THE ASSOCIATION BETWEEN MATERNAL MENTAL HEALTH AND CHILDHOOD OVERWEIGHT AND OBESITY: A CROSS-SECTIONAL STUDY OF 2011-2012 NATIONAL SURVEY OF CHILDREN'S HEALTH PARTICIPANTS

by

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ABSTRACT

JOANNA KAY BALL. The association between maternal mental health and childhood overweight and obesity. (Under the direction of DR. LARISSA R. BRUNNER HUBER)

Childhood overweight and obesity is one of the greatest challenges facing public health practitioners in the United States. The number of children who are overweight or obese in the country has grown considerably over the past few decades with rates highest among minority and low-income communities. Overweight or obese children are at an increased risk for physical and emotional health issues. While many risk factors for childhood overweight and obesity have been identified, it is imperative to identify other potential influencing factors since the prevalence remains high. Maternal mental health may be one such factor as the emotional well-being of a mother has been linked to child health outcomes. However, few studies have examined the maternal mental health-childhood overweight/obesity association and results have been conflicting.

As such, the primary aim of this study was to determine whether children whose mothers reported poor mental health had increased odds of overweight and obesity and whether the child's race/ethnicity was an effect modifier of the association. Self-reported data collected from 29,307 mothers of children ages 10 to 17 participating in the 2011-2012 National Survey of Children's Health (NSCH) were used in this secondary data analysis. Multivariate logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). Children of mothers who reported poor maternal mental health had increased odds of overweight and obesity as compared to children of mothers who reported good mental and emotional health in the unadjusted model (OR=1.66, 95% CI: 1.36, 2.02). However, after adjustment for maternal education, marital status, family

structure, and household income the finding was no longer statistically significant (OR=1.19, 95% CI: 0.97, 1.47). Additionally, race/ethnicity of the child was found to be an effect modifier of the maternal mental health-childhood overweight/obesity association (non-Hispanic white: OR=1.45, 95% CI: 1.09, 1.92; non-Hispanic black: OR=0.90, 95% CI: 0.59, 1.37; Hispanic: OR=0.94, 95% CI: 0.57, 1.54; Other: OR=1.69, 95% CI: 0.92, 3.09). Further prospective studies on this topic are needed as findings may have important policy implications and result in targeted maternal mental health interventions as a means to prevent childhood overweight and obesity.

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CHAPTER 1: INTRODUCTION

Since 1980, the rate of obesity has doubled globally (World Health Organization [WHO], 2014). In the United States, more than 30 percent of adults are considered obese based on BMI greater than or equal to 30 kg/m^2 (Ogden, Carroll, Kit, & Flegal, 2014). The prevalence of overweight status and obesity has caused immense concern among public health practitioners, medical professionals, and community leaders because of the associated detrimental health effects. Overweight status and obesity are linked with numerous chronic diseases such as heart disease, stroke, type 2 diabetes, and certain cancers (CDC, 2014).

The pervasiveness of childhood overweight and obesity, measured by BMI-for-age, in the United States is even more concerning. Once a BMI is calculated for a child or adolescent it is then expressed as a percentile called BMI-for-age, which must be interpreted relative to other children of the same sex and age (CDC, 2014). An overweight child's BMI-for-age falls between the 85th and less than 95th percentile and an obese child's BMI-for-age will be greater than or equal to the 95^{th} percentile (CDC, 2014). The number of children who are overweight or obese has increased significantly since the early 1980s and remains high today; the rate of overweight and obesity among children and adolescents from 1976-1980 was 9.2 percent and 5.5 percent, respectively (Fryar, Carroll, & Ogden, 2014). Approximately 15 percent of children and adolescents ages 2-19 are considered overweight and 17 percent are considered obese according to

data from the 2011-2012 National Health and Nutrition Examination Survey (NHANES) (Fryar, Carroll, & Ogden, 2014; Ogden, Carroll, Kit, & Flegal, 2014). Children who are obese are at greater risk for being obese or disabled in adulthood and premature death (World Health Organization [WHO], 2014). If the trend does not subside, the current cohort of children is predicted to have less healthy and possibly shorter lifespans than that of their parents, largely due to complications related to being overweight or obese (Olshanky et al., 2005).

Multiple risk factors for childhood overweight and obesity have been identified including: parental overweight and obesity, children's time spent watching television and consumption of sugar-sweetened beverages, and living in a low-income area (Ludwig, Peterson, & Gortmaker, 2001; Reilly et al., 2005; Veugelers & Fitzgerald, 2005). Identifying the aforementioned risk factors has contributed to the development of targeted interventions (Sung-Chan, Sung, Zhao, & Brownson, 2013; Waters et al., 2011), however, because the prevalence of childhood overweight and obesity remains high, the need to identify other influencing factors persists. Additionally, even though research has provided an understanding of the biological nature of weight management, treatment for childhood obesity has been essentially ineffective (Ebbeling, Pawlak, & Ludwig, 2002). Thus, it is imperative to examine other potential risk factors associated with the development of overweight and obesity in order to lessen the burden of disease for children and their families.

One such potential risk factor may be maternal mental health. Mental illness affects approximately 1 in 5 adults (18.6 percent) age 18 or older in the United States (Substance Abuse and Mental Health Services Administration [SAMHSA], 2014a).

While mental illness affects both men and women, sex differences do exist, especially in relationship to rates of common mental disorders; for instance, depression is reported by twice as many women than it does men (WHO, 2014). Further, the prevalence of any mental illness among adult women in the United States is 22.0 percent compared to 14.9 percent among adult men (SAMHSA, 2014b). Additionally, women are more susceptible to certain mental illnesses like anxiety disorders and eating disorders and may also present different symptoms than men (National Institutes for Mental Health [NIMH], n.d.a).

Mental health issues are common among women of reproductive age (18 to 44 years) and among a nationally representative sample, more than 14% had current depression and nearly 3% had current serious psychological distress (Farr, Bitsko, Hayes, & Dietz, 2010). Because women of reproductive age tend to have higher rates of mental health conditions, much research has emerged examining the unique mental health issues this group faces (CDC, 2013a). For example, the pharmacological treatment of pregnant women who have been diagnosed with a mental illness prior to or during their pregnancy has been extensively studied because of the developmental vulnerability of the fetus to chemical exposure (Altshuler, Cohen, Szuba, Burt, Gitlin, & Mintz, , 1996; Chambers, Johnson, Dick, Felix, & Jones, 1996; Iqbal, Sobhan, & Ryals, 2002; Oberlander, Warburton, Misri, Aghajanian, & Hertzman, 2006; Wisner, Gelenberg, Leonard, Zarin, & Frank, 1999). Similarly, the effects of postpartum depression – a maternal mental health condition causing severe sadness and anxiety – on children have also been thoroughly evaluated (Beck, 1998; Leung & Kaplan, 2009; Grace, Evindar, & Stewart, 2003; O'Hara & McCabe, 2013). While these topics warrant investigation because of their relationship

to the health and development of a child in the early stages of life, the long-term effects that chronically poor maternal mental health may have on offspring must be considered.

Research examining the relationship between maternal mental health and child health has included development and behavioral outcomes during the preconception, conception, postpartum periods and into early childhood (Brennan et al., 2000; Sohr-Preston, Scaramella, 2006; Vliegen, Casalin, & Luyten, 2014; Weissman et al., 2006). However, literature on the role of maternal mental health beyond these select stages is sparse. In particular, very little published research has examined the potential negative effect of chronically poor maternal mental health on child physical health outcomes after infancy and toddlerhood.

Since childhood overweight status and obesity presents a significant health problem, investigating other potential risk factors for these outcomes is warranted. Specifically, evaluating the potential effect of poor maternal mental health on childhood overweight and obesity may be an important step in the development of effective, evidence-based interventions. Thus, the purpose of this study was to examine the association between maternal mental health and childhood overweight and obesity in children ages 10 to 17 using data from the 2011-2012 National Survey of Children's Health. Furthermore, this study examined whether race/ethnicity of the child is an effect modifier of the association.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview of Childhood Overweight and Obesity

2.1a Prevalence of Childhood Obesity

The prevalence of obesity in the United States has increased markedly over the last few decades and while the rate has plateaued for some sub-populations, there is no sign of an overall decrease in the prevalence (McAllister et al., 2009). For instance, between the early 2000s and 2007 and 2008 the prevalence of obesity among low-income children who participate in nutrition assistance programs showed little change (Ogden, Carroll, Kit, & Flegal, 2012). Nonetheless, rates of obesity have doubled in children and quadrupled in adolescents in the United States over the past 30 years (CDC, 2014). In fact, nearly one-fifth of children and adolescents ages 2-19 were obese in 2011-2012 (Ogden, Carroll, Kit, & Flegal, 2014).

2.1b Adverse Health Outcomes for Overweight and Obese Children

Both the physical and psychological health of a child can be affected significantly if his/her weight is too high (Dehghan, Akhtar-Danesh, & Merchant, 2005). Children who are too heavy may suffer both short and long term health consequences. Short term effects of overweight or obesity in children include increased risk for high cholesterol, high blood pressure, pre-diabetes, and poor self-esteem (CDC, 2014). Obese children and adolescents also have a greater risk of social and psychological problems, which may persist into adulthood (CDC, 2012).

Overweight or obese children are also more likely to become overweight or obese adults and are at a much higher risk for adverse health outcomes such as cardiovascular disease (CVD), certain cancers, and stroke (CDC, 2014). For example, one study found 70% of obese children had at least one CVD risk factor, such as high blood pressure and high cholesterol, and 39% had two or more (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). Further, obese children and adolescents have been found to have a higher concentration of blood lipids, which characteristically consists of elevated serum low-density lipoprotein (LDL) cholesterol and triglycerides and lowered high-density lipoprotein cholesterol levels (Dietz, 1998). Children who are overweight are also at a higher risk of premature death; one study found adolescents with higher BMIs had a 30% higher rate of mortality as compared to adolescents with a healthy BMI (Biro & Wein, 2010).

2.1c Risk Factors for Childhood Overweight and Obesity

Factors such as age, sex, ethnic background, and socioeconomic class have been related to the risk of overweight and obesity in children (Gray et al., 2007). Aspects of a child's early life environment have also been associated with later childhood overweight and obesity (Bamman et al., 2014; Reilly et al., 2005). For instance, various studies have found an association between high parental BMI and risk for childhood overweight and obesity (Agras, Hammer, McNicholas, & Kraemer, 2004; Bammann et al., 2014; Dubois & Gerard, 2006; Lake, Power, & Cole, 1997; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Familial characteristics such as food preferences or family structure (e.g. single versus dual-parent household or number of children in the home) have also been associated with childhood overweight and obesity (Augustine & Kimbro, 2013; Chen &

Escarce, 2010; Veugelers & Fitzgerald, 2005). Similarly, children from single-parent households have been found to watch more television and have poorer eating habits as compared to children from two-parent households (Byrne, Cook, Skouteris, & Do, 2012).

Furthermore, children who did not participate in three specific household routines that included eating dinner as a family, getting adequate sleep, and/or having limits on screen-viewing time had a higher prevalence of obesity compared to those who participated in at least one of these routines (Anderson & Whitaker, 2010). Childhood habits such as having frequent tantrums over food or buying lunch at school, have also been associated with an increased risk of overweight in children (Agras, Hammer, McNicholas, & Kraemer, 2004; Veugelers & Fitzgerald, 2005). Additionally, in a cohort of American children, BMI-z scores were positively associated with parents who restrict foods, a permissive feeding style, and concern for the cost of healthy foods (Couch, Glanz, Zhou, Sallis, & Saelens, 2014). Parental restrictive feeding patterns have also been found to be associated with childhood obesity (Dev, McBride, Fiese, Jones, & Cho, 2013).

The built environment where a child lives and plays, can influence his or her physical activity and access to healthful foods; lack of neighborhood features such as sidewalks or playgrounds and access to high-caloric foods and convenience stores increases risk of overweight and obesity (Rahman, Cushing, & Jackson, 2011). Other risk factors for childhood overweight and obesity include excessive maternal weight gain during pregnancy (Bamman et al., 2014), high maternal preconception BMI (Catalano et al., 2009), maternal smoking during pregnancy (Reilly et al., 2005), and high intake of sugar-sweetened beverages by the child (Malik, Schulze, & Hu, 2006).

2.1d Racial/ethnic differences in childhood overweight and obesity

Significant racial and ethnic disparities in obesity prevalence exist among children and adolescents (2014, September 3a). Minority children experience higher rates of obesity as compared to white children (Fryar, Carroll, & Ogden, [September] 2012). For instance, obesity prevalence is higher among Hispanics (22.4%) and non-Hispanic black youth (20.2%) as compared to non-Hispanic white youth (14.1%) (Ogden, Carroll, Kit, & Flegal, 2014). Further, the rate of obesity was found to be twice as high among American Indian/Native Alaskan (31.2%) children who took part in the Early Childhood Longitudinal Study as compared to non-Hispanic white (15.9%) or Asian (12.8%) children (Anderson & Whitaker, 2009). Additionally, when analyzing and comparing data from NHANES 1999-2000 and 2009-2010, researchers found significant differences in weight status of children by race/ethnicity; Mexican Americans had an increased odds of high weight-for-recumbent length than non-Hispanic whites (adjusted for sex and survey period: OR=1.67 [95% CI: 1.29-2.15]) (Ogden Carroll, Kit, & Flegal, 2012). Further, the same study showed a higher prevalence of obesity among Hispanic and non-Hispanic black children and adolescents (21.2% and 24.3%, respectively) compared to non-Hispanic white children (14.0%) (Ogden Carroll, Kit, & Flegal, 2012).

2.2 Maternal Mental Health

2.2a Scope and Prevalence

While mental illness affects both men and women, gender differences in mental health have been observed (Rosenfield & Mouzon, p. 277, 2013). Women suffer from certain types of mental illness and tend to have more internalizing disorders, live with more phobias, and experience more panic attacks as compared to men (Rosenfield &

Mouzon, 2013). Major depression is twice as common in women as it is in men (The World Health Organization [WHO], 2014). In fact, the ratio of depressed women to men is 2:1 across all ethnic groups (Kulkarni, 2007). Further, results from the National Comorbidity Survey Replication (NCS-R), showed the lifetime prevalence of Major Depressive Disorder (MDD) was statistically significantly elevated for women (OR=1.7, 95%= 1.5-2.0) (Kessler et al., 2003).

Correspondingly, a recent study found the prevalence rates of mood and anxiety disorders to be higher in women as compared to men, who had higher rates of antisocial and substance use disorders (Eaton et al., 2012). The same study found lifetime rates of generalized anxiety, panic disorder, and specific phobia were higher in women (5.8%, 7.2%, 12.4%; respectively) as compared to men (3.1%, 3.7%, 6.2%; respectively) (Eaton et al., 2012). Additionally, women of reproductive age (18-44) are particularly susceptible to mental health conditions such as anxiety and depression (CDC, 2013b). According to data from the 2005-2009 National Survey of Drug Use and Health (NSDUH), approximately 1 in 10 women (8% of pregnant women and 11% of non-pregnant women of reproductive age) had one or more major depressive episode within the past year (Ko, Farr, Dieth, & Robbins, 2012).

2.2b Risk factors, symptoms, and treatment

The incidence of mood disorders [e.g. all types of depression and bipolar disorder], increases in childbearing years, however, the etiology is not completely understood (Kulkarni, 2007). Even so, risk factors for major depression and other serious psychological distress in non-pregnant women 18-44 years of age have been identified and include: older age, less education, being unmarried, inability to work or

unemployment, and low income (Farr, Bitsko, Hayes, & Dietz, 2010). Women may also be exposed to increased stress due to their socially-defined roles and when this stress is coupled with other negative experiences such as family violence and abuse, it can lead to higher rates of depression and anxiety (WHO, 2012). Further, lack of social support has been shown to be associated with higher odds of depression in women of reproductive age (OR=2.13, 95%: 1.30, 3.57) (Lee, Casanueva, & Martin, 2005).

The postpartum period leaves women particularly vulnerable to depressive symptoms and women who have experienced depression at another time in their life are at even greater risk of postpartum depression (Kulkarni, 2007). Depression and/or anxiety during pregnancy, experiencing stressful life events during pregnancy or just after giving birth, low levels of social support, and having a previous history of depression were the strongest predictors of postpartum depression (Stewart, Robertson, Dennis, Grace, & Wallington, 2003). Similarly, women with premenstrual dysphoric disorder, women who experienced mood symptoms within two to four days postpartum, and women with a past history of depression and mood symptoms when using oral contraceptives were found to be at greater risk for the development of postpartum mood disorders (Bloch, Rotenburg, Koren, & Klein, 2005).

Symptoms of mood disorders may include: persistent sadness, depressed mood, noticeably diminished interest in regular activities, significant weight fluctuations, insomnia or hypersomnia, fatigue, feelings of worthlessness or excessive guilt, difficulty concentrating, and recurrent thoughts of death, suicidal ideation, or suicide attempt (Johns Hopkins Medicine, n.d.). Anxiety disorders have different symptoms; however, all symptoms can be related to excessive and irrational fear and dread (NIMH, 2009).

Treatment of mental disorders varies depending on the individual, but typically involves some combination of psychotherapy, pharmaceutical therapy, and/or somatic therapies like electroconvulsive therapy or transcranial stimulation (National Alliance on Mental Illness [NAMI], 2014).

2.3 Maternal Mental Health and Childhood Overweight and Obesity

Many risk factors for childhood overweight and obesity have been identified in the literature. Psychosocial stressors, or events or conditions that threaten a person's well-being, have been associated with a variety of negative health outcomes in children and adolescents including overweight and obesity (Gunderson, Mahatmya, Garasky, & Lohman, 2010). Certain household characteristics can make some families more vulnerable to such stressors, thus heightening the risk for health problems like overweight and obesity (Gunderson, Mahatmya, Garasky, & Lohman, 2010). For example, exposure to family stress, specifically maternal stress, has been associated with poor child weight status (Stenhammer et al., 2010). Additionally, maternal psychological distress was significantly greater in mothers of obese youth as compared to mothers of non-overweight youth (Zeller et al., 2007). Further, poor family cohesion, high conflict and disruptive home environments have been associated with an elevated risk for overweight or obesity in children (Gunderson, Mahatmya, Garasky, & Lohman, 2010). These stressors have also been associated with increased maternal stress and/or distress suggesting it is plausible that maternal mental health is associated with childhood overweight or obesity.

2.3a Maternal Mental Health Measured Prenatally, Postpartum and/or During Early Childhood

The association between maternal mental health and childhood overweight and obesity has been studied, however, results have been inconsistent (Duarte et al., 2012; Ertel et al. 2010; Ertel et al., 2012; Lampard, Franckle, & Davison, 2014; Wang et al., 2013). Further, many of the studies examining this connection measure maternal mental health before the woman has given birth (antenatal), during the postpartum period (birth to year one) and/or during early childhood (age 0-8). By measuring maternal mental health during these time periods, researchers are not considering mothers who may have chronic mental health issues or those who experience mental health challenges later in their child's life. For example, among a cohort of 838 mother-child dyads in the United States, children of mothers who experienced depression, measured six months postpartum using the Edinburgh Postnatal Depression Scale (EPDS), had greater overall adiposity at age three as measured by the sum of subscapular (SS) and triceps (TR) skinfold thickness (SS+TR: 1.14 mm, [0.11, 2.18]) (Ertel et al., 2010). Their findings also demonstrated that while children whose mothers reported antenatal depression were lighter in weight compared to unexposed children, they had more central adiposity, measured as a ratio of SS to TR (SS:TR 0.05 [0.01, 0.09]). Their findings also indicated postpartum depression was not predictive of BMI >85th percentile (OR = 0.87; 95% CI: 0.45, 1.67) or < 15th percentile (Ertel et al., 2010). Limitations of this study include a relatively small sample size and concerns about generalizability due to the relatively high socioeconomic status among a majority of participants.

A prospective study that included 1,343 white, 355 black, and 128 Hispanic

mother-child pairs in the United States identified maternal depression during pregnancy as a risk factor for obesity at age 3, specifically among black and Hispanic children as compared to white children (black children: OR=2.31, 95% CI: 1.47, 3.62; Hispanic children: =2.96, 95% CI: 1.55, 5.62); however, these findings were adjusted for child sex only (Taveras et al., 2009). After adjustment for other covariates, the findings were no longer statistically significant. Limitations of the study include a high rate of non-random loss to follow up (42%) between measurements which could have resulted in an over or under estimate of the association. Additionally, researchers excluded Asian and multiracial participants from analyses and education and income levels were generally high among the study population; thus, results may not be generalizable.

A prospective population-based analysis of 6,782 mother-child pairs from the Netherlands' Generation R Study examined the association between maternal depression, assessed mid-pregnancy and 2 and 6 months postpartum using the Brief Symptom Inventory, and child BMI z-scores measured at 3 years of age (Ertel et al., 2012). The adjusted complete-case models showed a positive association between maternal depression at 2 months postpartum and child BMI z-score (β=0.27, 95% CI: 0.08, 0.45) (Ertel et al., 2012). However, the same models did not show an association between antenatal depression (β=0.11, 95% CI: 0.05, 0.28, p-value=0.19) or depression at 6 months postpartum (β=0.11 (_0.09, 0.30, p-value=0.29) and child BMI (Ertel et al., 2012). Further, when researchers used a multiple imputation model to account for missing data for several variables, researchers found no association between maternal depression at any time point and child BMI at 3 years of age. The study was not without limitations including missing data for several variables and a somewhat homogenous

sample of women from the Netherlands who were more likely to have higher incomes and education levels, and less likely to have prenatal depression as compared to the entire Generation R sample (Ertel et al., 2012). Thus, results are not easily generalizable to mothers and children in the United States.

Another study conducted in the United States (n=1,090) found the presence of postpartum depression, measured using the Center Epidemiologic Studies Depression Scale (CES-D), when the child was 1 month, 24 months, and 36 months of age, increased their risk of being overweight after controlling for child characteristics such as gender, birth weight, and ethnicity (OR=1.695, 95% CI: 1.001, 2.869) (Wang et al., 2013). Even greater odds of childhood overweight were observed if maternal depression was present at the same three intervals after controlling for sex, birth weight in kilograms, and ethnicity of the child as well as maternal age, education, marital status, income, breastfeeding status, smoking status within 1 year prior to birth, employment, and social support and sensitivity (OR= 2.13 95% CI: 1.05, 4.31) (Wang et al., 2013). Standardized procedures were used to collect each child's height and weight and then used to calculate CDC BMI age- and gender-specific percentile scores and corresponding standardized BMI z-scores. However, limitations do exist; researchers excluded low birth weight, premature, or sick infants from the study, conditions that have been associated with poor maternal mental health outcomes. The study may also lack generalizability since the authors only included English speaking parents, a majority of whom were affluent and highly educated.

A study of 3,792 urban Brazilian children investigated the association between maternal depression, as measured by a score $\geq$13 on the EPDS at 12, 24, and 48 months

postpartum, and child growth at age four, as measured by weight-for-age, height-for-age, and weight-for-height z-scores calculated according to WHO growth curves. Unadjusted analyses showed maternal depression was positively associated with underweight and stunting, however, after adjustment, the presence of maternal depression at each of the three follow-ups was not found to be a statistically significant risk factor for child overweight at age 4 (OR=1.6; 95% CI: 1.00, 2.5) (Santos et al., 2010). Because data were collected from Brazilian mothers and their children, results may not be generalizable to mothers and children in the United States.

Another study conducted using data from five high-income European countries also found no association between maternal depression, measured using the EPDS two, three and six months postpartum, and a child's BMI or other anthropometric indicators in the first two years of life (Grote et al., 2010). The weight-for-length Z-scores of infants whose mothers had high EPDS scores (-0.55, SD 0.74) were lower than infants whose mothers had normal EPDS scores (-0.36, SD 0.74; p=0.013). Further, BMI at 24 months of age did not differ between the high (16.3 kg/m2, SD 1.3) versus the normal EPDS groups (16.2 kg/m2, SD 1.3; p = 0.48). However, it is important to note that data from a randomized controlled trial assessing the effects of feeding a child a high- versus low-protein formula on childhood overweight was used for this study; thus participants' weight status could have been influenced by the amount of protein in the formula they received. Further, European data cannot necessarily be generalized to the population in the United States.

A European-based study of 21,000 mother-child dyads showed postpartum distress, was not associated with childhood risk of overweight at 7 years of age

(OR=1.00, 95% CI: 0.98, 1.02) (Ajslev et al., 2010). Maternal distress was measured six months postpartum as a summation of nine items chosen from the Symptom Distress Checklist (SCL-90) and the General Health Questionnaire (GHQ 60). The compiled items from the SCL-90 and GHQ 60 encompassed measures of depression, anxiety, and stress (Ajslev et al., 2010). Further, there was no association between exposure to maternal depression (OR= 1.01, 95% CI: 0.96, 1.07), anxiety (OR= 1.00, 95% CI: 0.96, 1.06), or stress (OR=0.99, 95% CI: 0.94, 1.05) independently and risk of childhood overweight (Ajslev et al., 2010). Results remained unchanged even after adjustment for potential confounders (Ajslev et al., 2010). However, because the study took place in Denmark, results cannot necessarily be extrapolated to mothers and children in the United States.

In contrast, Ramasubramanian et al. (2011) found maternal serious psychological distress, measured via Kessler-6 scores, was significantly associated with early childhood obesity, defined by the International Obesity Task Force cut-offs for BMI, among a UK cohort of 10,465 3-year-olds both before and after adjusting for potential confounders (Unadjusted OR=1.62, 95% CI: 1.11, 2.37, p=0.01; Adjusted OR 1.59, 95% CI: 1.08, 2.34, p=0.01). However, data were only collected for children 3 years of age and thus does not provide information about associations with maternal serious psychological distress and overweight and obesity in older children.

Similarly, results from a Swedish study of 843 parent-child dyads reported maternal Swedish Parenthood Stress Questionnaire [SPSQ] scores, assessed when the children were 3 years old, were statistically significantly associated with child BMI; specifically, there was a positive dose-response relationship between a mother's SPSQ score and the child's weight at 3 years of age (OR=4.61, 95% CI: 3.11, 6.84; $p < 0.001$)

(Stenhammer et al., 2010). The SPSQ measures aspects of perceived psychosocial stress associated with parenting and is a revised version of the American Parenting Stress Index. It is important to note the five maternal SPSQ subscales had consistent associations with both overweight and underweight in children (Stenhammer et al., 2010). However, due to the small sample size and the location of the study, generalizability to a United States sample population is limited.

A cross-sectional study of 401 low-income mother-child dyads living in the United States indicated that mothers with moderate to severe depression, measured using the Patient Health Questionnaire-9 (PHQ-9) when the child was 5 years old, were more likely to have an overweight or obese 5-year old as compared to non-depressed mothers (adjusted odds ratio [AOR] 2.62, 95% CI: 1.02, 6.70). Further, mild maternal depressive symptoms were found to increase the odds of having an overweight or obese child, however, this difference was not statistically significant (AOR 1.41, 95% CI: 0.73, 2.74) (Gross, Velazco, Briggs, & Racine, 2013). Mothers with depressive symptoms were also more likely to engage in several obesity-promoting practices such as using food as a reward or restricting food intake and their children were more likely to drink sweetened beverages and eat out at restaurants (Gross, Velazco, Briggs, & Racine, 2013). However, the study has limited generalizability due to the small, homogenous sample of low-income mothers from the Bronx, New York.

Research by Topham and colleagues (2009) supported that for depressed mothers, the interplay between maternal depression, measured by the CES-D scale when the child was approximately 6 years of age, and a permissive parenting style, measured by the Parenting Styles and Dimensions Questionnaire (PSDQ), was predictive of childhood

obesity in first-graders. To illustrate, each one-point increase in permissive parenting among the depressed mothers increased the odds of their child being obese by 6.74 times (OR=6.74, 95% CI: 0.96, 47.16). While not statistically significant, this finding suggests depressed mothers may generally have a parenting style that interacts with the risk of childhood obesity. However, this study was limited by a relatively small (n=176), homogenous sample of predominantly Euro-American mother-child dyads from a rural Midwest state (Topham et al., 2009).

2.3b Maternal Mental Health Measured During Middle Childhood and/or Adolescence

While most studies measured maternal mental health prenatally or during early child development, some researchers have assessed maternal mental health in older children. For instance, a cross-sectional case-comparison study of youth ages 6 to 13 in Australia found maternal depression was not directly associated with childhood obesity; however, after controlling for BMI-z scores, mothers of treatment-seeking overweight and obese children within the sample (n=23) were significantly more depressed than mothers of equally overweight, non-treatment seeking children (n=114) (Gibson et al., 2007). While the temporality of the association cannot be determined from data, it does imply that maternal mental health may influence the treatment-seeking behaviors of parents with overweight children (Gibson et al., 2007). Results should be thoughtfully considered due to the relatively small sample (n=329) and limited generalizability to the United States population.

Additionally, Gunderson et al., (2008) conducted a study in the United States of low-income children ages 3 to 17 years (n=841 mother-child dyads) and found children living in food secure households who experienced higher levels of maternal stressors

were at increased risk of being overweight (according to CDC age- and sex-specific BMI percentiles) as compared to low-income, food insecure children. Further, when a one-standard deviation increase above the mean in the total cumulative stressor index was tested, it revealed food-secure children had a 43.7% greater likelihood of being overweight or obese as compared to food insecure children (Gunderson et al., 2008). Maternal stress was measured using a cumulative maternal stressor model that included questions assessing maternal depression, anxiety, and occurrence of panic attacks (Gunderson et al., 2008). However, this study was not without limitations; first, due to confidentiality restrictions the researchers were unable to ascertain if the woman surveyed was the child's mother or some other relative. Second, the researchers only assessed low-income children, thereby limiting generalizability to other socioeconomic groups.

Similarly, Garasky et al., (2009) found that among a large nationally representative sample of 5-17 year-olds, overweight and obese adolescents ages 12-17 years (n=1,001) resided in households with higher levels of mental and physical health issues. More specifically, findings revealed that an adolescent experiencing one additional mental [or physical] health stressor within their household has a 6.0% lower likelihood of being healthy weight, a 1.6% higher likelihood of being overweight, and a 4.4% higher likelihood of being obese (Garasky et al., 2009). However, limitations of this study include a relatively small sample size and that both mental and physical health issues of the primary caregiver were assessed as one exposure.

In contrast, a retrospective cohort study of 1,011 mother-child dyads, identified from the first wave of interviews of the Welfare, Children, and Families: A Three-City

Study, found a food insecure child's probability of being overweight increases as maternal stressors increase. More specifically, analyses highlighted a statistically significant, positive relationship between food insecurity, maternal stress, and child overweight for adolescents 10 to 15 years of age (Lohman et al., 2009). Of note, six constructs were used to assess maternal stress during one in-home interview and included the Rosenberg Self-Esteem Scale and 18-items from the Brief Symptom Inventory (Lohman et al., 2009). It is important to note that the study's generalizability is limited by the relatively small, homogenous sample of low-income mothers and their children from only three cities in the United States.

Last, Zeller et al. (2007) found among 149 parent-child dyads, the mothers of obese youth ages 8 to 16 years reported significantly greater psychological distress over the past week, measured by the Symptom Checklist90-Revised, as compared to mothers of non-overweight youth (Maternal distress score for mothers of obese youth: μ=57.27, SD=11.19; Maternal distress score, mother of comparison group youth: μ=51.42, SD=10.31; two-tailed student t-test = 3.38 (0.53), p=0.01). However, the study sample was made up of families who were selected based on their access to and participation in a clinic-based pediatric weight management program and had successfully begun treatment; these factors limit the generalizability of the results.

2.4 Psychosocial & Behavioral Pathways in Childhood Overweight & Obesity

A child's weight status depend on numerous influencing environmental factors that often originate from the parent(s), especially in early life. Additionally, factors that directly influence children, like food intake, can be associated with other family characteristics (e.g., household income) which indirectly influence child health (Gable &

Lutz, 2000).

There are a variety of possible psychosocial and behavioral pathways explaining the relationship between maternal mental health and child overweight status or obesity. One such pathway suggests maternal psychological distress is related to poor parenting behaviors and disease prevention practices. For instance, maternal depression symptoms may be related to disordered feeding style which could result in weight issues (Surkan et al., 2008). Similarly, it has been suggested mothers who are experiencing psychological distress may make poorer food choices and/or use food to comfort or incentivize a child. These behaviors could cause the child to gain weight rapidly possibly leading to early childhood obesity (Ramasubramanian, Lane, & Rahman, 2013). Maternal depressive symptoms may also influence other identified risk factors for overweight in children thereby exacerbating the effects (Wang et al., 2013).

2.5 Summary

It is important to identify all potential risk factors for the development of overweight and obesity in children in order to develop targeted prevention strategies. Genetic, behavioral, and environmental risk factors associated with childhood overweight and obesity have been observed. In addition to these risk factors, researchers have begun to consider the etiologic importance of maternal mental health on childhood health outcomes. However, literature specifically addressing maternal mental health and childhood overweight and obesity in the United States is limited and often conflicting. Limitations of prior studies include small sample sizes (Garasky et al., 2009; Zeller et al., 2007) and lack of generalizability due to homogenous populations with similar socioeconomic or educational backgrounds (Ertel et al., 2010; Gross, Velazco, Briggs, &

Racine, 2013; Gunderson et al., 2008; Lohman et al., 2009; Taveras et al., 2009; Wang et al., 2013) or populations from outside the United States (Ajslev et al., 2010; Gibson et al., 2007; Grote et al., 2010; Ramasubramanian, Lane, & Rahman, 2013; Stenhammer et al., 2010).

Despite the limitations and inconsistencies, the literature still suggests that a woman's mental well-being is equally as important as her physical well-being in regard to the health and development of her offspring. Further, few studies have assessed the association between maternal mental health and childhood overweight and obesity while also considering race/ethnicity of the child as an effect modifier. Thus, the purpose of this study was to evaluate the relationship between maternal mental health and childhood overweight and obesity, and whether the child's race/ethnicity is an effect modifier of this relationship, using data from a nationally representative sample in the United States. Determining if maternal mental health is a risk factor for childhood overweight and obesity is important as it may provide an evidence-based objective for future obesity intervention strategies and could encourage novel approaches to obesity prevention. Additionally, if maternal mental health is identified as a risk factor this could also encourage clinicians to reframe preconception, conception, and postpartum care to include and emphasize mental health as much as physical health.

CHAPTER 3: HYPOTHESES

This study assessed the relationship between maternal mental health and childhood overweight and obesity among a nationally representative sample of mothers and children (ages 10-17) using data from the 2011-2012 National Survey of Children's Health (NSCH).

The following hypotheses were examined:

1. Poor self-reported maternal mental health is associated with an increased odds of childhood overweight and obesity.
2. Race/ethnicity of the child is an effect modifier of the relationship between poor maternal mental health and childhood overweight and obesity

CHAPTER 4: METHODS

4.1 Study Design & Population

This study used cross-sectional data from the 2011-2012 National Survey of Children's Health (NSCH). The NSCH was conducted from February 2011 through June 2012 by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) (Child and Adolescent Health Measurement Initiative [CAHMI], 2013). The survey is designed to capture prevalence data for a variety of child health and well-being indicators and these data are collected in a way that allows for comparisons between states (CAHMI, 2013). The purpose of the survey is to estimate the prevalence of physical, emotional, and behavioral child health indicators while also accounting for the child's family background and neighborhood context (CAHMI, 2013). Data collection was completed using the State and Local Area Integrated Telephone Survey (SLAITS) program (CAHMI, 2013). Households in the United States with at least one child between the ages of 0-17 are eligible to participate. Surveys have been professionally translated and can be conducted in English, Spanish, Mandarin, Cantonese, Vietnamese, or Korean. The child's information is reported by a primary parent or guardian who is knowledgeable of the health and health care of the sampled child in the household (CAHMI, 2013). Nearly 5,000 interviews were completed by a Spanish speaking interviewer and more than 200 were completed by an Asian-language interviewer (NSCH FAQs, 2013).

Two previous iterations of this survey were conducted in 2003 and 2007, but several distinct content changes were made to the 2011-2012 survey as compared to the previous versions (Centers for Disease Control and Prevention, National Center for Health Statistics, State and Local Area Integrated Telephone Survey, 2013). All 2011-2012 study participants were asked to report on demographics; health and functional status; health insurance coverage; health care access and utilization; medical home; family functioning; parental health; and neighborhood and community characteristics. However, only parents of children ages 0 to 5 years were asked questions about early childhood development and behavior, while only parents of children 6 to 17 years were asked questions about topics such as school enrollment, social activities, and technology use.

There were a total of 95,677 NSCH interviews completed. Data were collected from eligible households within the 50 states, the District of Columbia, and the United States Virgin Islands (USVI); however, interviews from the USVI were not included in the released NSCH data files. Prospective participants were identified using a list-assisted random-digit-dial (RDD) sample of landline telephone numbers, supplemented with an independent RDD sample of cell-phone numbers (NSCH FAQs, 2013). Participants included in the cell-phone sample (n=31,972) were eligible only if they reported they did not have a landline or were unlikely to be reached by landline even if they had access to one (NSCH FAQs, 2013). Households were considered eligible if there was at least one child age 0 to 17 living in the home at the time of the call; one child was selected for participation, even for households with multiple children (NSCH FAQs, 2013).

In the landline and cell phone samples, 847,881 households in the United States

and DC were screened. Among those households, 187,422 reported age-eligible children living in the home (NSCH FAQs, 2013). Interview completion rates were 54.1 percent and 41.2 percent for landline and cell phone samples, respectively (NSCH FAQs, 2013). Landline interviews took approximately 33 minutes on average and cell phone interviews took an average of approximately 34 minutes (NSCH FAQs, 2013). The number of completed interviews in each state ranged from 1,811 (South Dakota) to 2,200 (Texas) (NSCH FAQs, 2013). Results have been weighted to represent the population of non-institutionalized children ages 0-17 nationally and in each state (CAHMI, 2013).

A total of 95,677 NSCH 2011-2012 interviews were completed in the continental United States by parents/caregivers of children. For this study, interviews were excluded if a mother did not answer the survey (n=30,335). Additional exclusions were made if the sampled child was younger than 10 years of age (n=34,103). This particular exclusion was made primarily due to inconsistencies in reporting by the parent of the height and weight of children younger than 10 years of age, thus BMI data are only available for children 10-17 years of age in the NSCH. Children were further excluded if their mother did not provide complete information regarding her mental health status (n=154), education level (n=71), marital status and family structure (n=98), age (n=288), the child's height or weight (n=959), the child's race/ethnicity (n=346), or the child's health insurance coverage status (n=16). Thus, 29,307 children were available for analysis.

4.2 Measurement of Variables

4.2a Exposure Variable

Maternal mental health is the primary exposure variable. Mothers answered the following question in regard to their mental and emotional health status at the time of the

interview: "Would you say that, in general, your mental and emotional health is excellent, very good, good, fair, or poor?" If the respondent answered "fair" or "poor" the child was considered exposed. Alternatively, if the respondent answered 'excellent,' 'very good,' or 'good,' the child was considered unexposed. A response of 'don't know' or 'refused' was excluded from the analysis.

4.2b Outcome Variable

The primary outcome variable is the sampled child's weight status. BMI, which is calculated based on the mother's self-reported height and weight of the child, determined if the child was overweight or obese. BMI for children, which is also referred to as "BMI-for-age," is age and sex specific and translated into a percentile for analysis (CDC, 2014). An overweight child's BMI-for-age falls between the 85th and less than 95th percentile and an obese child's BMI-for-age will be greater than or equal to the 95th percentile (CDC, 2014). For the purposes of this study, overweight and obese were combined into one category; thus an overweight or obese child's BMI-for-age is greater than or equal to the 85th percentile. These categories were combined because both describe a child who has a BMI-for-age greater than what is generally considered healthy. Children below the 85th percentile were categorized as healthy weight.

4.3 Covariates

Race/ethnicity of the child was considered as a potential effect modifier of the exposure-disease association. This information is self-reported by the mother. The four racial/ethnic categories considered for this study were: 1. Hispanic, 2. White, non-Hispanic, 3. Black, non-Hispanic and 4. Other, non-Hispanic (considered to be a child reported as Asian, American Indian, Alaska Native, Native Hawaiian, Pacific Islander, or

multi-racial) (Data Resource Center for Child and Adolescent Health, CAHMI, 2013). Potential confounding factors included: age of the child, sex of the child, child insurance coverage status, maternal age, maternal education, maternal marital status, family structure (single-parent, dual-parent, or other family type), and household income (Braungart-Rieker, Moore, Planalp, & Lefever, 2014; Garasky, Stewart, Gundersen, Lohman, & Eisenmann, 2009; Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008; Lohman, Stewart, Gundersen, Garasky, & Eisenmann, 2009). All potential confounders were self-reported by the mother.

4.4 Data Analysis

Frequencies and percentages were calculated to describe the study sample. Logistic regression was used to obtain unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) to assess the association between maternal mental health and childhood overweight or obesity. In addition, other risk factors for childhood overweight/obesity were identified.

Multivariate logistic regression was utilized to calculate the OR and 95% CIs to assess the adjusted association between maternal mental health and childhood overweight and obesity while controlling for confounders (Table 3). Potential confounders included: age of the child, sex of the child, maternal age, maternal marital status, maternal education, household income, child's insurance coverage status, and family structure (single- or dual-parent family) (Braungart-Rieker, Moore, Planalp, & Lefever, 2014; Garasky, Stewart, Gundersen, Lohman, & Eisenmann, 2009; Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008; Lohman, Stewart, Gundersen, Garasky, & Eisenmann, 2009). If the potential confounding variable changed the OR by $\geq$ 10%, it

was considered a confounder of the association between maternal mental health and childhood overweight and obesity. Additionally, a stratified analysis was conducted to assess whether the race/ethnicity of the child was an effect modifier of the exposure-disease association (Table 4). Since the NSCH utilizes a complex weighting design, SAS-callable SUDAAN was used in all analyses.

4.5 Power and Sample Size

A total of 29,307 children were available for analysis. Considering children whose mothers reported ‘good’, ‘very good’, or ‘excellent’ mental health as unexposed, the ratio of unexposed to exposed was approximately 13.5:1. The prevalence of overweight and obesity among the unexposed was 30.28%. Setting alpha at 0.05 and power at 80%, the smallest detectable odds ratio was 1.15.

CHAPTER 5: RESULTS

5.1 Univariate results

Among the sample, 8.65% of children had mothers who reported poor mental and emotional health (n=2,023; Table 1). Additionally, the prevalence of overweight and obesity among the sample was 31.28%. Additionally, the distribution of race/ethnicity among the sample population was representative of the United States population of children under the age of 18 (United States Census Bureau, 2015); 58.01% of children were non-Hispanic white, 13.99% were non-Hispanic Black, 19.55% were Hispanic, and 8.44% were in the 'Other' category. Nearly one fifth (19.57%) of children in the sample lived in a home where the mother reported the household income was less than 100% of the Federal Poverty Level; however, almost 95% of the children in the sample had some form of insurance coverage. Over a third of the children lived with a mother who was not married at the time of the interview (30.98%).

5.2 Bivariate results

Children whose mothers reported being in poor mental health had 66% greater odds of being overweight or obese as compared to children whose mothers reported they were in good mental health and this result was statistically significant (OR=1.66, 95% CI: 1.36, 2.02; Table 2). More specifically, children whose mothers considered themselves to have poor mental health were more likely to be overweight or obese when compared to

children whose mothers considered themselves to be in good mental health. Compared to boys, girls had statistically significantly decreased odds of childhood overweight or obesity (OR=0.75, 95% CI: 0.67, 0.84). Children ages 10 to 12 and those ages 13 to 15 had statistically significant increased odds of being overweight or obese as compared to youth ages 16 to 17 (OR=1.73, 95% CI: 1.49, 2.01 and OR=1.32, 95% CI: 1.13, 1.55, respectively). All results in the bivariate analysis were statistically significant with the exception of children whose race/ethnicity was identified as "Other" and those with a family structure identified as "All other family structures."

Race/ethnicity was also found to be associated with a child's odds of overweight or obesity. Hispanic and non-Hispanic black youth had statistically significantly increased odds of overweight and obesity as compared to non-Hispanic white youth. Specifically, Hispanic children had 1.81 times the odds of overweight or obesity (95% CI: 1.51, 2.16) and non-Hispanic black children had over twice the odds of overweight or obesity as compared to non-Hispanic whites (OR=2.02, 95% CI: 1.73, 2.36).

Maternal marital status was statistically significantly associated with increased odds of overweight and obesity. Children of single, never married mothers had more than twice the odds of overweight and obesity as compared to children with married mothers (OR=2.01, 95% CI: 1.63, 2.48). Furthermore, as household income decreased, the odds of being overweight or obese increased. Specifically, youth who lived in a household with an income <100% of the 2015 Federal Poverty Guidelines (<$24,250 for a family of 4) had nearly a two-fold increase odds of overweight or obesity as compared to youth with a household income 200-399% of the Federal Poverty level (OR=1.98, 95% CI: 1.67, 2.35) (US Department of Health & Human Services, 2015).

5.3 Multivariate analysis

After adjustment for confounding variables, maternal marital status, maternal education, family structure and household income, the association between maternal mental health and childhood overweight and obesity was attenuated and no longer statistically significant. Specifically, children whose mothers reported having poor mental health had a 19% increased odds of being overweight or obese as compared to mothers who reported being in good mental health, but results were not statistically significant (95% CI: 0.97, 1.47; Table 3).

5.4 Effect Modification

Race/ethnicity modified the association between maternal mental health status and childhood overweight/obesity. Specifically, among non-Hispanic white children, those children with mothers who reported poor mental health status (6.81%) had 1.45 times the odds of overweight or obesity as compared to children whose mothers did not report poor mental health (95% CI: 1.09, 1.92; Table 4). Among children whose race/ethnicity was categorized as "Other," those with mothers who reported poor mental health (10.58%) also had increased odds childhood overweight or obesity as compared to children whose mothers did not report poor mental health; however, this result was not statistically significant (OR=1.69, 95% CI: 0.92, 3.09). In contrast, among Hispanic and non-Hispanic black children, there was no association between poor maternal mental health and childhood overweight or obesity (OR= 0.94, 95% CI: 0.57, 1.54 and OR= 0.90, 95% CI: 0.59, 1.37; respectively).

CHAPTER 6: DISCUSSION

In this cross-sectional study, poor maternal mental health was statistically significantly associated with overweight and obesity among children ages 10-17 in the unadjusted model. However, after adjustment for maternal education, marital status, family structure and household income, the magnitude of the association was attenuated and the result was no longer statistically significant. Additionally, race/ethnicity of the child was found to be an effect modifier of the maternal mental health-childhood overweight/obesity association.

The present study's results were consistent with the major findings of Ertel et al. (2010) who found postpartum depression, measured using the EPDS, was not a predictor of childhood overweight or obesity among 838 3-year-old American children. Similarly, results of this study were consistent with findings from Ajslev et al. (2010) who concluded no significant relationship was present between maternal postpartum distress, anxiety, depression, or stress, measured using nine items compiled from the SCL-90 and GHQ 60, and risk of overweight among a Dutch cohort of over 21,000 children ages 5 to 8 years.

In contrast, the current study's results did not support findings by Ramasubramanian et al. (2011) and Wang et al. (2013) who concluded that maternal mental health status increased a child's odds of being overweight or obese after adjusting for confounders. Specifically, findings from Ramasubramanian et al. (2011) demonstrate

that maternal serious psychological distress, measured via Kessler-6 scores, was significantly associated with early childhood obesity among a cohort of 10,465 3-year-olds in the United Kingdom. Similarly, research conducted in the United States by Wang et al. (2013) found that the presence of maternal postpartum depression measured via the CES-D when the child was one month, 24 months, and 36 months, increased the risk of childhood overweight. The discrepancies in findings could be due to the fact that Ramasubramanian et al. (2011) and Wang et al. (2013) used standardized methods to collect child weight and height and calculate BMI as opposed to using the mother's report of her child's height and weight. Furthermore, valid and reliable instruments were used to assess maternal mental health rather than relying on self-report. Additionally, previous studies have predominantly focused on maternal mental health post-partum or during the early stages of the child's development, while far fewer have examined the effects of maternal mental health in adolescent children. Thus, age differences in children at the time of maternal mental health assessment could help explain inconsistencies in that associations between maternal mental health and child weight appear when children are younger, but do not persist when the child is older.

Race/ethnicity was an effect modifier of the maternal mental health-childhood overweight/obesity association. Perceptions, attitudes, and beliefs about mental health may be influenced by a person's race/ethnicity and vary based on each individuals' social and cultural context (US Department of Health and Human Services [DHHS], 2001). As such, effect modification results from the present study may be explained by a variety of social and cultural factors such as disparities in mental health care among minorities. Minorities have less access to, and availability of, mental health services and are less

likely to receive needed services. Further, minorities often receive poorer quality mental health care and are often underrepresented in mental health research (DHHS, 2001). These disparities may alter an individual's perspective on mental health and mental health care, and ultimately discourage care-seeking behaviors.

Furthermore, treatment seeking behaviors for mental health issues may also vary between races/ethnicities due to beliefs about mental illness. Culture may influence whether people seek help at all and if so, what types of help they seek. Culture can also play a role in a person's coping styles, their selection of social support systems, and the level of stigma they attach to mental illness (DHHS, 2001). One study examining predictors of mental health service use among an ethnically diverse group of patients at a public clinic found white women were much more likely to have made a mental health visit in the past as compared to the ethnic minority women (Alvidrez, 1999). Additionally, even after removing instrumental barriers, such as access to service, psychological barriers to utilizing mental health services may exist. For example, exposure to mental health issues and attitudes and beliefs about the causes of mental illness and the stigma associated with it, may influence utilization practices among ethnic minorities (Alvidrez, 1999). These observed differences could possibly account for inaccuracies in self-reporting about mental and emotional distress among minorities.

Like all research, the present study had limitations and strengths. The exposure and outcome variables were self-reported by the child's mother and were not confirmed by medical records, thus increasing the possibility for nondifferential misclassification of the exposure and/or the outcome. The exposure variable, maternal mental health, was assessed using only one item on the NSCH questionnaire and since no definition of

mental or emotional health was given to respondents, some respondents may have had difficulty understanding the question. Thus, mothers answered this survey item based on their own interpretation of mental health, which may have resulted in inaccurate reflections of their true mental health status. If this occurred, nondifferential misclassification of the exposure may have occurred, thereby biasing results towards the null.

In addition, nondifferential misclassification of the outcome, childhood overweight and obesity, may have occurred due to the mother's potentially inaccurate perception of her child's height and/or weight. For instance, if the child visits the doctor infrequently, the mother may not know the child's most up-to-date height and weight measurements. Cultural perceptions of weight status may have also resulted in inaccurate reporting of the child's measurements. In fact, a meta-analysis examining the literature on the disconnect between parental perceptions of their child's weight status and actual weight status found that parents often underestimate their child's weight, especially if they themselves are overweight (Doolen, Alpert, & Miller, 2009). It is important to note that the NSCH survey does not include BMI for children under 10 years of age due to the inconsistencies in reporting of the child's height and weight by the parent, thereby somewhat limiting nondifferential misclassification. However, if this type of misclassification did occur, it would likely bias the results towards the null.

Potential confounders related to both the exposure and the outcome were considered including: child sex, child age, child race/ethnicity, child's health insurance coverage status, maternal age, maternal education, maternal marital status, family structure, and household income (Braungart-Rieker, Moore, Planalp, & Lefever, 2014;

Garasky, Stewart, Gundersen, Lohman, & Eisenmann, 2009; Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008; Lohman, Stewart, Gundersen, Garasky, & Eisenmann, 2009). However, the existence of another unknown variable, such as the child's diet or level of physical activity related to both the exposure and outcome that is not on the causal pathway is possible. Failure to control for an unknown confounder could result in an over or underestimate of the true association.

Selection bias may have occurred due to only choosing families with a telephone. Creating a random sample by using a list of telephone numbers may result in leaving out people who do not have a telephone or those who only have a cell phone that has an area code outside of the area being surveyed. Thus only choosing people with a telephone systematically excludes certain types of potential respondents. Additionally, low interview completion rates presented a concern for selection bias; 54.1% of the landline sample and 41.2% of the cell-phone sample had complete interviews (NSCH FAQs, 2013). However, these completion rates are comparable to the response rates for the BRFSS survey (median response rate=46.4%) (CDC, 2014). An over or underestimate of the true association may have occurred if completion of the survey was somehow related to the exposure and outcome. However, surveillance methodology of the NSCH involves telephone contact by trained interviewers and bi-lingual options to increase the likelihood of interview completion and thereby minimize selection bias concerns.

Additionally, the potential for information bias is present. Height and weight of the sampled child were self-reported by the mother. If the mother of an overweight or obese child also has poor mental health, she may have reported inaccurate outcome

information as compared to mothers without poor mental health. However, extensive training of the survey interviewers limits concerns about this type of bias.

This study had several strengths. Unlike prior studies, this study considered race/ethnicity of the child as an effect modifier of the maternal mental health-childhood overweight/obesity association, which allowed for more rigorous examination of the influence race/ethnicity may have on the magnitude of this relationship. Further, NSCH uses a complex sampling design that helps ensure results are generalizable to children throughout the United States. Finally, the current study also considered the maternal mental health-childhood overweight/obesity association among older children and had a larger sample size compared to previous studies examining maternal mental health and childhood overweight and obesity (Braungart-Rieker et al., 2014; Gross et al., 2013; Wang et al., 2013).

Based on the current study's findings, it does not appear children ages 10-17 years have an increased risk of overweight or obesity based on their mother's mental health status. However, it is important to recognize the present study demonstrated the child's race/ethnicity was an effect modifier of the maternal mental health-child overweight/obesity association. Specifically, this finding demonstrated statistically significantly increased odds among non-Hispanic white children. Children categorized as "Other" race/ethnicity also had increased odds, but the finding was not statistically significant. No statistically significant relationship was found among non-Hispanic black or Hispanic children.

Although the current study did not find a strong association between maternal mental health and childhood overweight/obesity, more research is warranted. Research

examining the maternal mental health-childhood overweight/obesity association among older children is limited, therefore researchers should focus future study among this group. Further, the exposure should be collected using a valid, reliable instrument to more accurately ascertain maternal mental health status. The method by which maternal mental health was assessed in this study did not account for the potential effects of chronic mental illness on child overweight and obesity during middle childhood and adolescence. The timing and chronicity of mental health issues may have undiscovered influence on childhood overweight and obesity. For example, researchers may investigate whether episodic mental health issues, such as postpartum depression, have a different level of influence on child weight status versus intermittent or chronic depression. Furthermore, measuring the mother's mental health at different intervals would also enable investigators the opportunity to also obtain multiple measurements of the children's height and weight instead of relying on self-report.

While current results indicate maternal mental health does not directly influence childhood overweight and obesity, a mother's emotional well-being may influence other risk factors affecting the health of her children including their weight status. The presence of effect modification suggests providing mental health resources may be especially important among non-Hispanic white mothers. Additionally, mental health screenings may be important among new mothers as it may help reduce the risk of overweight and obesity. It may also be important to provide clinicians with training and education about the role of maternal mental health in the health of children. Thus, providing mothers with mental health support and resources as a part of routine health visits for mother and child may aid in the prevention of childhood overweight and obesity.

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APPENDIX: TABLES

Table 1: Demographic Characteristics of Selected Mothers and Children who participated in the 2011-2012 National Survey of Children's Health

	n	%[1]
Poor Maternal Mental Health		
Yes	2,023	8.65
No	27,284	91.35
Childhood Overweight/Obesity		
Yes	8,453	31.28
No	20,854	68.72
Child Age in Years		
10-12	10,330	36.32
13-15	10,662	38.15
16-17	8,315	25.54
Child Race/ethnicity		
Non-Hispanic White	20,875	58.01
Non-Hispanic Black	2,665	13.99
Hispanic	3,189	19.55
Other	2,578	8.44
Child Sex		
Male	15,116	50.03
Female	14,191	49.97
Maternal Age		
21-29 years	367	2.20
30-39 years	6,418	32.64
40-49 years	15,405	49.50
>50 years	6,834	15.66
Maternal Education		
Less than HS graduate	1,860	11.89
HS graduate	5,400	21.96
More than HS	22,047	66.15
Household Income		
< 100% Federal Poverty Level (FPL)	3,806	19.57
100-199% FPL	5,006	21.34
200-399% FPL	9,357	29.60
≥400% FPL	11,138	29.49
Family Structure		
Two parent household	22,834	73.59
Mother-only household, no father present	6,362	26.15
All other family structures	111	0.26
Maternal Marital Status		
Married	21,761	69.02
Cohabiting	1,073	4.76
Separated or Divorced	4,792	18.77
Never married	1,570	7.45
Child Health Insurance Status		
Yes (*has some form of health insurance*)	28,003	94.73
No	1,304	5.27

[1] Weighted percent

Table 2: Unadjusted Association (reported as Odds Ratios) between Various Demographic and Lifestyle Characteristics and Childhood Overweight and Obesity

Variables	Odds Ratios (OR)	95% Confidence Intervals (CI)
Poor Maternal Mental Health		
Yes	1.66	1.36, 2.02
No	1.00	Referent
Child Sex		
Male	1.00	Referent
Female	0.75	0.67, 0.84
Child Age in years		
10-12	1.73	1.49, 2.01
13-15	1.32	1.13, 1.55
16-17	1.00	Referent
Child Race/Ethnicity		
Non-Hispanic White	1.00	Referent
Non-Hispanic Black	2.02	1.73, 2.36
Hispanic	1.81	1.51, 2.16
Other	1.23	0.99, 1.52
Child health insurance coverage status		
Yes	1.00	Referent
No	1.48	1.14, 1.93
Maternal Age		
>20-29 years	0.94	0.65, 1.37
30-39 years (ref)	1.00	Referent
40-49 years	0.68	0.59, 0.77
≥50 years	0.64	0.54, 0.76
Maternal Education		
Less than HS graduate	1.52	1.21, 1.91
HS graduate	1.71	1.49, 1.97
More than HS	1.00	Referent
Maternal Marital Status		
Married	1.00	Referent
Cohabiting	1.68	1.30, 2.17
Separated or Divorced	1.67	1.44, 1.93
Never married	2.01	1.63, 2.48
Family structure		
Two parent household	1.00	Referent
Mother-only household, no father present	1.70	1.49, 1.92
All other family structures	1.10	0.54, 2.22
Household Income		
< 100% Federal Poverty Level [FPL]	1.98	1.67, 2.35
100-199% FPL	1.50	1.27, 1.78
200-399% FPL	1.00	Referent
≥400 FPL	0.66	0.57, 0.76

Table 3: Adjusted Odds Ratios and 95% Confidence Intervals between Maternal Mental Health and Childhood Overweight and Obesity

Variables	**Odds Ratio (OR)**	**95% CI**
Poor Maternal Mental Health[1]		
Yes	1.19	0.97, 1.47
No	1.00	Referent

[1]This model was adjusted for: maternal marital status, maternal education, household income, and family structure (single-parent, dual-parent, or other family structure type)

Table 4: The association between maternal mental health and childhood overweight and obesity, as modified by the child's race/ethnicity

		Poor Mental Health		Good Mental Health	
Race/Ethnicity	**% with Poor Mental Health**	**OR**	**95% CI**	**OR**	**95% CI**
Non-Hispanic White	6.81	1.45	1.09, 1.92	1.00	Referent
Non-Hispanic Black	13.14	0.90	0.59, 1.37	1.00	Referent
Hispanic	10.08	0.94	0.57, 1.54	1.00	Referent
Other	10.58	1.69	0.92, 3.09	1.00	Referent

This model was adjusted for: maternal marital status, maternal education, household income, and family structure (single-parent, dual-parent, or other family structure type)