.89)	19271 (77.11)	291 (18.27)	1302 (81.73)
Other	-	-	1 (50.00)	1 (50.00)
Region				
Missing	0 (0.00)	1 (100.00)	-	-
Alaska	109 (20.49)	423 (79.51)	2 (5.88)	32 (94.12)
North	2256 (31.04)	7012 (68.96)	117 (19.44)	485 (80.56)
OCONUS	324 (24.16)	1017 (75.84)	10 (13.51)	64 (86.49)
South	1981 (22.69)	6749 (77.31)	94 (17.22)	452 (82.78)
West	2115 (23.77)	6784 (76.23)	104 (19.40)	432 (80.60)
Delivery Type				
Vaginal	5184 (24.94)	15602 (75.06)	204 (19.30)	853 (80.70)
C-section	1601 (20.05)	6384 (79.95)	123 (16.73)	612 (83.27)

Table 20. Logistic Regression Predicting Likelihood of Meeting IOM Weight Gain Guidelines During Pregnancy, Aim 1-5a Population

Logistic Regression									
Predictor	**Max Likelihood Estimate**	**Std. Error**	**Wald Chi-Sq**	**df**	**P-value of Chi-Sq**	**Odds Ratio**	**95% C.I. for OR**		**P-value of OR**
							Lower	**Upper**	
Age Group (Ages 25-29 Reference Category)									
Ages 18-24	-0.04	0.03	1.83	1	0.1761	1.00	0.93	1.07	0.9349
Ages 30-34	-0.05	0.03	2.79	1	0.0946	0.99	0.90	1.08	0.7707
Ages 35-40	0.13	0.04	10.16	1	0.0014*	1.19	1.06	1.34	0.0035*
Race (Caucasian Reference Category)									
Asian	0.07	0.06	1.68	1	0.1955	1.15	1.03	1.29	0.0165*
African American	0.07	0.04	3.10	1	0.0784	1.15	1.07	1.23	<.0001*
AI/Alaska Native	-0.02	0.09	0.07	1	0.7948	1.05	0.86	1.28	0.6469
Other	-0.03	0.05	0.43	1	0.5142	1.04	0.94	1.14	0.4436
Unknown	-0.02	0.13	0.02	1	0.8792	1.05	0.78	1.41	0.7398
Marital Status (Married Reference Category)									
Divorced	-0.07	0.12	0.39	1	0.5335	0.92	0.82	1.03	0.1604
Single	-0.07	0.11	0.41	1	0.5209	0.92	0.87	0.98	0.0104*
Widowed	0.14	0.42	0.11	1	0.7435	1.14	0.40	3.20	0.8091
Parity (1st Child Reference Category)									
1+ Children	0.05	0.04	1.60	1	0.2066	1.10	0.95	1.28	0.2066
Baseline Body Mass Index (Normal/Healthy Reference Category)									
Obese Baseline BMI	-0.26	0.04	46.49	1	<.0001*	0.45	0.40	0.50	<.0001*
Overweight Baseline BMI	-0.28	0.03	123.06	1	<.0001*	0.44	0.41	0.47	<.0001*
Mental Health Diagnosis (Mental Health Diagnosis Reference Category									
No Mental Health Diagnosis	-0.03	0.03	0.89	1	0.3443	0.94	0.84	1.07	0.3508
Service Branch (Marine Corps Reference Category)									
Army	-0.07	0.02	8.36	1	0.0038*	1.01	0.91	1.12	0.8260
Air Force	0.07	0.03	4.89	1	0.0270*	1.16	1.04	1.31	0.0107*
Navy	0.08	0.03	9.36	1	0.0022*	1.18	1.06	1.32	0.0029*
Rank (Enlisted Reference Category)									
Officer	0.09	0.02	14.45	1	0.0001*	1.19	1.09	1.30	0.0001*
TRICARE Region (South Reference Category)									
Alaska	-0.15	0.09	2.99	1	0.0839	0.87	0.70	1.08	0.2130
North	0.06	0.03	2.97	1	0.0849	1.08	1.00	1.16	0.0528
OCONUS	0.09	0.06	2.50	1	0.1136	1.11	0.97	1.28	0.1361
West	0.02	0.03	0.3403	1	0.5596	1.03	0.96	1.11	0.3644
Type of Delivery (Cesarean delivery Reference Category)									
Vaginal Delivery	0.11	0.02	42.63	1	<.0001*	1.24	1.16	1.33	<.0001*

Note. Each variable category is compared to a reference group category. Reference groups are indicated at the top of each variable category. Odd ratios less than 1 indicate the variable category is less likely to meet IOM guidelines compared to the reference group. Odds ratios greater than 1 indicate the variable category has a higher likelihood of meeting IOM guidelines compared to the reference group.

*$p < .05$

Chapter 4: Discussion

Summary of Results

The purpose of the proposed study was to examine the impact of demographic factors (i.e., marital status, parity, entering pregnancy overweight and/or obese), mental health diagnoses, military service branch, rank of active duty member, region of TRICARE service, type of delivery, and preeclampsia diagnosis on pregnancy weight gain and postpartum weight retention in a large sample of women in the Military Health System. This study used linear and logistic regression analyses, followed by individual Bonferroni-corrected comparisons, to examine these relationships. This study used linear and logistic regression analyses to examine the relationships. Primary study findings were that overall, individuals who were single, enlisted, and had a cesarean delivery gained and retained more weight than their counterparts. In addition, individuals who were in the Marine Corps or had a diagnosis of preeclampsia also evidenced more weight gain and retained more weight during pregnancy and postpartum. TRICARE service region impacted weight gain but not weight retention. Parity was not related to weight gain, but affected weight retention, and mental health was not related to weight gain or retention. A summary of the study results is presented in Table 21 below. The following discussion section will first consider the findings of each study aim individually, followed by examining general issues related to all study aims and the implications of the present study findings.

Table 21. Summary of Results for Aims 1-5

Hypothesis	*Independent Variable*	*Results for Weight Gain*	*Results for Weight Retention*
Hypothesis 1a	Marital Status	*Single gained more weight	*Single retained more weight
Hypothesis 1b	Parity	No significant differences	*Parity 1+ retained more weight
Hypothesis 1c	Baseline BMI	*Obese gained less weight	*Obese retained less weight; Overweight retained more
Hypothesis 2	Mental Health Diagnosis	No significant findings	No significant findings
Hypothesis 3a	Service Branch	*Army, Navy, & AF gained less than MC	*AF retained less than MC
Hypothesis 3b	Rank	*Enlisted gained more weight than officers	*Enlisted retained more weight than officers
Hypothesis 4	Region of TRICARE Service	*Individuals in Alaska gained more weight than individuals in the South	No significant differences
Hypothesis 5a	Type of Delivery	*Cesarean delivery gained more than vaginal delivery	*Cesarean delivery retained more than vaginal delivery
Hypothesis 5b	Preeclampsia	*Preeclampsia gained more	*Preeclampsia retained more

Note. * indicates $p < .05$

Aim One Results

The first aim of the study was to determine the relationship between demographic factors and variables affecting home demands, and weight change during pregnancy and postpartum. Based on previous research (Klos & Sobal, 2013; Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015; Schoenborn, 2004), married women have a higher risk of being overweight or obese compared to single, divorced, or widowed women. However, there are inconsistencies in the results of in previous studies (Auger et al., 2008; Kac, Benicio, Velasquez-Melendez, Valente, & Struchiner, 2004; Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015; Schoenborn, 2004) as to how much weight married women gain during pregnancy and postpartum. Some studies indicate that married women gain and retain more weight compared to their single, divorced, or widowed counterparts (Klos & Sobal, 2013; Mohd Zain, Low, & Othman, 2015; Reyes-Guzman, Bray, Forman-Hoffman, & Williams, 2015), and other studies finding that single women gain and/or retain the most weight (Olson, Strawderman, Hinton, & Pearson, 2003; Rooney & Schauberger, 2002).

This study proposed that married women would gain more weight and retain more weight compared to single, divorced, or widowed women. However, results were not as expected. Compared to married women, single women gained more weight during pregnancy and retained more weight during postpartum. Marital status did not impact women's ability to meet IOM pregnancy weight gain guidelines. There are several possible interpretations for the present findings.

Several of the present study findings, including those relating to Aim 1, suggest that the work, home, and physical health demands that women face when working and managing their household affect pregnancy weight gain and postpartum weight retention.

The concept of home, work, and physical health demands as it may influence pregnancy will be elaborated in another section below (Defense Advisory Committee on Women in the Services, 2017; Ertel, Koenen, & Berkman, 2008; Figa-Talamanca, 2006; Fujishiro et al., 2015). However, as applied to marital status (e.g., single parent versus married), women presumed to have higher demands/stressors (e.g., financial, social) during pregnancy and postpartum are found to gain and retain more weight during pregnancy and postpartum (Ertel, Koenen, & Berkman, 2008; Hakanen, Schaufeli, & Ahola, 2008; Landsbergis & Hatch, 1996; Luecken et al., 1997; Provenzano, Rifas-Shiman, Herring, Rich-Edwards, & Oken, 2015; Stark, 2013). This may be especially true for active duty women who have an obligation to serve in the military for a set number of years and cannot quit their job at any time (Defense Advisory Committee on Women in the Services, 2017; Figa-Talamanca, 2006; Fujishiro et al., 2015; Maucione, 2018). Additionally, active duty women are subject to permanent change of location (PCS), temporary duty (TDY), and deployments, all which may take time away from their family and create additional demand (Ertel, Koenen, & Berkman, 2008; Landsbergis & Hatch, 1996).

Regarding parity and weight gain and postpartum weight retention, previous studies in civilian samples have also yielded inconsistent findings (Bastian et al., 2010; Chu, Callaghan, Bish, & D'Angelo, 2009; Hill et al., 2017; Nohr et al., 2009; Reynolds, Osmond, Phillips, & Godfrey, 2010). The present study proposed that women who had one or more children in the home would gain and retain less weight and found that there was not a significant difference in weight gain between women who had one or more children compared to women in their first pregnancy. However, contrary to what was

predicted, women with one or more children retained more weight during postpartum than women in their first pregnancy. Parity also did not impact women's ability to meet IOM pregnancy weight gain guidelines. In past studies, women who had pregnancies closely spaced (i.e., within two years of each other), were more likely to retain more weight than women in their first pregnancy (Nohr et al., 2009). However, one of the reasons it is believed that women gain excess weight during pregnancy and retain weight during postpartum is lack of education with regards to the IOM pregnancy weight gain guidelines (Hill et al., 2017; Institute of Medicine, 2009; Mcphie et al., 2015). After their first pregnancy, women in the military would be much more likely to be aware of the IOM guidelines. Additionally, women in the military are required to maintain physical height and weight standards (Armitage & Smart, 2012; Carter, Wood Baker, & Brownell, 2000; Chauhan et al., 2013; Cofell, 2011). Therefore, they may be more conscious of how much weight they are gaining during pregnancy and may try to limit the amount of weight they gain. However, the extra demands placed on women with at least two children, especially if single, may lead to them retaining weight during postpartum even if they are conscious of their height and weight standards in the military.

Prior research has indicated that women with a higher baseline BMI gained and retained more weight during pregnancy and postpartum (Davis, Hofferth, & Shenass, 2014; Deputy et al., 2015; Hunt et al., 2013; Hochner et al., 2012; Institute of Medicine, 2009; Lau et al., 2014; Restall et al., 2014). Therefore, this study hypothesized that women with an obese or overweight BMI at baseline would gain and retain more weight during pregnancy and postpartum. Surprisingly, women with an obese baseline BMI actually gained less weight during pregnancy and retained less weight during postpartum

compared to women who had a normal/healthy baseline BMI. Consistent with prior research, women with an overweight baseline BMI retained more weight during postpartum compared to women with a normal/healthy baseline BMI. There were no significant differences in weight gain between women with an overweight baseline BMI and women with a normal/healthy baseline BMI. Women who were overweight and obese at baseline were less likely to meet IOM guidelines. Several possible explanations can be offered for these findings.

First, results for meeting IOM guidelines do indicate that women who were obese are less likely to meet these guidelines. Therefore, the finding of obese women gaining less weight may be attributable to the fact that their physicians emphasize the IOM guidelines with their patients and recommend that they gain less weight during pregnancy than women who are in the normal/healthy baseline BMI category (IOM, 2009).

Second, the findings regarding obesity and weight gain might also be explained in part by the fact that this study solely examined active duty women in the military. Active duty women are required to adhere to certain height and weight guidelines and may therefore be more likely to try to control their weight (Armitage & Smart, 2012; Carter, Wood Baker, & Brownell, 2000; Chauhan et al., 2013; Cofell, 2011). Women who are classified as obese are outside the height and weight standards of the military while certain branches allow for women who are overweight to continue to serve in the military. Military service members are required to maintain height and weight standards to keep their careers (AFPC/DPS, 2015; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; Chief of Naval Operations, 2007; The Surgeon General, 2012; US Department of

the Army, 2007; US Department of the Army, 2007; US Department of the Army, 2012). Therefore, compared to civilian women, they have a higher incentive compared to civilian women to gain less weight during pregnancy and retain less weight during postpartum. Furthermore, for certain career fields, the military has different appearance and physical fitness requirements, and women who are obese may be motivated to return to lose weight gained during pregnancy in order to qualify for these career fields. Additionally, even in pregnancy, physical appearance is important for promotions, awards, and career progression (AFPC/DPS, 2015; Commandant of the Marine Corps, 2008; Manpower Personnel Training and Education, 2016; Chief of Naval Operations, 2007; US Department of the Army, 2007; US Department of the Army, 2012). Therefore, women may try to maintain an appearance of physical fitness even during pregnancy (Armitage & Smart, 2012; Chauhan et al., 2013).

Aim Two Results

The second aim of the study examined the relationship between mental health, weight gain during pregnancy, and weight retention during postpartum. There was no significant difference in weight gain during pregnancy and weight retention during postpartum in women with a mental health diagnosis compared to those without a mental health diagnosis. Furthermore, a mental health diagnosis did not significantly impact women's ability to meet IOM pregnancy weight gain guidelines. This may be attributable to the fact that military members are frequently reluctant to seek mental health treatment in the military, primarily because of concerns about the impact of mental health diagnoses on their career (Eaton et al., 2008; Greene-Shortridge, Britt, & Castro, 2007; Hoge et al., 2004). In the present study, mental health diagnosis was derived from MHS

codes based on whether they sought help from an MHS provider. Some of the women in the overall population may also have mental health concerns for which they are not seeking treatment in the MHS due to a variety of reasons including mental health stigma. Thus, the findings for Aim 2 may be attributable to the small number of women with a mental health diagnosis compared to the overall population in the MHS and may not be generalizable to the broader population of pregnant women. Additionally, this study did not examine the use of antidepressant medications prior to, during, or after pregnancy. Many antidepressant medications affect weight (Grundy, Cotterchio, Kirsh, & Kreiger, 2014; Hinze-Selch et al., 2000), and since they could not be examined in this study, they may explain and/or confound the results. Many women discontinue the use of antidepressant medications once they are pregnant. Therefore, as is consistent with this study, there may be a difference in baseline weight between women with a mental health diagnosis and women without one due to the use of antidepressant medications, and there may not be a difference in weight gain and weight retention between the two groups. On the other hand, if women continue to take antidepressant medications while pregnant, it may confound the amount of weight they gained since they are more likely to gain additional weight while taking certain antidepressant mediations.

Aim Three Results

The third aim of the study was to determine the relationship between work factors, pregnancy weight gain, and postpartum weight retention. Previous research indicated differences in baseline weight and weight standards in active duty women of different military service branches (AFPC/DPS, 2015; Commandant of the Marine Corps, 2008; Commandant of the Marine Corps, 2008; Manpower Personnel Training and

Education, 2016; Chief of Naval Operations, 2007; The Surgeon General, 2012; US Department of the Army, 2007; US Department of the Army, 2007; US Department of the Army, 2012). For example, women in the Marine Corps have stricter height and weight standards as compared to the Air Force. For this reason, the study hypothesized that women in the Marine Corps would gain less weight during pregnancy and retain less weight during postpartum compared to women in other service branches. This hypothesis was partially supported in that compared to women in the Marine Corps, women in the Air Force, Army, and Navy gained less weight. However, women in the Navy retained more weight than women in the Marine Corps, and women in the Air Force retained less weight than women in the Marine Corps. In addition, women in the Marine Corps were the least likely to meet IOM weight gain guidelines during pregnancy. There were no significant differences between women in the Marine Corps and Army in postpartum weight retention.

One explanation once again explains these findings in terms of the demands placed on women in the Marines (see below section on demands). Additionally, there are fewer women (percentage-wise) in the Marine Corps, and this may affect the level of support they may have during and after pregnancy. For example, the Army and not the Marine Corps, has a program (P3T) (US Department of the Army, 2012). This program has topics such as exercise and dietary habits, which may help women in the Army not gain as much weight as women in some of the other service branches.

Current and preliminary research findings also indicate there are differences in pregnancy weight gain and postpartum weight retention between enlisted members and officers (MacLean & Edwards, 2010; Rogers et al., 2017; Schoenfeld, McCriskin, Hsiao,

& Burks, 2011; Tarman et al., 2000). Accordingly, the present study hypothesized and found that enlisted women would gain and retain more weight than officers. Officers were also more likely to meet IOM weight gain guidelines during pregnancy than enlisted women. This may be explained by the fact that rank is frequently used as a proxy for socio-economic status (SES). In prior research, women with a lower SES gained and retained more weight during pregnancy and postpartum than women in a higher SES class. This may hold true for the military as well. Additionally, enlisted members frequently have higher demands placed on them than officers (MacLean & Edwards, 2010), and enlisted members would be expected to gain and retain more weight than officers (See section on demands below).

Aim Four Results

The fourth aim of the study was to determine the relationship between regions of TRICARE service and pregnancy weight gain and postpartum weight retention. Previous research in civilian populations has indicated that women in the South were at a higher risk of being overweight and obese (Kulkarni, 2004; Le et al., 2014; Myers et al., 2015). This is the first study to look at pregnancy weight gain as a function of region in the military. Results did not support the hypothesis that women in the South TRICARE service region would gain the most and retain the most weight. Conversely, women in the Alaska region of TRICARE service gained more weight compared to women in the South TRICARE service region. Region of TRICARE service did not impact whether women met IOM weight gain guidelines during pregnancy. It should be noted that other analyses from the MHS cohort indicated that there were some regional differences in weight gain during pregnancy weight gain and postpartum weight retention. However, these results

are difficult to explain, and these findings are beyond the scope of this dissertation and are not presented further.

Several factors may explain the lack of findings supporting the hypothesis. Women living in the Alaska TRICARE service region are exposed to a generally colder climate, less densely populated area of the US. They may be limited in the availability of healthy food (e.g., food deserts) and exercise opportunities. Additionally, there is not as many military members in Alaska, and the resources to care for women's health may be limited compared to other TRICARE service regions. Furthermore, the lack of findings supporting this hypothesis may be in part due to active duty women living in the South TRICARE service region moving every few years from duty station to duty station around the world. Women may not be native to the region in which they are living. Thus, this study may not be representative of regional differences in pregnancy weight gain and postpartum weight retention that may be found in individuals native to the South, North, or West regions of the United States. In addition, since there are only three TRICARE service regions covering the 48 contiguous states in the United States, they may also not be indicative of regional differences that might be observed if dividing the country into regions such as the "deep south" (e.g., Alabama, Mississippi, Louisiana), East (e.g., North Carolina, Virginia, Maryland), Midwest (e.g., Minnesota, Illinois, Indiana, Missouri), West (e.g., Colorado, Utah, Nevada, California), Northeast (e.g., Massachusetts, New Hampshire, Maine), and Southwest (e.g., Arizona, New Mexico) (TRICARE, 2017). Dividing the United States into regions such as those listed above may show if region is a factor in differences in pregnancy weight gain and postpartum weight retention.

Aim Five Results

The fifth aim of the study was to determine the relationship between health factors (e.g., type of delivery, a diagnosis or preeclampsia, and pregnancy weight gain and postpartum weight retention). Prior researchers found that women who enter pregnancy at a higher BMI (i.e., overweight or obese), and/or gain excessive weight during pregnancy are at a higher risk of having a cesarean delivery (Catalano & Ehrenberg, 2006; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). Additionally, women with cesarean delivery deliveries retain more weight than women who have vaginal births. Therefore, this study hypothesized that women with cesarean delivery deliveries would gain and retain more weight than women with vaginal births. This hypothesis was supported. Active duty women who had cesarean deliveries gained and retained more weight than women with vaginal deliveries. Additionally, women who had a cesarean delivery were less likely to meet IOM pregnancy weight gain guidelines.

One explanation for this might be that women who have cesarean deliveries may have a health condition or pregnancy complication that requires them to have a cesarean delivery (Emmett, Shaw, Montgomery, & Murphy, 2006). They may be also less active and therefore, at a higher risk for gaining more weight and retaining more weight during pregnancy and postpartum. Therefore, they may be less active and at a higher risk for gaining more weight during pregnancy.

Having a cesarean delivery requires surgical intervention and is more invasive than a vaginal birth and involves cutting through muscles and organs that are integral to fitness (e.g., abdominal muscles). Therefore, it likely takes women longer to recover from a cesarean delivery than a vaginal delivery. Additionally, women who have cesarean

delivery deliveries may be given different physical limitations post-delivery compared to women with a vaginal birth. This may affect postpartum weight retention.

Aim 5 also hypothesized an association of a diagnosis of preeclampsia and pregnancy weight gain and postpartum weight retention. While women with a higher BMI (e.g., overweight, obese), have a higher likelihood of developing preeclampsia during pregnancy (O'Brien, Ray, & Chan, 2003), few studies have previously been conducted to examine the association of preeclampsia and pregnancy weight gain and postpartum weight retention. Preeclampsia is a high risk pregnancy condition affecting approximately 5-8% of pregnancies, similar to what was found in this study with 6% of active duty women being diagnosed with preeclampsia. Prior research into other health conditions during pregnancy that place a pregnancy into a high risk category indicates that women in the high risk pregnancy category gain and retain more weight compared to their peers in the low risk category for pregnancy (Catalano & Ehrenberg, 2006; Sattar & Greer, 2002; Villamor & Cnattingius, 2006). Therefore, since preeclampsia is a high risk condition, it may impact pregnancy weight gain and retention. Similar to other health conditions putting women at a high risk during pregnancy, the results of this study found that women diagnosed with preeclampsia also gained and retained more weight compared to women without preeclampsia. Additionally, women with preeclampsia were less likely to meet IOM weight gain guidelines compared to women without preeclampsia. Women with high risk pregnancies frequently have physical limitations places on them. They may have to change their daily routine, including exercise and dietary restrictions. This may impact women's pregnancy weight gain and postpartum weight retention.

Some of the reasons that may explain these findings are that there is more stress upon women with preeclampsia compared to women without the diagnosis. This may create a higher demand on these women leading to higher weight gain and weight retention. Additionally, it is not clear as to whether women with a higher baseline BMI (i.e., overweight, obese) developed preeclampsia because they gained more weight or if they gained more weight because they developed preeclampsia.

Results of Additional Analyses

Study Covariates and Study Findings: Age and Race

Age and race were utilized as covariates in this study. Age was significant for differences in baseline weight, pregnancy weight gain, postpartum weight retention, and weight change from third trimester in pregnancy to six months postpartum. On average, women who are older have a harder time losing weight compared to younger women. Additionally, women who are younger started at a lower baseline weight compared to women who were in older age groups (Baum & Ruhm, 2009; Bello et al., 2016; Gore, Brown, & West, 2003).

Race was also found to have a statistically significant association with baseline weight and pregnancy weight gain. It was not significantly associated with postpartum weight retention. Women identifying as Asian or "Other" weighed significantly less at baseline compared to Caucasian women. African American women weighed significantly more than Caucasian women at baseline. Women identifying as Asian, African American, "Other," or Unknown gained significantly less weight during pregnancy than Caucasian women. Furthermore, Asian and African American women were more likely to meet IOM guidelines compared to Caucasian women. These ethnic and racial

differences may be attributed to cultural differences in what these various groups value as "beautiful." For example, some researchers have found that African Americans are likely to have more flexible and individual beliefs of beauty ideals compared to other races (Fiery, Martz, Webb, & Curtin, 2016; Grabe & Hyde, 2006). Therefore, they may view different sizes and shapes in women beautiful as compared to races with a stricter sense of beauty. Due to the sample consisting of all active duty women, they were all offered similar healthcare for their pregnancy and postpartum periods. This eliminates some of the healthcare disparities within the sample that are typically found among the civilian population and may account for the significant differences being small between the women of different racial backgrounds.

Baseline Weight Differences

Significant differences in baseline weight were found among many of the variable categories. Women who were single weighed more than married women. Women who were overweight or obese weighed significantly more than women who were of normal/healthy baseline BMI. Women in the Army, Air Force, and Navy weighed significantly more than women in the Marine Corps, and women who had a vaginal delivery weighed more than women who had a cesarean delivery. Many of these differences have been explained in prior sections of the discussion. However, it is difficult to explain why women who subsequently had vaginal, compared to cesarean deliveries weighed more. This finding might be attributable to chance or the unique features of the TRICARE sample. However, if replicated, an explanation may require future to identify the reasons for this relationship.

Weight Change from Third Trimester to Six Months Postpartum

The study hypotheses deal with pregnancy weight gain and weight retention defined in terms of changes from baseline to postpartum. Although not specifically presented as part of the study hypotheses, there are several interesting findings regarding comparisons of third trimester weight to weight at six months postpartum. In some cases, these findings parallel results obtained for weight retention (baseline to postpartum); however, in some cases, these results differed. Women in their first pregnancy, were found to lose significantly more weight from third trimester to 6 months postpartum. Women in the Army and Navy lost more weight than those in the Marine Corps while enlisted members lost more weight compared to officers. Women who had a cesarean delivery or those diagnosed with preeclampsia lost more weight compared to women with a vaginal birth or those without preeclampsia.

Interestingly, many of the women who gained more weight during pregnancy lost more weight from third trimester to six months postpartum. This is likely due to the fact that women in the military must maintain certain height and weight standards. In other words, if women gain more weight during pregnancy, they will have to lose more weight during postpartum to maintain the same physical standards prior to pregnancy. If this explanation is accurate, these findings may not hold in civilian populations. Once again, these finding might be explained in terms of demands placed on the women (See section on demands below).

BMI Category Change from Baseline to Six Months Postpartum

This study found that a significant number of active duty women moved up a BMI category from baseline to six months postpartum. Over 30% of women moved up a BMI

category while less than 15% moved down a category. This has implications for both the health of women and military readiness. Pregnancy is a time in life when many women gain and retain excess weight. When women retain excess weight and move up a BMI category, they are at a higher risk for health concerns including hypertension, diabetes, and heart disease. Additionally, they may not be able to perform as well physically, and this impacts military readiness.

General Discussion of Results

Revised Conceptual Model for the Present Results

The revised conceptual model to explain findings for demographic factors, work factors, cultural factors, psychological factors, and excessive gestational weight gain and postpartum weight retention is found in Figure 6. In this revised model, the concept of "demand" is introduced as an intervening variable between familial factors, cultural factors, and work structure and pregnancy weight gain and weight retention. By grouping this variety of factors in terms of the demands placed on women, it is possible to provide a unifying conceptualization of the present study findings. The rationale for this conceptualization is as follows: Factors that affect stress in working women include home, family, work, and physical demands. Attention is frequently divided while trying to balance all the roles women are fulfilling (e.g., occupationally, family-wise, physically) (Jones & Bright, 2001; Kodz, Harper, & Dench, 2002). As mentioned previously, women with at least one child at home reported significantly more home demands (Ertel, Koenen, & Berkman, 2008). Additionally, demands on the women may play a role in how much weight they lose. For example, women with more than one child lost less weight than women with only one child. The additional home demands may

cause the women to forego some of their health needs in order to meet the demands at home. However, this study may also indicate that women with children are not the only women subject to demands that may impact their health and weight during pregnancy and postpartum. For example, women in the Army and Marine Corps have high demands placed on them and are considered the more stringent service branches with a high number of deployments and TDYs. Therefore, women in these branches may have a higher demand on them. Furthermore, women who are diagnosed with preeclampsia have additional physical demands placed on them that may impact their gestational weight gain and postpartum weight retention. Overall, women who had more demands placed on them, both physically and mentally, gained and retained more weight during pregnancy and postpartum. Therefore, the revised conceptual model included the concept as demands since according to the study findings, demands are associated with pregnancy weight gain and postpartum weight retention.

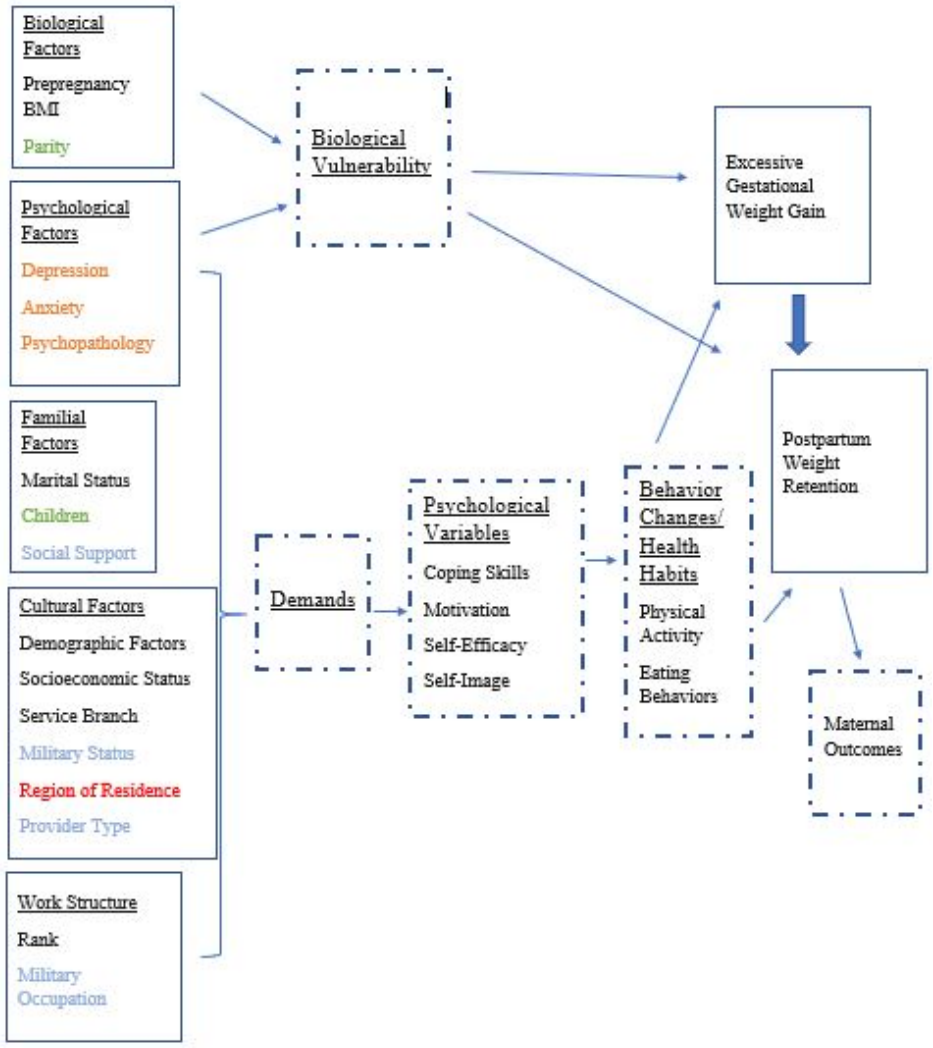

Figure 6. Revised Conceptual Model for Demographic Factors, Work Factors, Cultural Factors, Psychological Factors, and Excessive Gestational Weight Gain and Postpartum Weight Retention (Adapted from Hill et al., 2013).

a. Boxes with solid lines represent variables directly measured in the study. Boxes with dashed lines represent unmeasured variables or theoretical constructs.

b. Independent Variables in the boxes on the left in black are associated with weight gain and weight retention, independent variables in the boxes on the left in red are associated with gestational weight gain but not PPWR, independent variables in the boxes on the left in green are associated with PPWR but not gestational weight gain, independent variables in boxes on the left in orange need further study in an active duty population, independent variables in the boxes in the left in blue were not examined and need further study in the future.

This study found relationships between marital status, pre-pregnancy body mass index (BMI), military service branch, military rank, delivery type, a diagnosis of

preeclampsia, and pregnancy weight gain and postpartum weight retention. According to the findings of this study, region of residence was only associated with pregnancy weight gain and parity was only associated with postpartum weight retention.

A variable that indicated some significance in this study but showed results that were difficult to explain was region of current residence. More research is needed in this topic in both civilian and military populations to determine to if region of residence impacts pregnancy weight gain and postpartum weight retention in active duty women.

Another variable needing further investigation in an active duty population is psychological health variables (e.g, depression and anxiety) since findings in this study may be influenced by the reluctance of active duty members to seek help from a mental health professional in a behavioral health clinic because of mental health stigma and the possible implications this may have on their career. However, many active duty members will visit a primary care physician to discuss their mental health concerns. Here, the diagnosis for these problems may be different from those given by mental health practitioners. Therefore, further research is needed to determine if active duty members who are seen for mental health concerns in primary care clinics display differences in their pregnancy weight gain and postpartum weight retention compared to those who do not express mental health concerns.

Variables listed in blue were not examined in this study but are variables of interest in an active duty population and would add to this study's findings. Overall, the factors in black in the boxes on the left were significantly associated with pregnancy weight gain and postpartum weight retention in an active duty sample. In the future, interventions should be utilized to educate and help women in these categories since they

have a higher likelihood of gaining and retaining excess weight during pregnancy and postpartum.

Study Limitations and Strengths

The limitations and strengths of this study should be considered when interpreting its results. First, this is a retrospective study of an existing database from an active duty population of pregnant and postpartum women of an existing database. Therefore, there are certain variables that could not be accounted for (e.g., education, planned or unplanned pregnancies, women with eating disorders) that may influence the results and potentially interact with effects of other variables (e.g., marital status, mental health status, number of children). Additionally, not many psychological variables assessed and factors such as service branch, child(ren) in the home, and mental health diagnosis were used as proxy variables for women's stress or demand levels, without actually a measurement of self-reported stress. Second, this study utilized the Bonferroni-adjusted p-values to adjust for multiple comparisons. Bonferroni-adjusted p-values are more conservative limiting the family-wise error rate, or Type I error. Therefore, some associations between the predictor variables and pregnancy weight gain and postpartum weight retention may not be found in this study. Third, it is not clear whether the scales in the clinics were properly calibrated and/or whether height and weight measurements were self-reported by some women. Scales in military clinics are to be calibrated every year at a minimum, however, it is unknown if this occurred in all clinics. Even if measured on a calibrated scale, it is also not known whether weight was measured with women in civilian or military clothing - most civilian clothes weigh less than the military uniform, and this factor may not be adequately accounted for in the data. Furthermore, women

were not required to return to the doctor after their 6-week postpartum visit. Whether or not women attended their long-term follow-up visits may be related to the woman's overall health (e.g., overweight and obese women), or the number of children a woman has, thereby affecting or biasing the data. Additionally, women may not visit the doctor due to concerns about their weight, which cannot be known in this dataset. This study also did not examine the use of antidepressant medications prior to, during, or after pregnancy. Many antidepressant medications are associated with weight gain, and it was not possible to examine the effects of antidepressants on weight gain and weight retention in this study. Furthermore, the data cannot adequately account for if the women were involved in a commercial or military weight management program prior to, during, or after pregnancy. Therefore, the data may not fully capture some of the variables that may be associated with pre-pregnancy weight, gestational weight gain and PPWR. Another limitation of the study is that a number of the factors in the study are correlated with one another. While one model was run, it should be noted that a number of predictor variables are correlated with one another (e.g., officer associated with older age and education), and it is difficult to tell the results for any one of these variables from the effects of others.

Additionally, since the sample consisted only of active duty women, they may not be typical of all pregnant women. However, they are representative of a large population of active duty women who are pregnant and postpartum. This study drew directly from the MHS population and utilized all active duty women who met the inclusion and exclusion criteria.

A strength of this study is that the study sample consisted of all active duty women eligible for care in the Military Health System, looking at a population rather than a sample. A benefit of studying individuals in the MHS is that all active duty women are given comprehensive healthcare as part of their benefits when joining the military and are eligible for care in the MHS when joining the military. They are not limited by cost or healthcare resources frequently found in the civilian population. Furthermore, even if an active duty member moved during or after her pregnancy, she could continue to be seen at her next permanent change of location or temporary duty location. She would be assigned to a new provider once she relocated and could continue care. Her medical records would also be available to her new providers, and this would encourage a smooth transition of care. These factors minimize health disparities found in other populations.

Military and Policy Relevance

The present study is a study of active duty military women who were pregnant and postpartum. It sought to examine factors associated with pregnancy weight gain and postpartum weight retention. This study considered all women who were pregnant in the MHS and analyzed factors associated with pregnancy weight gain and postpartum weight retention. Therefore, there are some implications from this study for the military to consider.

The findings from this study have several implications for the military to consider. First, it is important to highlight that over 30% of women in this study moved up a BMI category from baseline to six months postpartum. In addition, a high percentage of active duty women did not meet the IOM weight gain guidelines. While the differences in weight gain and weight retention may be small, it places the women and

their infants at a higher risk for health concerns (e.g., diabetes, overweight/obesity, hypertension) and additional time away from the military mission. To better understand why the majority of women did not meet the weight gain guidelines and many also had weight retention, it is necessary to consider the demands placed upon pregnant women in the military during pregnancy and postpartum. Overall, as noted previously in the Discussion, several of the findings of this study may be interpreted as indicating that demands on military women may affect pregnancy weight gain and weight retention. The findings of this study indicate that women who have a higher demand placed on them gain and retain more weight during pregnancy and postpartum. Therefore, in the future, it is important for the military to consider how the demands placed on women during pregnancy and how their effects on weight gain impact mission readiness in the future.

As stated previously, women with high risk health conditions, such as preeclampsia, are at a higher likelihood of gaining more weight during pregnancy and retaining more weight during postpartum. More research is needed in this area to understand the factors impacting this relationship. Additionally, it is recommended that the military do further research to determine what specific high risk factors are associated with pregnancy weight gain and postpartum weight retention in order to inform policy for pregnancy and postpartum periods. Specifically, while there are health risks for women and their children when gaining more weight during pregnancy, the military should be most concerned with women retaining weight at six to twelve months postpartum due to the potential mission impact (e.g., military readiness, policy considerations necessary for certain factors in pregnancy and postpartum). It is also imperative that this research be disseminated to providers in order that military healthcare providers, specifically

providers interacting with women during the prenatal and postpartum periods, be educated and have the ability to inform their patients about these risk factors.

Furthermore, there has been some debate as to how women with a cesarean delivery fare in their recovery compared to women with a vaginal birth. This study supports the proposition that women with cesarean deliveries gain and retain more weight than women with a vaginal delivery. Due to these differences, the military should consider policy changes giving women with a cesarean delivery additional support and a prolonged recovery time.

Clinical Implications

There are also several potential clinical and practical implications from the present study. First, providers should be made aware of the risk factors described in this study that may place active duty women at a higher risk for gaining and retaining excess weight during pregnancy and postpartum. For example, women who are single, overweight, enlisted, in the Marine Corps, have a cesarean delivery, and have preeclampsia are at the highest risk of gaining excess weight during pregnancy. Women who are single, enlisted, in the Navy, have a cesarean delivery, and have preeclampsia are at the highest risk for retaining excess weight during postpartum. These risk factors indicated that special clinical and practical considerations should be given to them when counseling them about weight gain and weight retention. For example, education may be helpful for provider to discuss how these factors place women at a higher risk for excess pregnancy weight gain and postpartum weight retention. Furthermore, since weight is such a private issue to many women, sensitivity training may be helpful for providers when discussing pregnancy weight gain and retention with active duty women, especially

those at a higher likelihood to gain and retain excess weight. Also, of note is that even though some of the findings in weight gain and weight retention were significant, the clinical implications of them may be relatively small in certain populations (e.g., 1-2 lbs difference). This should be taken into consideration when educating women about pregnancy weight gain and weight retention. The best guideline may be for women to follow the IOM pregnancy weight gain guidelines and to follow and accept their bodies new set point after postpartum while maintaining height, weight, and physical fitness standards of the military.

Research Implications and Future Directions

This study covered several factors that impact pregnancy weight gain and postpartum weight retention in active duty women. However, there are several areas that need further study. As noted previously, more research is needed in the military to examine the differences in women with additional health concerns compared to their counterparts (e.g., preeclampsia, cesarean delivery, parity, gestational diabetes). Additionally, this study did not examine the differences in pregnancy weight gain and postpartum weight retention associated with the different career fields in which active duty women serve. Different career fields have different demands on active duty women, and this is an important area to examine in the future that would add to the body of this literature. Another area of research to consider is the policy changes that have recently taken place in the military such as extending maternity leave and then shortening it to include primary caregiver leave (AFPC/DPF, 2018; Department of the Navy, 2018). The maternity leave and primary caregiver leave policies are different in the different service branches and has changed several times since 2015. Therefore, it would be interesting to

consider the length of maternity leave and postpartum weight retention to examine if there is any relationship between the two. Further research is needed to examine psychological variables in the military that could not be addressed in this study. Due to many military members being reluctant to seek mental health care treatment in a mental health clinic due to stigma, it may be helpful to consider examining women who visit primary care for mental health concerns. Also, as previously stated, there were regional differences that need to be examined both in military and civilian populations. This study indicated that there may be regional differences in pregnancy weight gain and postpartum weight retention, but the findings were beyond the scope of this study and need further examination. Additionally, the type of provider an individual is assigned to may make a difference in pregnancy weight gain and postpartum weight retention, and further study is needed in this area. Another area for future research to consider is the outcome of the babies (e.g., weight, BMI, overall health) born to the participants in this study.

SUMMARY AND CONCLUSION

The present study was one the few to draw from entire population of active duty women in the MHS population between 2010-2014. It is the first study to consider factors affecting weight gain and weight retention in this population of women who are pregnant. Findings indicated that demographic, occupational, and health factors influence pregnancy weight gain and postpartum weight retention in active duty women. In several cases, the findings in this active duty military population differ from what has been found in civilian populations. These study findings have implications for research, practice, and policy relating to women's health, pregnancy, and weight policies in the military.

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