The Association Between Depression and Overweight/Obesity Among Ethnic Minority Youth

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Abstract

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Depression and obesity are two conditions that influence many of today's children and adolescents. Individually, each condition can have adverse developmental and functional consequences. There is growing interest in examination of the two together and recent research has established a link between them. This dissertation study reviews the current knowledge about the association between depression and overweight/obesity in youth, as well as risk factors for overweight/obesity. It adds new directions to the recent research by exploring the association among ethnic minority youth in order to address the shortcomings of previous studies. Two separate study samples were examined in this dissertation. Study 1 consisted of 1,106 ethnically diverse middle school students from Seattle, WA. An examination of race/ethnicity and gender differences in the association between depression and overweight/obesity was conducted using a cross-sectional design. Results suggested that a positive association existed for White adolescents, but not for the other groups. In addition, Latino adolescents had higher weight status compared to their peers who were White. Further, a three-way interaction emerged whereby Latino males with higher levels of depressive symptoms had lower weight status as well as decreased odds of being classified overweight/obese. Study 2 consisted of two examinations with a sample of 674 Mexican

American youth from Northern California. The first was a longitudinal examination of the depression–overweight/obesity association as Mexican American children transitioned from 5th -7th grade. While no association was found from 5th to 6th grade, a negative association emerged whereby higher weight status in 6th grade was associated with lower depressive symptoms in 7th grade. The second examination tested a hypothesized model of the development of overweight/obesity among Mexican American adolescents. The model found that sleep influences physical exercise and depression among Mexican American youth, but risk factors and predictors for overweight/obesity were not found and remain unclear. Together, results from both Study 1 and Study 2 provide complex support for the association among Latino youth and suggest that the two conditions may not be positively associated among this ethnic group.

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CHAPTER 1

Introduction to the Dissertation

Extensive research has been conducted in the area of child depression, as well as in the area of child obesity. Separately, they have been considered of great importance for the mental and physical well-being of children and adolescents in the United States. More recently, in order to uncover possible links between child obesity and depression, there has been a growing interest on the examination of the two together. Little, however, has been done to shed light on the nature of the association among ethnic minority children and adolescents, particularly among racial and ethnic groups that have been identified as being at most risk for both depression and obesity. The purpose of this review is to provide a useful and brief summary of the state of the literature on the co-occurrence of youth depression and obesity and to describe how they have been examined in relation to one another. The coverage will be selective and focus largely on empirical work examining the co-occurrence of depression and obesity in youth, particularly highlighting what is known about the two topics across ethnic minority groups. The review will begin with sections that summarize the main risk factors for overweight and obesity among youth, followed by the main findings on the co-occurrence of depression and obesity. The remainder of the paper details the aims of the dissertation study, followed by methods, results, limitations, and implications of the dissertation. Throughout the paper, "children" will be used to refer to children up to 12 years of age, "adolescent" will refer to 13-18 years of age, and the word "youth" will be used to refer collectively to both children and adolescents. In accordance with guidelines from the Centers for Disease Control (CDC, 2011) , youth were classified as "overweight" if they had a Body Mass Index (BMI) greater than or equal to the 85th percentile through the 95th percentile, "obese" if they had a BMI greater than or equal to the 95th percentile, and "overweight/obese" to refer collectively to both.

RISK FACTORS FOR OVERWEIGHT AND OBESITY IN YOUTH

Overview

The vast majority of research examining obesity has focused on genetic and environmental factors that account for the development of this complex disorder among youth (e.g., Comuzzie, Williams, Martin, & Blangero, 2001; Croker & Yanovski, 2009). Genetic studies have suggested that 60-80% of observed variance in weight is accounted for by genetic influences (Wardle, Carnell, Haworth, et al, 2008). Despite the fact that susceptibility to obesity is determined largely by genetic influences, the environment plays a critical role in determining the phenotype expression. The nationwide prevalence for childhood obesity has increased so rapidly that significant changes in the gene pool cannot be considered as the only explanation (U.S. Center for Disease Control and Prevention, 2009). The current environmental factors in the U.S, including an unlimited supply of convenient, energy-dense foods, coupled with lifestyles typified by low physical activity, have been identified as contributing to recent child and adolescent obesity rates. For example, Simon et al. (2006) found that, at a community level, obesity is associated with greater access to inexpensive, calorie-dense foods and with reduced opportunities for physical activity. Such findings support the fact that obesity emerges when there is an imbalance between energy intake and expenditure. The term "obesogenic" environment has been coined to describe the industrialization and modernization of surroundings that require little energy expenditure, paired with caloric overabundance in high density foods, thus resulting in an imbalance and leading to overweight and obesity. Of note, the concept of energy intake includes all foods and drinks that are consumed, and the concept of energy expenditure is much more complex concept as it includes a combination of resting metabolic rate, thermic effects of food, and all of the activities an individual does in a day (Krebs, Himes, Jacobson, Nicklas, Guilday, 2007). The following describes environmental risk factors for overweight/obesity in youth.

Family and Parental Overweight. The strongest predictor for an overweight child is an overweight parent, and having 2 overweight parents has been associated with an increased risk of a child being obese

in White, Black (Dubois & Girard, 2006; Salsberry & Reagan, 2005; Whitaker, 2004), and Mexican-origin children (Hernández-Valero et al., 2007). While genetic factors influence to the child's heritability of becoming overweight, there is also a need to consider environmental influences in the transmission, including parents' own health behaviors. Parents establish the rules and routines that surround meals and food choices for their children. Other important roles for parents include selecting the foods of the family diet, serving as models of eating that children learn to emulate, and using feeding practices to encourage the development of appropriate eating patterns and behaviors in children. In low socioeconomic status (SES) families, however, time and resource constraints from parents may be a barrier in promoting healthy eating and exercise behaviors in children.

***Appetite, Food Intake, Food Preferences, and Food Choices*.** Appetite and food intake are inevitable parts of development of overweight/obesity and are referred to as energy intake. For children and adolescents, fast food, sweetened drinks, and large portion sizes in particular, have been frequently named as contributors to excess energy intake (Agras & Mascola, 2005; Diliberti, Bordi, Conklin, Roe, & Rolls, 2004). For example, frequent fast food consumption has been correlated with increased BMI and body fat in both adults and children (Bowman & Vinyard, 2004; Kant & Graubard, 2004). Further, longitudinal studies among girls 8-12 years of age have found that the frequency of fast-food consumption at baseline was positively associated with increases in BMI z-scores at follow up evaluations 11- and 19-years later (Thompson, Ballew, Resnicow et al., 2004). Such findings coincide with the fact that the consumption of foods away from home has increased considerably in children within the last three decades (Nicklas, O'Neil, & Myers, 2004; St-Onge, Keller, & Heymsfield, 2003).

Low fruit and vegetable consumption is also an important factor in overweight/obesity and studies have found an association between lower intake of fruits and overweight status in children (Lin & Morrison, 2002). Similarly, a protective effect on the risk of overweight with the intake of vegetables was observed in children and adolescents (Matthews, Wien, & Sabate, 2011). This is an increasing area of research as well as in obesity prevention efforts as it appears that fruit and vegetable consumption among

children in the U.S. remains low despite widespread recommendations to consume several servings per day (Krebs et al., 1996).

Since food preferences relate to the consumption of healthier foods like fruits and vegetables, recent research on the development of a child's food preferences have been beneficial for child obesity researchers. Generally, the human predisposition is to prefer foods that are sweet and salty, and to reject novel foods. For example, in regards to preference for the more familiar, there is increasing evidence that a mother's food choices during pregnancy and while breastfeeding have an impact on the child's own food preferences. In their study, Mennella, Jagnow, & Beauchamp (2001) documented evidence for a "flavor bridge", whereby the infant's acceptances of foods are based on the maternal diet. Infants that were exposed to the flavor of carrots in either amniotic fluid or breast milk behaved differently in response to that flavor in a food base, enjoyed carrot-flavor food base more, and showed fewer negative facial expressions compared to non-exposed control infants whose mothers drank only water during pregnancy and lactation and did not expose their infants to carrots through either amniotic fluid or breast milk. The authors described this as a "flavor bridge" and concluded that this bridge can promote the infant's acceptance of foods later in life.

In terms of food accessibility, the availability of healthy and nutritious foods has been a focus of health disparities research examining socioeconomic differences in obesity. For example, at the level of the communities in which families reside, disadvantage may constrain the ability to acquire and maintain a healthy diet. That is, low availability of fresh, healthy foods and the overabundance of fast-food restaurants in low-income communities have been hypothesized as factors that help explain why obesity does not affect all population groups equally (Diez-Roux, Nietom Caulfield, et al., 1999). Further, the availability of supermarkets has been associated with more healthful diets, higher vegetable and fruit consumption, and lower rates of obesity. A recent study showed significant disparities in the availability of chain supermarkets, such that Black and Latino neighborhoods had about 50 percent and 70 percent

fewer supermarkets, respectively compared with White and non- Hispanic neighborhoods (Powell, Slater, Mirtcheva, et al., 2007).

***Physical Activity and Exercise*.** Physical activity is defined as the bodily movements that are produced by the contraction of skeletal muscles that increase energy level above the basal level. Physical activity has important benefits for people of all ages. For children in particular, activity promotes bone formation, increases physical fitness, prevents cardiovascular risk factors, improves self-esteem and mental health status, and aids in weight maintenance (Baranowski et al., 2000). Since overweight and obesity may result when energy intake is greater than energy expenditure, physical activity is necessary for energy balance. Among children, lower levels of physical activity are contributing factors to being overweight or obese (Babey et al., 2005; Duke et al., 2003), and experts have recommended that children and adolescents receive at least 60 minutes of moderate physical activity on a daily basis (Byers, Nestle, McTiernan, et al., 2002; Koplan, Liverman, & Kraak, 2005).

Importantly, studies have found that low-income populations (who are disproportionately ethnic and racial minorities) experience increased obstacles to obtaining the recommended levels of physical activity. For example, compared to children living in higher income households, lower income children had less access to portable play equipment (e.g., jump rope, bike, etc.) and lower SES families also had more restrictive rules about physical activity (Tandon et al., 2012). Restrictive rules about physical activity may be related to neighborhood characteristics that parents perceive as being unsafe for their children. Concerns about neighborhood safety can be a barrier and possibly decrease the amount of physical activity for low-income ethnic-minority families. As an example of this, it has been found that in neighborhoods characterized by high community violence, children may be more likely to be confined to their homes after school rather than allowed to go outside (Randolph, Koblinsky, & Roberts, 1996). Moreover, with regard to socioeconomic differences and disparities in the availability of recreational facilities and the relation to obesity, findings from the National Longitudinal Study of Adolescent Health (Add Health) find that lower-SES and ethnic- minority groups have less access to physical activity

facilities, which in turn is associated with decreased physical activity and increased overweight (Morland, Diez-Roux, & Wing, 2006; Morland, Wing, & Diez-Roux, 2002). Other studies have replicated the findings and shown that low income minority adolescents report having reduced access to recreational facilities in their neighborhoods, which leads to less physical activity and, in turn, increases levels of overweight status (Gordon-Larsen, Nelson, Page, & Popkin, 2006). Particularly among Mexican American youth, results from the National Health and Nutrition Examination Survey (NHANES) have indicated that Mexican American children reported engaging in less physical activity per week than non-Hispanic children. Perhaps, this could be explained by findings that Latino parent populations report neighborhood safety as a significant barrier to physical activity participation among their children (Duke et al., 2003).

Immigration and Acculturative Factors. Latino and Asian adolescents born in the U.S. have a higher prevalence of obesity than immigrant group members of the same community (Popkin & Udry, 1998). That is, Latino and Asian adolescents who were either second or third generation had higher rates of obesity than those who were born outside the U.S. and had immigrated (first generation). Among Latinos specifically, it has been found that, as Latinos spend more time in the U.S., they adopt a less healthy diet than their more recently immigrated counterparts, and that obesity increases from one generation to the next (Bates et al., 2008; Kaplan et al., 2004; Ward, 2008). A full understanding of acculturative factors that influence obesity among youth immigrant backgrounds is limited at this point since values and beliefs vary by culture and race/ethnicity. It can be argued, however, that for many immigrants, acculturation and assimilation to the new country means adopting foods and lifestyle choices that are represented in the host country, possibly leaving behind the lifestyle and choices from their country of origin. For example, a dietary study on the acculturation processes suggests that fast food consumption increases with moving to or increased residence in the United States (Ayala, Baquero, & Klinger, 2008). Further, it can be argued that children of immigrant parents may live in conditions that place them at risk for obesity as it has been found that immigrants are more likely to live in neighborhoods with fewer

recreational exercise resources, worse safety, lower social cohesion, and worse walkability (Osypuk, Diez Roux, Hadley, & Kandula, 2009).

Other findings related to intracultural differences in child obesity are noteworthy. While some studies have uncovered that Mexican-origin mother's length of stay in the U.S. is not associated with the probabilities of the child being overweight (Rosas, Guendelman, Harley, Fernald, Neufeld, et al., 2011), the majority of findings do suggest that maternal acculturation and length of stay in the U.S. is a risk factor for child overweight/obesity among Mexican American children. For example, a recent study examining dyads of Mexican origin mothers and their children, found that women born in the U.S. were twice as likely to have an overweight and/or at-risk-for-overweight child compared with women born in Mexico (Hernández-Valero et al., 2007). Further, when comparing Mexican-origin children living in California with Mexican-born children living in Mexico, significantly more children were classified with a BMI above the 85th percentile in California (53.3%) compared to Mexico (14.9%) (Rosas et al., 2011). Possible reasons for these differences based on nativity and acculturation levels may relate to dietary patterns among parents, particularly mothers. For example, U.S. born women have been found to consume more sugar-sweetened beverages and fast-food meals compared to their Mexican-born counterparts (Sharkley, Johnson, & Dean, 2011), and mothers born in Mexico have been found to consume significantly more fiber, vitamins, minerals, and consume less fat than Mexican American mothers born in the U.S. (Dixon, Sundquist, & Winkleby, 2000). Given that mothers typically make food and dietary choices in the household, these patterns may be transmitted to children in the family and a greater adherence to traditional values and orientation, as defined by being less acculturated, is expected to decrease the risk for child obesity as these mothers' food choices may differ from more acculturated mothers. Importantly, for Mexican-origin families with high prevalence of overweight/obesity, food choices may be largely driven by availability, convenience and cost, and as noted previously, low-income neighborhoods tend to be disproportionately represented by fast-food restaurants and low access to fresh fruits and vegetables (e.g., Powell, Slater, Mirtcheva, et al., 2007).

SES. In developed economies, like the U.S., obesity is inversely associated with income and other indicators of socioeconomic status. That is, factors typically associated with low SES such as poverty, low parental education, and single-parent households, have been found to contribute to health disparities among children, including obesity (Shrewsbury & Wardle, 2008). Moreover, Mexican-origin women with less than a high school education are twice as likely to have an overweight child compared to more educated mothers (Hernández-Valero et al., 2007). As mentioned in sections above, SES is intertwined with many risk factors for the development of childhood overweight and obesity, including unsafe neighborhood conditions and limited recreational facilities, limited fresh food choices, more availability of fast-food restaurants, as well as income factors that could influence parental work responsibilities and limit resources for healthier lifestyle choices.

Antidepressant Medications. A retrospective study shows that excessive weight gain and obesity was more likely for children and adolescents prescribed with psychotropic medications as compared to those not treated with such medications (Jerrell, 2010). The likelihood was particularly higher for those taking selective serotonin reuptake inhibitors (SSRI's) and antipsychotics, and lower for those taking stimulants. Thus, a child taking antidepressants and/or antipsychotics would be more likely than a child who is not taking these medications to experience metabolic adverse effects, such as excessive weight gain and obesity.

OVERVIEW OF RESEARCH ON THE CO-OCCURRENCE OF YOUTH DEPRESSION AND OBESITY

Investigations among youth have examined the association between depression and overweight and obesity status among both clinical (Benson, Williams, & Novick, 2013; Britz et al., 2000; Eremis et al., 2004) and community (Bardone et al., 1998; Goodman & Must, 2011; Halfon, Larson, & Slusser, 2013; Merten, Wickrama, & Williams, 2008; Tanofsky-Kraff et al., 2004) samples. These investigations have shown that a positive association exists, but have also reported mixed and inconsistent findings in the

association, as detailed below. Table 1 provides information on the clinical and community studies that are described in this section.

Clinical Samples. There is suitable evidence in support of a positive depression-obesity association based on studies conducted with clinical populations. For example, Pine, Goldstein, Wolk, & Weismman (2001) found that 6-17 year olds diagnosed with depression had a significantly higher BMI 10-15 years later compared to those who were not depressed in childhood. Similarly, among female adolescents, those with a greater number of depressive episodes during adolescence had increased risk for obesity in adulthood compared to their non-depressed counterparts (Richardson et al., 2003). Moreover, an examination of 15-21 year-old adolescents and young adults presenting for inpatient treatment for obesity found that this sample had high rates of mood, anxiety, and eating disorders (Brtiz et al., 2000). Further, compared to non-clinical obese adolescents, clinical samples of obese adolescents have significantly higher scores on the Children's Depression Inventory (CDI) (Eremis et al., 2004). Results from clinical samples should be interpreted with caution, however, as clinical samples may be experiencing higher levels of distress if seeking treatment compared to non-clinical samples. Contrary to longitudinal findings, cross-sectional examinations of clinical samples presenting to pediatric weight management clinics have reported no association between depression and obesity (Benson, Williams, & Novick, 2013; Vila et al. 2004), and suggest inconsistencies among clinical samples.

Community Samples. Similarly, findings from community studies on the depression-obesity association indicate both positive and negative associations. For example, compared with normal-weight children, overweight children (Tanofsky-Kraff et al. 2004) and severely obese adolescents (Isnard et al. 2003) experienced more internalizing distress. However, a longitudinal study of 15 year old girls with high depressive symptoms found there was no significant increase in BMI at 21 years of age when compared to those with low depressive symptoms at age 15 (Bardone et al. 1998). Other longitudinal studies on community samples have found that there is no association between obesity and high levels of depressive symptoms during the first two years examined but, an association emerged in the third year whereby non-Hispanic Whites had a positive association between weight status and high scores on the

Center for Epidemiologic Studies Depression Scale (CES-D) (Goodman & Must, 2011). A cross-sectional study with a community sample also found that, while overweight/obese adolescents had higher depressive mood and stress scores and lower coping and social support scores when compared to normal weight adolescents, the differences were not statistically significant (Martyn-Nemeth & Penckofer, 2012).

More recent research has suggested that, if there is an association, it may be explained by socio-economic or demographic factors. For example, a national sample of children aged 10-17 indicated that obese children have increased odds of general internalizing problems and increased odds of having depression . However, after controlling for sociodemographic factors such as household income and parental education, the magnitude of the association greatly decreased, suggesting that social risk factors may be contributing to some of the overlap between obesity and other health problems (Halfon, Larson, & Slusser, 2013).

DIRECTIONALITY IN THE CO-OCCURRENCE OF DEPRESSION AND OBESITY

Despite a dearth of formalized theory, there are two general rationales that have been proposed for the directionality of the association. The first rationale suggests that psychological disorders including depressive symptoms may be a consequence of being overweight or obese in a culture that stigmatizes obesity. Moreover, obesity carries with it physical, psychological, and social sequelae that may serve to increase risk for depression. For example, physical limitations as a result of obesity such as the inability to engage in regular physical activity are proposed to be functional impairments that relate to the development of depressive symptomatology. Similarly, psychological factors, such as the depressogenic beliefs that one's health is deteriorating and physical health will not improve, may also contribute to negative mood. Lastly, social factors, in the forms of stigma, discrimination and maltreatment, may account for subsequent depression among obese individuals. On the other hand, an alternative rationale posits that depressive disorders may contribute to the development of obesity through increased appetite, overeating, inactivity, and hypersomnia whereby recurrent depressive episodes may lead to weight gain over time (Kalarchian & Marcus, 2012).

Longitudinal data from children and adolescents suggest that depression early in life may lead to an increased risk for overweight and obesity later in life. For instance, in a large sample of children, the risk for subsequent obesity later in adult life has been found to be stronger among individuals who had been diagnosed with depression at ages 6-17 (Pine at al., 2001). Similarly, another large study found that depression diagnoses before age 17 was associated with increased weight gain and obesity in adulthood (Hasler et al. 2005). Additional studies suggest further evidence that such an association exists (Barefoot et al. 1998; Hasler et al. 2004; Richardson et al. 2003). Studies also indicate the opposite whereby obesity predicts later depression as a result of functional, psychological, and social factors (Markowitz et al. 2008). Evidence for obesity promoting depression has been established using prospective, longitudinal data. Among a large sample of adults, findings suggest that obesity at baseline predicts depression 1 year later (Roberts et al., 2000), as well as 5 years later (Roberts et al., 2003). The latter study did not find support for depression increasing the risk for obesity among adults.

CORRELATES OF DEPRESSION AND OVERWEIGHT/OBESITY: OVERLAPPING RISK FACTORS

While mechanisms by which depression and obesity are related to each other are not clear, there are common factors found among both that are important to consider including sleep, sedentary behaviors, appetite increases, and shared adverse experiences. The following describes how each factor is associated with depression, and further details how it is associated with overweight/obesity.

Sleep. One overlapping factor is sleep, particularly sleep disturbances. Sleep complaints have been reported by over 90% of children and adolescents with major depressive disorder (Roberts, Lewinsohn, & Seeley, 1995), and short sleep durations have also been linked to obesity in children and adolescents and important contributors to excessive weight gain during childhood (Beebe, Lewin, Zeller, et al., 2007; Cappuccio et al., 2008; Taheri, 2006). Moreover, depressed children with high BMI have more fragmented sleep than normal-weight depressed children and healthy control children of all weights

(Wojnar et al., 2010). Additionally, meta-analytic findings from different countries around the world suggest that children with shorter sleep durations had a 58-92% higher risk for being overweight or obese in comparison to children who had longer durations of sleep (Chen, Beydoun, & Wang, 2008). Further, in a longitudinal study of children from birth to 9 ½ yrs old, Agras et al. (2004) documented that shorter sleep times predict the emergence of overweight. Agras et al. (2005) further stated that, once these differences in sleep pattern emerged, where overweight children slept less than non-overweight children, a cycle continues that maintains the pattern. It could be that overweight/obese children typically have low activity levels, and may sleep less during the night because they are less tired as a result of inactivity. It has also been hypothesized that sleep loss may cause fatigue, which could then deter an adolescent from physical activity and increase hunger for carbohydrate-rich foods, potentially leading to weight gain (Landis & Parker, 2007). Moreover, an association between daytime sleep and eating behaviors that potentially lead to obesity was found by Landis, Parker, & Dunbar (2008) whereby increases in daytime sleep, such as taking naps, were associated with decreased nocturnal sleep, which then significantly predicted food cravings.

Sedentary Behavior. Another shared factor is sedentary behavior. A core feature of depression is decreased interest and motivation for activity (DSM-IV; American Psychiatric Association, 2000) and, similarly, time spent in sedentary activity has been a strong correlate of obesity, even stronger than moderate/vigorous activity (Reeves, Postolache, & Snitker, 2008). This may be due to modern environments and lifestyles around the world which have led to people becoming increasingly reliant on machines for transportation and work and as a result, increasingly sedentary. In addition, television viewing has been associated with an increase in children's BMI (Anderson, Crespo, Bartlett, Cheskin, & Pratt, 1998), and Robinson (1999) found that children who had received a 6-month psychosocial intervention that reduced media use (television, videotapes, & videogames) had a significant reduction in BMI compared to control groups who did not receive the intervention. Importantly, it has been found that parents of lower socioeconomic status tend to watch TV/DVDs with their children more often than in families of higher socioeconomic status (Tandon et al., 2012). These higher rates of sedentary screen

time for low SES may be due to greater concern over the safety of neighborhood which would deter outdoor activities (Weir, Etelson, & Brand, 2006), or there may not be access to resources that would promote physical activity such as parks and recreational facilities (Fairclough, Boddy, Hackett, & Stratton, 2009). Given that rates of overweight and obesity are higher in lower socioeconomic status families, intervention efforts encouraging family activities that involve more physical activity and less sedentary behavior among these families may have positive effects in child health outcomes, as well as family health outcomes. Recently, the overall importance of balancing sedentary activity, such as television watching and videogames, with physical activity has been stressed for the health and well-being of youth. For example, a national sample of children aged 10-17 indicated that obese children were more likely to have activity restrictions and be limited in their ability to do things that other same-aged children were able to do (Halfon, Larson, & Slusser, 2013).

Appetite & Food Intake. Appetite and food intake are also shared among the two conditions. Symptoms associated with depression are changes in appetite (increases or decreases) as well as weight changes (significant gain or loss) for individuals of all ages including children and adolescents (DSM-IV; American Psychiatric Association, 2000). Similarly, food intake is of great importance for obesity as an imbalance between energy and expenditure may contribute to excess weight (Reeves, Postolache, Snitker, 2008). Therefore, a strong overlap exists because weight gain is a depressive symptom, and weight gain is also an indicator of obesity.

Shared Environmental Risk Factors. In addition to shared characteristics, it has also been proposed that depression and obesity could have shared environmental risk factors such as adverse childhood experiences (Kalarchian & Marcus, 2012). For example, female victims of childhood sexual abuse have been found to be at increased risk for developing obesity (Noll, Zeller, Trickett, & Putman, 2007), and adverse childhood adversities including abuse and assault, have been associated with depression (Schilling, Aseltine, & Gore, 2007).

CULTURAL DIFFERENCES

It is important to consider how cultural values might impact the association between depression and obesity. That is, it is possible that cultural norms influence the perception of being overweight or obese and that there is less or no stigmatization among groups where the cultural environment values fuller body frames. While not comprehensive, the following section describes cultural differences among different ethnic minority groups that may influence the depression-obesity association among youth.

Latinos. Parents of Latino descent have been found to value higher weight among their offspring and this preference may be based on immigration status. For example, with regard to immigrant parents and their beliefs about their child's weight, Mexican-origin mothers residing in Mexico have been found more likely than Mexican-origin mothers living in California to express traditional beliefs that heavier infants are healthier and were more accepting of overweight because of their belief that infants and very young children outgrow excess weight (Guendelman, Fernald, Nuefeld, & Fuenters-Afflick, 2010). A preference for heavier infants and children on behalf of the parent's cultural beliefs may predispose children and adolescents to develop overweight/obesity. Furthermore, in cultures where food is scarce, being heavier is valued as it is an indication of power, wealth, and higher social standing (Sobal & Stunkard, 1989), and the positive views about heavier weight among Mexican-origin mothers may be related to these historical experiences with food scarcity in their native country.

Blacks. Similar findings have been reported for Black groups where the attitudes of Black adults towards larger body size tend to be more accepting when compared to Caucasian views (Averett & Korenman, 1999; Latner, Stunkard & Wilson, 2005), suggesting possible differences in cultural beliefs regarding physical appearance, and indicating possible differences in the depression-obesity association if larger body sizes are viewed positively. Moreover, Black adolescents are more likely to underestimate their weight, particularly among overweight girls and obese boys (Martin, Frisco, & May, 2009), which may subsequently place them at greater risk of long-term weight problems.

Asians. Recent findings on Asian parents parallel those reported for Latinos. That is, first generation Asian immigrants who may have come from environments where food is less plentiful have been found to perceive 'fat' children as healthy, and have reported lavishing food on children as a sign of affection (Pallan, Parry, & Adab, 2012). As for Asian adolescents' own views about their weight, it has been found that Asian-American girls are more likely to underestimate their weight than are White girls (Martin, Frisco, & May, 2009).

ETHNIC DIFFERENCES IN THE CO-OCCURRENCE OF YOUTH DEPRESSION AND OBESITY

Race and ethnicity are underexplored in the literature on co-occurrence between depression and obesity (Wardle & Cooke, 2005). To my knowledge, estimates of the co-occurrence of depression and obesity among ethnic minority children do not exist. There are, however, data from Add Health studies that compare the impact of SES on depression and obesity separately for White vs. Non-White adolescent males and females. Non-Whites in this study were Black, Latino, Asian, and other race/ethnicity adolescents who were placed in a dichotomous Non-White category. Results from this national sample indicate that the prevalence of obesity among Non-Whites females (11.5%) is higher than White females (6.7%), and similar findings exist for Non-White males (13.8%) compared to White males (11.9%). The prevalence for depression was also higher for Non-Whites compared to Whites (Non-White Females=12.7%; Non-White Males=10%; White Females=9.5%; White Males=7%). Importantly, however, SES had a broad influence on these variables, with lower household income and lower parental education accounting for approximately one-third of the variance in depression and one-third of the variance in obesity (Goodman, Slap, & Huang, 2003). Despite unknown prevalence rates of the co-occurrence among ethnic minorities, several studies indicate that there may be some differences in the association depending on the race or ethnic group of the youth. As mentioned in the previous section, being overweight or obese is conceptualized to be perceived differently among different groups based on

their culture of origin and their environment, and recent findings representative of U.S. school-children aged 11-17 years old show that race/ethnicity differences in perceived appearance and body satisfaction may begin as early as age 11 (Mikolajczyk, Iannitto, Farhat, & Thomas, 2012). The following briefly describes studies that focus on racial and ethnic differences in being overweight or obese and the association with general factors of psychological well-being.

Latinos. Research on Latino youth provides evidence for an association in depression and overweight/obesity. For example, a longitudinal study found that self-esteem levels of obese Latino youth decreased significantly over time (Strauss, 2000). Similarly, using a population-based sample of youth ages 12-17 years old from the National Survey of Children's Health, BeLue, Francis, & Colaco (2009) found that the association between mental health problems and youth overweight was moderated by racial/ethnic group. This study suggested that, compared to their non-overweight counterparts, Latino youth who were overweight were significantly more likely to report depression or anxiety, feelings of worthlessness or inferiority, behavior problems, and bullying of others (BeLue et al., 2009).

Blacks. As previously described, for Black youth, being overweight may not have the negative connotations that are otherwise found to exist among other groups and Black youth are not more likely to report depression or anxiety, or feelings of inferiority, if they were overweight (BeLue et al., 2009). Further, longitudinal findings suggest that, over time, levels of self-esteem among obese Black youth do not decrease (Strauss, 2000). Overall, these findings may be attributed to higher levels of positive perceived body appearance among Black youth compared to Whites and Latinos (Mikolajczyk et al., 2012).

Asians. Although prevalence rates of obesity have been found to be the lowest among Asian-American youth compared to any other racial/ethnic group (Robbins, Mallya, Polansky, & Schwarz, 2012), it has been found that, for Chinese and Korean adolescents, perceptions of being overweight increased the likelihood of experiencing depressive symptoms (Kim & Kim, 2001; Xie et al., 2003). Further, a more recent study that examined female youth from different racial/ethnic groups found that for Asian-American female adolescents, deviating from their ethnic group's norm towards obesity made them more

vulnerable to depression and lower levels of self-worth compared to females of other ethnic groups (Lanza, Echols, & Graham, 2013).

Whites. Some research has suggested that the association exists for White youth, but not for the other ethnic groups being compared. For example, a national study by Halfon and colleagues (2013) found that the obesity-health association, which included depression, was stronger for White than for Latino children. Moreover, Goodman & Must (2011) examined the association of severe obesity and depressive symptoms over a 3 year time span in a community-based sample of adolescents and found that while there was no association at baseline or at 2 years, an association did emerge at 3 years and this association was moderated by race whereby it was only present among White adolescents.

GENDER DIFFERENCES IN THE CO-OCCURRENCE OF YOUTH DEPRESSION AND OBESITY

Studies that have examined whether gender influences the association between obesity and depression among children and adolescents have found that the association is stronger among female adolescents compared to males (Anderson et al., 2007; Atlantis & Baker, 2008; Liem, Sauer, Oldehinkel, & Stolk, 2008; Wardle, Williamson, Johnson, et al., 2006), whereas one study only found that an association exists among male adolescents and not females (Mustillo et al., 2003). For example, among 7^{th}-11^{th} graders, Falkner et al. (2001) found that compared to average weight girls and obese boys, obese girls had more adverse effects in academic, social, and psychological domains. Indeed, a review of the literature on overweight youth has found that in comparison to overweight boys, overweight girls experience stigmatization, in the form of social isolation, teasing and bullying, to a much larger degree (Tang-Péronard & Heitmann, 2008). Similarly, using longitudinal data from Add Health with close to 11, 000 adolescents across the country, Merten, Wirckrama, & Williams (2008) found that obese adolescent females have more depressive symptoms in young adulthood than normal weight females, even after controlling for prior depressive symptoms in adolescence. While this study also further tested racial

differences between White and Black females, there was no racial differences in the association for White females compare to Black females (Merten et al., 2008).

CHAPTER 2

Aims of Dissertation Studies

Introduction and Overview of Specific Aims

This dissertation study sets out to advance the knowledge on the co-occurrence of depression and overweight/obesity within and between diverse groups of youth. Such studies are particularly important to shed light on factors that influence populations of youth who are disproportionately affected by both conditions, such as Latino youth (McLaughlin, Hilt & Nolen-Hoeksema, 2007; Ogden, Carroll, Kit, & Flegal, 2012). Given that most studies of the association between depression and overweight/obesity among youth have been limited in the diversity of their sample (Wardle & Cooke, 2005), there is a need for studies that examine the associations among ethnic minority youth. Therefore, this dissertation seeks to address this gap in the literature by contributing findings from two studies with three distinct aims. The first aim addresses the issue of whether race/ethnicity moderates the association between depression and obesity by comparing and contrasting the depression-overweight/obesity association among four distinct racial/ethnic groups of youth (White, Asian, Black, and Latino). In this aim, we also examine gender as a moderator, as well as race/ethnicity x gender interactions.

A second important objective of this dissertation is to examine the association between overweight/ obesity longitudinally among Mexican American youth. A little more than half of the depression-obesity research reviewed in this dissertation (refer to Table 1) is based on cross-sectional designs which assume a static, rather than dynamic, relationship. While such studies are largely informative, longitudinal designs can improve the conceptualization of our understanding of the interplay between depression and overweight/obesity. The association between depression and obesity at a young age is particularly important to understand because this is the developmental period during which both conditions may have an early-onset. That is, obesity "early-onset" is classified as 16 years of age or younger (Wardle, Waller, & Fox, 2002) and depressive episodes with onset before age 16 are considered "early-onset" and are

associated with a more chronic and debilitating course of the disorder (Hammen, Brennan, Keenan-Miller, & Herr, 2008). Thus, to address the early course of these conditions, the current dissertation examines a sample of Mexican-American youth and tests a model that considers the transactional and changing processes over time. This dissertation endeavors to contribute to what is currently known about the longitudinal association between depression and overweight/obesity among Mexican-American youth.

Lastly, this dissertation examines psychosocial factors in the environment of Mexican American youth that may potentially contribute to their higher rates of overweight/obesity as they transition from childhood to adolescence. There have not been many models proposed to explain obesity among Mexican American children and adolescents, despite their comparatively higher risk. Thus, this dissertation addresses the limited research by examining depression and overweight/obesity among Mexican American youth in a longitudinal model that theorizes the pathways to the development of overweight/obesity. The following sections describe the background and importance for each of the three specific aims developed for the dissertation study. The hypothesized outcomes for the aims are described within each specific aim.

SPECIFIC AIMS

Specific Aim #1: Examine the association between depression and overweight/obesity among different groups of adolescents.

For this aim, the association between depression and overweight/obesity was compared and contrasted among four ethnic/racial groups of youth (White, Asian, Black, and Latino). The following hypothesis was proposed for Aim #1:

*Hypothesis 1***.** Depressive symptoms will be associated with overweight/obesity for White, Asian, and Latino youth, but not for Black youth.

Aside from examining whether the association varies by ethnic group, I was also interested in examining whether gender interacted within ethnicity (Figure 1) for Aim #1. The suggestion of gender

serving as a moderator in the depression-obesity association has been strongly advocated by investigators (Friedman & Brownell, 1995; Stunkard, Faith, & Allison, 2003), with stronger relations suggested for girls. In this study, we assessed the moderating role of gender in the depression-overweight/obesity association within the groups of race/ethnicity. Thus, the following hypothesis related to the second part of Aim #1 was proposed:

*Hypothesis 2***.** Across all four groups of youth (White, Asian, Black, and Latino), a stronger association between depression and overweight/obesity will emerge among adolescent girls as compared to boys.

Additionally, information on the use of antidepressants, which has been linked to weight gain, was examined for Aim #1.

Specific Aim #2: Examine the temporal sequencing of depression and overweight/obesity among Mexican American children as they transition into adolescence.

As mentioned in the review, the association between depression and obesity has been investigated in both directions: obesity as a cause of depression, and depression as a cause of obesity and there is no conclusive evidence indicating whether one causes the other more typically. These two conditions may perpetuate one another; obesity may increase risk for depression (Markowitz et al., 2008), and depression may simultaneously promote obesity (e.g., Kalarchian & Marcus, 2012). Further, little is known about how the association unfolds over time for Mexican American children, a group with a high prevalence for obesity compared to other ethnic groups (Ogden et al. 2006), and also a group with higher levels of depressive symptoms in comparison to other groups of youth (McLaughlin, Hilt & Nolen-Hoeksema, 2007; Roberts & Sobhan, 1992; Twenge & Nolen-Hoeksema, 2002). Given the inconclusive evidence on directionality, a joint effects approach appeared to be appropriate in the examination of the association. For this aim, a cross-lagged model (Figure 2) was examined by which depression and overweight/obesity each contributed to each other among a sample of Mexican American children transitioning into adolescence. Given that a large proportion of overweight and obese youth are Mexican-American, it is

important to identify whether this is a population at risk for some, or all, of the links previously established by the literature. To the best of my knowledge, this is the first study that examined these joint effects on depression and overweight/obesity using Mexican-American youth. The directionality of the depression-obesity association was not restricted as previous research has supported both directions. The following was hypothesized for Aim #2:

Hypothesis 3. Depression and overweight/obesity will be reciprocally related to each other over time for Mexican-American youth. Depression will predict overweight/obesity and conversely, overweight/obesity will predict depression over time.

Specific Aim #3: Evaluate a longitudinal model for the development of overweight and obesity status among Mexican American children which proposes that the process of maternal acculturation, maternal overweight, neighborhood quality, sleep, physical exercise, and depressive symptoms will increase risk for overweight/obesity into early adolescence.

According to the Institute of Medicine, Latino children, particularly those of Mexican descent, have the highest rates of obesity relative to other ethnic and racial groups (IOM, 2005). The third aim was proposed to more closely investigate this group of Mexican American youth and examine factors in their environment that are potentially contributing to higher rates of overweight and obesity. There have not been many models proposed to explain overweight and obesity among Mexican American children and adolescents, despite the fact that Mexican American youth are at comparatively higher risk, and models that have been examined have been cross-sectional in nature (Hernandez-Valero et al., 2012; Rosas et al., 2011). Thus, this aim sought to address the limited research by examining depression and overweight/obesity among Mexican American youth in a longitudinal model incorporating multiple important risk factors (Figure 3).

The theoretical origins of the model are social ecological in nature, examining multiple levels of subsystems within the environment, guided by Dahlgren and Whitehead's (1991) Social Determinants of Health Model. Their model (Figure 4) proposes that conditions of daily living and overall life

circumstances of certain groups, such as their social, economic and environmental conditions, may place them in positions of having a much poorer chance of achieving full health. Accordingly, the most disadvantaged groups have the poorest health and the highest exposure to health-damaging risk factors (Roe, 1995). The model by Dahlgren & White (1991) maps associations between the individual, their environment and disease/health outcome and places emphasis on multiple levels including individual lifestyle factors, social and community networks, and general socio-economic, cultural and environmental conditions. Given the model's focus on health outcomes, the hypothesized model of overweight/obesity outcomes among Mexican American youth in Aim 3 was guided by this ecological framework and examined cultural and environmental systems (acculturation), social and community networks (neighborhood, parental weight status), individual lifestyle factors (sleep, exercise), and constitutional factors (weight, depressive symptoms, gender) that have been previously reviewed in this paper as correlates or risk factors for youth in developing overweight and obesity. In the following discussion, I provide the hypothesized connections among the constructs of the model, and further provide the series of testable research hypotheses that were generated.

The hypothesized model (Figure 3) examines potential risk factors for overweight/obesity among Mexican American children as they transition through early adolescence. First, the model proposes that maternal acculturation directly relates to child obesity (Path 1). Higher levels of acculturation in the mother are expected to increase the risk for having an overweight child. That is, identifying more strongly with American culture and values, as defined by being more acculturated, is expected to significantly increase the risk for having an overweight or obese child. Acculturation has been regarded as one of the key factors in understanding obesity among Mexican American populations (IOM, 2007), and we expected degree of acculturation in the mother to play a dominant role in our findings.

Second, the model proposes that maternal overweight/obesity directly relates to child overweight/obesity (Path 2). Among Mexican American children, overweight and obesity status in the mother significantly increased the child's risk for being overweight (IOM, 2007). Moreover, among the

general U.S. population, Mexican-American women have been reported to have a 15% greater increase in the prevalence of obesity than non-Hispanic white women (Flegal et al., 1998), suggesting a greater likelihood that the mothers would have a high weight status. Thus, we expected that the influence of having an overweight or obese mother would significantly contribute to Mexican American children also being overweight or obese due to both genetic and environmental factors.

Third, neighborhood quality is also conceptualized to be an important risk factor for which Mexican American youth develop overweight or obese status (Path 3). Based on earlier research, it is evident that certain ethnic minority groups may have more limited access to resources that promote healthy lifestyles, such as access to recreational facilities, safe neighborhoods to engage in outside physical activity, and access to fresh fruits and vegetables. In our model, we expected that a parental perception of living in a low quality neighborhood with low cohesiveness and a high crime rate would substantially increase the risk for child weight gain. Additionally, we suspected that it would also be correlated with maternal obesity, as other family members are expected to be similarly affected by neighborhood conditions (i.e., low walkability).

Given these 3 risk factors, the following hypothesis was tested:

Hypothesis 4. Higher maternal acculturation, maternal overweight, and poor neighborhood quality are expected to be risk factors that directly contribute to overweight and obesity status among Mexican American children.

Sleep is the fourth factor in the model. Based on previous research, it was not only expected that sleep deprivation would be a consequence of being overweight or obese (Path 4), but it was also expected to be a mechanism for contributing to later overweight and obesity. That is, being overweight or obese results in less sleep, but lack of sleep also influences exercise by decreasing physical activity as a result of insufficient energy (Path 6), and increasing depressive symptoms (Path 7).

Fifth, physical exercise is conceptualized to play a vital role as numerous studies have demonstrated that it is a critical part of overweight/obesity. In our model, we hypothesized that physical activity would

be influenced by child BMI as overweight and obese children are likely to find exercise more difficult. We also hypothesized that physical activity would be influenced by the amount of sleep the child was receiving (Path 6). Lastly, we predicted that less physical activity would directly relate to the child's reporting greater depressive symptoms (Path 8). Depression appears more commonly in Latino youth compared to other groups (McLaughlin, Hilt & Nolen-Hoeksema, 2007; Roberts & Sobhan, 1992), and we incorporated its relation in the sixth pathway of the model. It was hypothesized that depressive symptomatology would increase if a child receives inadequate sleep. It was also hypothesized that physical inactivity would contribute to lethargy and would create particular vulnerability to negative mood. Depressive symptoms at the previous time point is added to this depression factor to establish temporal precedence (Path 11), and depression at the previous time point is also modeled as a covariate with the other factors from the same time point (maternal acculturation, maternal BMI, and neighborhood).

Based on these hypothesized constructs, the following was tested:

Hypothesis 5. The mechanisms that contribute to overweight and obesity into adolescence will include sleep, physical exercise, and depression.

Lastly, I tested gender as a moderator in the hypothesized model (not depicted in Figure 3), to evaluate the following hypothesis:

Hypothesis 6. Associations in the hypothesized model will differ based on gender, with stronger effects to be found among Mexican American girls compared to boys.

In summary, the hypothesized model examined whether maternal acculturation, maternal overweight, and neighborhood quality were risk factors for child overweight/obesity, and whether sleep, physical exercise, and depression were mechanisms that further increased the likelihood the development of overweight or obesity into early adolescence, controlling for prior levels. This model addressed some previously established contributors to overweight/obesity, while also incorporating acculturation, which is an environmental factor conceptualized to specifically influence weight status in this group. In addition,

the model tested moderating relationships to determine whether certain factors such as gender magnified, or diminished, associations in this investigation.

CHAPTER 3

Methods: Study 1 (Aim 1)

RESEARCH DESIGN AND METHODS

Overview: This dissertation consisted of secondary data analyses utilizing two distinct study samples of adolescents to address the specified aims. For Study 1, the sample consisted of a data set from the Middle School Matters (MSM) Study (referred to as Study 1 in this dissertation). This sample consisted of diverse students from public, urban middle schools in Seattle, WA. Details of the participants and the procedures are described below.

Study Participants

Study 1: A total of 1,106 adolescents were recruited from four Seattle public middle schools to participate in the Middle School Matters (MSM) screening study. Briefly, the main purpose of the Middle School Matters (MSM) screening study was to select students to participate in a school-based depression prevention program. The adolescents were all enrolled in 7^{th} or 8^{th} grade, and ranged in age from 11-15. Six-hundred and fifteen (615) were females and 491 were male. The following is the ethnic and racial breakdown of the sample: 49.8% White, 21.2% Asian, 12.4% Latinos, 6.1% More than One race/Bi-multi racial, 3.8% Black, 3.6% American Indian, and 3% Native American. Of the sample, information on parent education and family composition was obtained for the subsample of students who met eligibility criteria for the depression prevention program (N=109). For this subsample, the highest level of parent education was as follows: HS Diploma 45.9% (N=50), Bachelors Degree 34.9% (N=38), Masters/Doctoral/Professional Degree 19.3% (N=21). The family composition was as follows: Single-parent 37.6% (N=41), Two-parent/Married 62.4% (N=68). This study was approved by the Seattle Children's Hospital IRB, and both parent and child consent were obtained prior to participation.

Procedures

Study 1: Height and weight were directly measured by study staff either in the hallway, or in a separate area of the classroom. Height was obtained with a stadiometer height measuring device, and weight was obtained using the *Detecto* ® Model DR550 professional weighing scale. Trained staff measured height and weight of students wearing indoor clothing, with shoes removed and pockets empty. In order to precisely calculate BMI, weight was measured in kilograms (kg) and height was measured in centimeters (cm). Each student was measured and weighted twice by rounding two-decimal points and, if measurements differed by more than one unit, a third measurement was made. The mean of each set was used in analyses.

The Mood and Feelings Questionnaire (MFQ) was administered at school to all assenting youths whose parents provided consent (N=1106). Questionnaires were administered by a study staff member during a classroom period. Study staff gathered follow-up information on antidepressant usage for the sample of youth who scored above a 14 on the MFQ, as part of the clinical follow up procedure.

Measures

Demographics, including age, birth date, gender, and ethnicity were evaluated from the sample. Below are the measures used for the current study.

Mood and Feelings Questionnaire (MFQ): Depressive symptoms in adolescents were obtained using the Mood and Feelings Questionnaire (MFQ; Angold & Costello, 1987). The MFQ is a 33-item measure that consists of questions regarding how the youth has been feeling or acting recently, within the past two weeks. It was designed for the age range of 8 to18 and comprises both the full range of items assessing the DSM diagnostic criteria for depressive disorders. For adolescents, the cut-off score on the full version for distinguishing youth who are likely to have a depressive disorder from those who are not is a score of 12 or higher. Items from the MFQ are rated on a 3-point scale (0=*not true,* 1=*sometimes,* 2=*true*) and this measure showed overall reliability with this sample (α= .91). For purposes of this study, the total MFQ score variable was centered by subtracting the MFQ mean of the sample (*M*=10.87) from the data points,

creating a "*MFQ centered*" variable to be used as the depression predictor variable for regression and interaction analyses. For the analyses and results of this dissertation study, the term "*depressive symptoms*" will be used to refer to this centered variable.

Adolescent Overweight/Obesity: Body Mass Index (BMI) values were calculated using adolescent's direct height and weight measurements. Using a CDC program, I also calculated the percentiles of participants' BMI compared to 2000 U.S. growth charts that take age and sex into account. BMI percentiles are recommended for use with children and adolescents by the Center for Disease Control (CDC, 2011) and thus were used for the purposes of this study. Participants were classified as "overweight" if they had a BMI greater than or equal to the 85th percentile, and "obese" if they had a BMI greater than or equal to the 95th percentile.

Antidepressant Medications: Information on the use of antidepressants was obtained the subsample of youth who report elevated depressive symptoms on the MFQ (score above 14). Adolescents were asked by an interviewer in a private setting whether they had ever taken antidepressant medications.

Data Analysis

Bivariate correlations between the depressive symptoms other covariates and the main outcome of BMI percentiles were examined, and scatter plots were utilized to detect distributional abnormalities and outliers. Dummy coding was then conducted in order to include racial/ethnic groups as predictors in the model. Four racial/ethnic groups were included in the coding scheme (White, Asian, Black, and Latinos). Given that the White group represented the majority of the sample (49.8%), the White group was used as the referent group against which the other groups were compared. Choosing the reference group based on the group that represents the majority of the people in the sample has been suggested as a way to compare other groups against the majority in dummy coding (Field, 2005). The following 3 dummy variables were created and used: Asian (1= White vs. Asian, 0= not White vs. Asian), Black (1= White vs. Black, 0=not White vs. Black), Latino (1=White vs. Latino, 0= not White vs. Latino). Other racial/ethnic groups are not the focus of this study's hypotheses and consisted of a small sample of the overall sample, so were

excluded from analyses. Sensitivity analyses were conducted for the excluded groups and confirmed that excluding these groups did not affect analyses. Each of the three dummy variables used in analyses (Asian, Black, & Latino) was interpreted as the influence relative to the reference group which was assigned a value of 0 (White). The dummy variables were entered in the complete model to determine their association with BMI percentiles. In dummy coding, the constant is equal to the mean for the reference group therefore, in the analyses; the value of the constant is the mean value for Whites.

In order to address Hypothesis 1, a multiple regression model was tested to examine whether depressive symptoms, race/ethnicity, and the interaction of depressive symptoms and race/ethnicity, predict higher BMI percentiles.

A second multiple regression model was tested to address Hypothesis 2, whereby the interaction of gender was added to the first model in order to asses improvement in model fit. In order to follow recommendations on how to adequately test for interaction effects and have parameters be meaningful (e.g., West, Aiken, & Krull, 1996), each of the individual variables (depressive symptoms, race/ethnicity, gender) served as a separate predictor, and all possible combinations of the individual predictors, which included all two-way and three-way interactions, also served as predictors in the regression equation. Lastly, in order to adjust for sociodemographic factors, a third regression model was tested where parent education (HS Diploma, Bachelors Degree, Professional/Graduate Degree) and family structure (single parent, married/cohabitating parents) were added as controls. These covariates were selected to determine possible confounding factors related to economic and social characteristics that have been established in previous studies of obesity and co-morbid health conditions (e.g., BeLue, Francis, & Colaco, 2009; Skinner, Mayer, Flower, & Weinberger, 2008). However, given that sociodemographic variables were only reported for 109 out of the 1,106 subjects, a smaller regression model was examined as 109 subjects would not be a reliable sample size to examine all of the predictors and two- and three-way interactions. Therefore, an adjusted model that examined the direct effects of parent education, family composition, depressive symptoms, and gender predicting BMI percentiles was examined for the 109 subjects. In the analyses, higher values of the parent education variable indicate higher levels of education, and single-

parent households were coded to be 0 and two-parent households were coded to be 1. The results separately present models with and without such adjustment.

Supplemental Analyses: Multiple Regressions. Additional multiple regressions with a re-coded referent group were conducted in order to corroborate results obtained from the original dummy coding scheme noted above. For this dummy coding scheme, the Latino group was used as the referent group against which the other groups were compared. The following 3 dummy variables were created and used: Asian (1= Latino vs. Asian, 0= not Latino vs. Asian), Black (1= Latino vs. Black, 0=not Latino vs. Black), White (1=Latino vs. White, 0= not Latino vs. White). In these analyses, all dummy variables were being measured relative to the Latino referent group.

Supplemental Analyses: Logistic Regressions. In addition to the multiple regression analyses, logistic regression analyses were conducted in order to evaluate the association between depressive symptoms, race/ethnicity, and gender, and the probability of being overweight/obese. The outcome variable was defined as a binary indicator of overweight or obesity (Y=1 if BMI percentile is at or above the 85^{th} percentile, Y=0 otherwise). The logistic regression model related to the probability of being overweight/obese (P[Y=1]) with the predictors of depressive symptoms, race/ethnicity, and gender. In order to evaluate if the association between depressive symptoms and the probability of being overweight/obese was different for race/ethnicity, interaction terms were included by using the dummy variables applied to the multiple regression models whereby the White group was the reference group. Therefore, Asian, Black, and Latino were the race indicators of the three groups other than White (the reference group). In the logistic regression model, the interaction was entered as "*depressive symptoms* * *race*" where depressive symptoms is the product of the centered MFQ score. Including these interaction terms for each race/ethnicity allowed estimating different Odds Ratios (ORs) associated with a one point difference in the depression score for each race/ethnicity when compared the White group. Further, in order to test differences in the association between boys and girls and between race/ethnicity, three-way interaction terms were included (depressive symptoms x race x gender). As was done in multiple regression analyses, all possible combinations of two-way and three-way interactions were included as

predictors in the regression equation. In all analyses, females were coded to be 0 and males were coded to be 1. All of the 15 predictors were entered simultaneously.

After estimating the coefficients, the overall goodness of fit of the logistic model fitted was assessed. The log-likelihood statistic (-2 Log likelihood) was used which is assessed using a chi-square statistic and a value significant at a .05 level is required to indicate that the overall model predicts the outcome. The Hosmer-Lemeshow test was also used to test for model fit as this test allows for any number of predictor variables, which may either be continuous or categorical. This tests the hypothesis that the observed data are significantly different from the predicted values from the model and non-significant *p*-values (>.05) are desired as that would indicate the overall model fit is good.

In addition to reporting the Odds Ratio (OR) as a measure of risk in those associations that were significant as measured by chi square, Relative Risk Ratios (RRR) were also calculated and reported in the Results section. While ORs are the most widely used method of reporting coefficients in a logistic regression, RRRs have been labeled as a more intuitive measure of an association (Schmidt & Kohlmann, 2008). For both OR and RRR measures, values greater than 1indicate a positive association with the outcome of overweight/obesity and values less than 1 indicated a negative association with overweight/obesity. RRRs are reported for categorical associations that were found significant in these logistic regression analyses and were calculated using cross tabulations in a 2x2 table through SPSS software. As was done for ORs, a significant association was measured with chi-square for RRRs.

As was done in the multiple regression models, a logistic model that adjusted for demographic and sociodemographic factors was tested where parent education and family structure were added as covariates for the 109 subjects who had reported these sociodemographic variables. The logistic regression results are presented with and without such adjustment in the Results section.

Power and Sample Size Considerations in Regression

Based on recommended sample sizes to achieve a high level of power (Miles & Shevlin, 2001), the sample size of 1,106 being used for the currents study exceeds the size for a reliable regression model.

The Hosmer and Lemeshow test recommends sample sizes greater than 400 (Bewick, Cheek, & Ball, 2005), and our sample exceeds that recommendation prior to stratification by racial/ethnic groups. For two-way interactions, sample sizes of 200 have been determined large enough to have power and, in order to achieve 80% power with respect to three-way interactions, it has been recommended that sample size be greater than 600 (e.g., Heo & Leon, 2010). While the overall sample size is 1,106, when the sample is divided into racial/ethnic groups for the two-way interactions, Whites and Asians are the only groups greater than 200, and for three-way interactions, the sample size is less than 600 for all race/ethnicity. Therefore, the sample sizes divided into race/ethnicity may not have sufficient power to detect reliable results and should be interpreted with caution.

Chapter 4

Methods: Study 2 (Aims 2 &3)

Study Participants

Study 2: For the purposes of this dissertation, this sample is referred as Study 2. Mexican American families (N=674) participated in the California Families Project (CFP), a longitudinal study examining risk and resilience to substance use among Mexican American youth. Families with a child attending the 5th grade were recruited from public and Catholic schools within the cities of Sacramento or Woodland, California between 2006 and 2008. Seventy-two point-six percent (72.6%) of eligible families agreed to participate. Families were assessed during the child's 5th (T1), 6th (T2), and 7th (T3) grades, and interviews were spaced approximately one year apart. First, second, and third generation children of Mexican origin were eligible for the study. In terms of sample demographics (see Table 14), the average age of children was 10.39 years-old (*SD*=0.6; Range= 9-12), and 49.8% of the children were male (50.2% Female). The majority (70.5%) of children were born in the United States, whereas 28.8% were born in Mexico. The mean age of the mothers who participated was 36.7 year-old (*SD*=5.93; Range= 26-57), and mothers had an average of nine years of education (*SD*=3.65). A large majority (82.8%) of mothers were born in Mexico, whereas 16.3% were born in the United States. The majority of participating families were married, two-parent households (82%), whereas only 18% were single-parent families. The median total family income was approximately $37,500 (*SD*= $17,500, *Range* = < $5,000 to >$95,000).

Procedures

Study 2: Written informed consent was obtained from parents, and assent from the participating children. Parents and children were interviewed separately to maintain confidentiality of all responses. Trained research staff interviewed the participants in their homes using laptop computers. They visited the families on two separate occasions within a one week period. Visits lasted approximately three hours in which each participant was interviewed separately by one of two interviewers. The mother provided demographic information about the family. Interviews were conducted in Spanish or English based on the

preference of the participant. Items were marked as "*don't know*" by interviewers if the participant responded that they did not know the response to the interview question (e.g., height, weight, sleep). A total of 674 families and children were assessed at Time 1 (N=674, T1), with 569 subjects re-interviewed at Time 2 (T2) and 578 retained at Time 3 (T3).

Measures

Maternal Acculturation: Maternal acculturation is modeled as a latent variable with three indicators from two measures that examine the dual process of acculturation and enculturation. The concept of dual cultural adaptation is based on theoretical perspectives that acculturation and enculturation are not independent or orthogonal, are not separate, and the processes of both lead an individual to achieve a combination of levels among each that may be associated with cultural orientation and qualities of the home and family (Knight, Vargas-Chanes, Losoya, Cota-Robles, Chassin, & Lee, 2009). The **Hazuda Acculturation and Assimilation Scale (HAAS)** (Hazuda et al., 1988) is the first measure in this variable. For purposes of this study, the 6-item Interaction with Mainstream Society subscale was used. This subscale views acculturation as a multi-dimensional process involving "structural assimilation,"--the integration of members of the minority group into the social structure of the majority group (α=.80). The second measure is the **Mexican American/ Acculturation Scale (MAAS)**, and two subscales were used: the 14-itemed Acculturation subscale (α= .75) and the 24-itemed Enculturation (α=.86) subscale. High scores on the Acculturation subscale reflect agreement with mainstream American values, while high scores on the Enculturation subscale reflect agreement with traditional Mexican values and beliefs.

Maternal Overweight/Obesity: Self-reported height and weight were obtained by study interviewers. These data were used to calculate maternal BMI and, using CDC criteria, we calculated "overweight" as a BMI between 25.0 – 29.9, and "obese" as a BMI of 30 and above.

Neighborhood: The quality of child's neighborhood was evaluated as a latent variable with three indicators using maternal reports on three measures. The first was the **Neighborhood Criminal Events Scale (NCES)**. Higher scores indicate greater criminal or negative neighborhood events (e.g., **"**How often

did violent crimes including stabbings, shootings, and violent assaults happen in your neighborhood in the past year?"). This scale consists of 10 items on a 4-point scale (1=*almost never or never*, 4=*almost always or always*), and has an alpha of .92 for the present sample. The second measure was the **Social Cohesion** scale. Higher scores indicate greater neighborhood social cohesion (e.g. "People in this neighborhood can be trusted"). This scale consists of 3 items rated on a 4-point scale (1=*not at all true*, 4=*very true*), and has an alpha of .83.The third measure is the **Neighborhood Quality Scale**, and measures quality with 6 items (e.g., "Your neighborhood is clean and attractive"). Items are rated on a 4-point scale (1=*not at all true*, 4=*very true*) (α= .91).

Child and Adolescent Overweight/Obesity: Self-reported height and weight from children were obtained by study interviewers. These data were used to calculate youth BMI and, using a CDC program, the percentiles of participants' BMI compared to 2000 U.S. growth charts that take age and sex into account were calculated. Participants were referred to as "overweight" if they had a BMI greater than or equal to the 85th percentile, and "obese" if they have a BMI greater than or equal to the 95th percentile (CDC, 2011).

Sleep: The number of hours of sleep on a typical night was evaluated from a single-item variable derived from the following two interview questions: "*What time do you usually go to bed*?" and "*What time do you usually wake up in the morning*?" Based on the child's response to both questions, an integer was calculated by the interviewer where number of hours of sleep was rounded to two decimal places.

Physical Exercise: Child physical activity consists of a single-item variable evaluated from a self-report item (i.e., "How often do you get physical exercise either at school or after school?"), and responses were rated on a 4-point scale (1=*never*, 2=*seldom*, 3=*sometimes*, 4=*often*).

Computerized Diagnostic Interview Schedule for Children (**C-DISC):** Depressive symptoms for Mexican American youth were obtained using the Computerized Diagnostic Interview Schedule for Children (C-DISC-IV; Shaffer et al., 2000). The C-DISC-IV is a comprehensive structured interview that assesses various disorders using DSM-IV criteria. The Mood Disorders module from the C-DISC-IV was

used to measure the child's endorsed depressive symptoms, using symptoms counts. The range of possible symptom counts were from 0-21 (α= .82).

Data Analysis

Analyses under **Specific Aim#2** modeled cross-lagged effects among depression and overweight/obesity in Mexican-American students in 5th, 6th, and 7th grades. A longitudinal design, where each variable is measured at two or more time points, is an optimal way to examine reciprocal causal effects between variables (Kline, 2005). The model included three measurement waves and was guided by the cross-sectional examination discussed in Aim #1, by extending it into a longitudinal design. I specified variables representing depression and overweight/obesity at T1, with parallel sets of variables reflecting depression and overweight/obesity at T2 and T3. Stability paths were estimated between similar constructs at each of the different time points. Cross-lagged paths from T1 to T2 and from T2 to T3 were estimated by specified paths from depressive symptoms at one time point to overweight/obesity at later time points, and vice versa. The hypothesis under this aim was tested using structural equation modeling (SEM).These analyses were conducted using EQS version 6.1 (Bentler, 2002), and allowed the estimation of different directions of causation simultaneously in a multi-wave model. The use of SEM also addressed the issue of measurement error for the variables in the model and the full information maximum likelihood estimation was used to handle missing data. Three different indices were used to assess the overall fit of the model: the Yuan-Bentler-scaled chi-square (Y-B χ^2), the comparative fit index (CFI), and Bentler-Bonett (Hu & Bentler, 1999).

The analyses under **Specific Aim#3** investigated the overweight/obesity risk-related hypotheses 4, 5, and 6. In order to examine the key constructs in the hypothesized model, SEM was used to test the relations between maternal acculturation, maternal obesity, neighborhood quality, sleep, physical exercise, depression, and the outcome of adolescent overweight/obesity. In order to adjust for departures from multivariate normality in the data, the maximum likelihood estimation was used with robust scaling

techniques to better estimate model fit and standard errors (Kline, 2005). Model fit was determined with the two previously mentioned fit indices (Y-B χ^2, CFI), and the root mean square error of approximation (RMSEA) (Yuan & Bentler, 2000; Hu & Bentler, 1999; Browne & Cudeck, 1993). Lastly, in order to test for the moderating role of gender, a gender-constrained model was stacked over a gender-specific model and improvements in model fit were assessed using Chi-square difference tests.

Power and Sample Size Considerations

Study 2: Power for SEM analyses was estimated using benchmarks suggested by MacCallum, Browne, and Sugawara (1996). Using an alpha level of .05, a desired RMSEA of .05, and our established sample size of 674, we have the following levels of power to reject a model with an RMSEA of .08 (i.e., a model at the dividing point between acceptable and poor fit): *df* = 30, power = .97. This MacCallum et al. procedure implies that there was adequate power for the SEM analyses.

Chapter 5

Results: Study 1 (Aim 1)

Results: Aim 1

Table 2 depicts the descriptive statistics of the variable of interest for this study. Table 3 shows the bivariate correlations of depressive symptoms with other covariates and the main outcome of BMI percentiles. Only seven adolescents indicated having taken antidepressant medications. Of those, only one adolescent female met criteria for classification of obese (BMI% =98.6). Given these small numbers, antidepressant medications were not examined in the models. The bivariate correlations of depressive symptoms, BMI percentiles, and gender, separated by groups of race/ethnicity of focus to this study are shown in Table 4. The frequencies and percentages of race/ethnicity in the overall data sample are represented in Table 5, including those racial groups that were not included in regression analyses. Table 6 displays the frequencies and percentages of overweight/obese categorizations by race/ethnicity. Table 7 shows the breakdown of race/ethnicity and gender for the 109 subjects who reported sociodemographic variables.

The first multiple regression model examined whether depressive symptoms, race/ethnicity, and the interaction of depressive symptoms and race/ethnicity predicted BMI percentiles, with results depicted in Table 8. The model was statistically significant F (7, 1080) =5.31, p<.001, and accounted for approximately 3.3% of the variance of higher BMI percentiles (R^2=.033). The depressive symptoms were significantly associated with higher BMI percentiles among White adolescents, whereby an increase in one unit in depressive symptoms is associated with an increase of .382 units of a BMI percentile (unstandardized b=.382, standardized β=.146, t=3.79, p<.001). In addition, Latino adolescents had higher BMI percentiles compared to White adolescents (unstandardized b=10.83, standardized β=.129, t=4.18, p<.001). None of the other main effects for race/ethnicity were significant. Interactions between depressive symptoms and race/ethnicity were not significant, suggesting that the association between

depressive symptoms and increasing BMI percentiles is not moderated by race/ethnicity. Overall, these results lead to the rejection of Hypothesis 1 that depressive symptoms are associated with higher weight status for White, Asian, and Latino youth, but not for Black youth.

To address Hypothesis 2, a second multiple regression model was analyzed including gender as a main effect and as it interacted with depressive symptoms, race/ethnicity, and both depressive symptoms and race/ethnicity, as shown in Table 9. This model was statistically significant F (15, 1072) =3.17, p<.001, and accounted for approximately 4.0% of the variance of higher BMI percentiles (R^2=.040, Adjusted R^2=.029). The significant associations found in the previous model remained where there was a positive association between depressive symptoms and higher BMI percentiles among Whites (unstandardized b=.403, standardized β=.154, t=3.02, p<.01), and a significant difference in BMI percentiles based on Latino vs. White ethnicity (unstandardized b=8.43, standardized β=.100, t=2.50, p<.05). As for interactions with gender, the three-way interaction of depressive symptoms x race/ethnicity x gender was marginally significant for Latinos and showed a negative association whereby a one unit increase in depressive symptom scores for Latino males was associated with a .80 decrease in a BMI percentile (unstandardized b= -.804, standardized β= -.08, t= -1.88, p=.06). Figure 5 depicts a graph of this marginally significant three-way interaction. To further explore the direct effects for Latinos only, without dummy coding comparison with Whites, a supplemental regression model was fitted with Latinos (F (3, 130) =2.79, p<.05, R^2=.06) (Table 10). This supplemental regression on Latinos further supported the three-way interaction and showed a significant interaction with depressive symptoms x gender whereby increasing depressive symptoms in males predicted a decrease in BMI percentile (unstandardized b= -.84, standardized β= -.28, t= -2.61, p<.01). In the overall sample, the three-way interaction of depressive symptoms x race/ethnicity x gender was not significant for the other groups. Additionally, the two-way interactions between race/ethnicity x gender that were entered as predictors were not significant (see Table 9), suggesting that there were no gender differences in BMI percentiles when comparing race/ethnicity. Non-significant two-way and three-way interactions were then removed from the model in order to test if the three-way interaction remained significant in a less restrictive model.

Findings further supported the three-way interaction of depressive symptoms x race/ethnicity x gender, and showed that, in a less restrictive model, Latinos males with a one unit increase in depressive symptom scores were associated with a .30 decrease in a BMI percentile (unstandardized *b*= -.30, standardized β= -.07, *t*= -2.22, *p*=.02). Overall, these findings led to the rejection of Hypothesis 2 that gender differences would be found between depression and increasing weight status among all four groups of youth (White, Asian, Black, and Latino).

A third model adjusted for sociodemographic factors for the 109 subjects that these data were available for (Table 11). This adjusted model examined depressive symptoms and gender predicting BMI percentiles, controlling for parent education and family composition. The model was significant *F* (4, 104) =4.10, *p*<.01, and accounted for approximately 13.6% of the variance of BMI percentiles (R^2=.136, Adjusted R^2=.103). In this model, two-parent households (married or cohabitating partners) were negatively associated with BMI percentiles whereby youth who lived in a two-parent household were associated with a 11.70 decrease in BMI percentiles (unstandardized *b*= -11.70, standardized β= -.20, *t*= -2.24, *p*<.05). In this adjusted model, higher levels of depressive symptoms were associated with higher BMI percentiles over and above the effects of parent education and family composition (unstandardized *b*=.57, standardized β=.18, *t*=1.99, *p*<.05). This suggests that the association between depression and higher BMI percentiles remains significant for these 109 adolescents after accounting for sociodemographic factors. In addition, gender was associated with higher BMI percentiles and showed that males had higher BMI percentiles, over and above the effects of sociodemographic factors (unstandardized *b*= 9.88, standardized β= .17, *t*= 1.91, *p*<.05).

Supplemental Analyses: Multiple Regressions. Additional multiple regressions with Latino coded as the referent group in the dummy coding scheme were conducted in order to validate results obtained from the original dummy coding scheme where White was coded as the referent group. Results from these

supplemental analyses support the results obtained from the original coding scheme and further support the rejection of Hypothesis 1 and Hypothesis 2.

Supplemental Analyses: Logistic Regressions. Logistic Regression analyses were conducted in order to examine the probability of an adolescent reaching a dichotomous threshold for overweight/obese given the same set of predictor variables and two- and three-way interactions.

The results of this logistic regression model are depicted in Table 12. Overall, this model correctly classifies 67.4% of adolescents and provides a significant fit to the data ($X^2(15, N=1,106) = 28.25$, $p<.05$). The Hosmer–Lemeshow test ($p= .86$) indicates that the overall model fit is good. Of the 15 indicators, 1 indicator was marginally significant, and 1 was significant. First, the odds of an adolescent who is a White male being overweight/obese is 1.36 higher than those of an adolescent who is White female (OR 1.36, 95% CI .98-1.90, p=.06), suggesting that White males in this study are at increased risk for developing overweight/obesity compared to females (RRR 1.27, 95% CI 1.07-1.51, p=.005). Second, a three-way interaction in depressive symptoms x race x gender was significant such that if the level of depressive symptoms increases by one point along the MFQ, given that the adolescent is Latino and is male, then the odds of being overweight/obese decrease (OR .93, 95% CI .87-.99, p=.03).

Next, a second logistic regression model adjusted for sociodemographic factors in the subset of 109 subjects (Table 13). This adjusted model examined depressive symptoms and gender predicting the probabilities of being overweight/obese, controlling for parent education and family composition. The results of this adjusted logistic regression show that the odds of an adolescent being male being overweight/obese are 2.63 higher than those of an adolescent who is female (OR 2.63, 95% CI 1.11-6.19, p=.02), and that males are at increased risk for overweight/obesity over and above the effects of sociodemographic variables (RRR 1.33, 95% CI .98-1.79, p=.03). Depressive symptoms, however, were not significant after controls. This finding stands in contrast to the findings of the adjusted multiple regression model where the association between depressive symptoms and higher BMI percentiles remained significant , even after controlling for parent education and family composition. However, since

this logistic regression model was specifically examining the odds of being overweight/obese, these results suggest that probability of being overweight/obese if there is an increase in depression among the 109 adolescents may be accounted for by accounted for by sociodemographic factors.

Chapter 6

Results: Study 2 (Aims 2 & 3)

The descriptive statistics of all variables used in Study 2, which includes variables used in Aims 2 & 3, are found in Table 14.

Results: Aim 2

Table 15 details the frequencies of the BMI calculations that were obtained across the three time points examined in Aim 2. As can be seen in Table 15, BMI calculations were low at Time 1 (N= 222) and Time 2 (N=210), but improved at Time 3 (N=420). BMI calculations require both height and weight, and subjects could have reported one but not the other, leading to the inability to calculate BMI. Therefore, BMI and BMI Percentiles were only calculated for subjects who reported both height and weight (Table 15). Exploratory analyses were conducted to examine if demographic variables predicted the missing BMI data. Logistic regression analyses were run on age, gender, grade, and puberty status, to test for predictors of missing data. None of these demographic variables, however, were significant. In the next step, the prevalence of overweight or obesity in Mexican American youth across the three time points were calculated (Table 16). As can be seen from the table, in 5th grade (T1) the prevalence of overweight or obesity in this sample was 55% and, of those, 36% were obese. The prevalence for overweight/obesity drops to 45% in 6th grade (T2), and drops further to 35% in 7th grade (T3).

The results for the longitudinal associations between depression and obesity in Mexican-American children as they transition into adolescence are shown in Figure 6. Correlations for these constructs are depicted in Table 17. The model (Figure 6) demonstrated good fit according to these 3 fit index criteria (Y-B χ^2 (4, N=674) =4.70, p >.05; CFI =.98; Bentler-Bonett= .92).

The findings provided some support for particular aspects of the longitudinal depression-overweight/obesity model with Mexican American youth, while showing less robust evidence for particular links (results depicted in Figure 6). Four significant stability paths emerged in the transition to adolescence: i) Depressive symptoms in 5th grade predicted depressive symptoms in 6th grade; ii)

Depressive symptoms in 6th grade predicted depressive symptoms in 7th grade; iii) Overweight/obesity in 5th predicted overweight/obesity in 6th grade; iv) Overweight/obesity in 6th grade predicted overweight/obesity in 7th grade. While the cross-lagged paths were not significant for the first two time points, one significant cross-lagged path did emerge from 6th to 7th grade: i) the presence of overweight/obesity in 6th grade was significantly negatively associated with depressive symptoms at 7th grade whereby higher weight in 6th predicted lower levels of depressive symptoms in 7th grade (unstandardized b= -.22, standardized β= -.36, p <.05).

Hypothesis 3, which predicted that depression and obesity would be reciprocally related to each other over time for Mexican-American youth, whereby depression would predict overweight and obesity and conversely, overweight and obesity would predict depression, was therefore rejected. .

Results: Aim 3

Measurement Model. Confirmatory factor analyses (CFA) were first used to determine whether the measurement model provided an acceptable fit with the data. A series of models were tested in a series of stages in order to examine the effects of adding the latent and manifest variables to the hypothesized model (hypothesized model in Figure 3). Stage A tested a 4-factor CFA model consisting of the first 2 latent variables and 2 manifest variables in the hypothesized model (Child Depression T1, Maternal Acculturation T1, Maternal BMI T1, & Neighborhood T1), where all factors were allowed to correlate freely. This model showed a fit of: Y-B χ^2 (16)=182.88, p <.00 CFI=.76; and RMSEA=.15. In order to improve model fit, the Lagrange Multiplier (LM) Test indicated having the following error residuals free to correlate a) Acculturation Hazuda and Acculturation MAAS in the latent variable for Maternal Acculturation, d) Acculturation MAAS and Enculturation MAAS in the latent variable for Maternal Acculturation. This led to a significant improvement in model fit: χ^2 (14) =70.22, p <.00 CFI=.92, RMSEA=.09; $\Delta\chi^2$ (2) =112.66, p <.001. Stage B consisted of a 5-factor CFA model where the variable of Child Overweight/Obesity was added. Next, a 7-factor CFA was tested in Stage C where the variables

of Sleep and Physical Exercise were incorporated and, in Stage D, an 8-factor CFA was tested by adding Child Depression T2. In the last step of testing the measurement model, Stage E tested the complete 9-factor CFA by adding Child Overweight/Obesity T3 (χ^2 (34) =49.36, p =.04 CFI=.83; and RMSEA=.11). On the basis of the LM Test, and because these model changes made conceptual sense, the following error residuals were then freed to correlate in Stage F: Neighborhood Quality in the latent variable for Neighborhood and Acculturation Hazuda in the latent variable for Maternal Acculturation. As indicated by the chi-square difference test, the fit of this re-specified model in Stage F was significantly better than that of the original model in Stage E, $\Delta\chi^2$(1) =11.82, p <.001, and the fit indices improved; CFI=.95; and RMSEA=.06. This was accepted as the final measurement model. The correlation coefficients for the measured variables in this hypothesized model are depicted in Table 18.

Structural Model. In the first step of the SEM analyses, the model was estimated exactly as hypothesized (refer to Figure 3 for hypothesized model). Results from the SEM indicated that this model did not demonstrate an acceptable fit to the data; Y-B χ^2 (48)=71.90, p =.01 CFI=.74; and RMSEA=.12. In order to improve model fit, the LM test suggested adding parameters. Two of the LM suggestions were rejected as they did not make conceptual sense (rejected: adding Depression T1 indicator to Neighborhood Quality latent variable, and adding Depression T2 indicator to Neighborhood Quality latent variable). Two parameters suggested by LM Test were added: a) error residuals from Neighborhood Crime and Physical Exercise were freed to correlate, and b) error residuals from Neighborhood Crime and Depression T2 were freed to correlate. The fit indices of this model were significantly improved, with a CFI value of .92, and a RMSEA of .06, ($\Delta\chi^2$(2) =19.26, p <.01), and was accepted as the best fitting model (Figure 7). As can be seen from Figure 7, the final model indicated the hypothesized risk factors of maternal acculturation, maternal weight status, and neighborhood quality were not significantly associated with child overweight/obesity in 5th grade. Second, child overweight/obesity in 5th grade was not significantly associated with sleep or physical exercise in 6th

grade. Third, greater hours of sleep were significantly associated with more physical exercise in 6th grade (unstandardized b=.55, standardized β=3.87, p <.05). Fourth, greater hours of sleep were also significantly associated with higher depressive symptoms in 6th grade (unstandardized b=.85, standardized β=1.41, p <.05). Fifth, physical exercise was not significantly associated with depressive symptoms in 6th grade. Sixth, depressive symptoms in 6th grade were not significantly associated with adolescent overweight/obesity in 7th grade. In addition, depressive symptoms in 5th grade were positively associated with depressive symptoms in 6th grade, and child weight in 5th grade was positively associated with adolescent weight in 7th grade. Based on these results, Hypotheses 4 and 5 were rejected.

The next set of analyses tested whether the hypothesized model held equally for males and females. Simultaneously constraining path coefficients to be equal across males and females did not produce a significant increase in model fit ($\Delta\chi^2(19)$ =9.74, p >.05), indicating that path coefficients were the same across gender and Hypotheses 6 was rejected.

Chapter 7

Discussion

Significance from Aim 1

Using a large, ethnically-diverse sample of middle school students from the Middle School Matters study, I examined whether the association between depressive symptoms and weight status was moderated by race/ethnicity and gender. Interactions between race and depressive symptoms were not significant for any of the racial/ethnic groups compared, suggesting that race does not significantly affect the association between depressive symptoms and weight status for Asians, Blacks and Latinos. The major findings of this Aim are that depressive symptoms are positively associated with higher BMI for White adolescents, and provide support for an association among this group. Other studies have noted similar findings and have reported that obesity has a greater influence on health for White or higher-income children (Halfon, Larson, & Slusser, 2013). In addition, it was found that adolescents who were Latino had higher weight status than their peers who were White. This finding trends towards a recent national study representative of the U.S. population of children and adolescents which documents racial and ethnic differences whereby the prevalence for obesity continues to be higher among Latinos than White youth (Ogden, Carroll, Kit, & Flegal, 2012), as well as other findings that show Latinos face 68% increased odds of being obese compared to Whites (Kimbro & Denney, 2012). Interactions between race, depressive symptoms, and gender were also examined as it has been found that obese females experience higher rates of depression (Stunkard et al., 2003). While findings did not emerge for females in the three-way interactions, support was found for Latino males with higher levels of depressive symptoms having lower BMI, as well as decreased odds of being classified overweight/obese. Given that the data are cross-sectional and causality cannot be inferred, this interaction could be interpreted in two ways. The first is that Latino males with smaller body mass may be at risk for depression. It is possible that these Latino males are becoming aware of sociocultural ideal for males and may be experiencing body dissatisfaction due to pressure or expectations to have a larger, more muscular body, which may in turn be associated

with experiencing higher depressive symptoms. For example, since it has been found that body dissatisfaction mediates the relationship between overweight and emotional well-being as classified by depressed mood and low self-esteem (Mond, van den Berg, Boutelle, Hannan, & Neumark-Sztainer, 2011), it is possible that body dissatisfaction in Latino males may also mediate the association between their low body size and depressive symptoms. On the other hand, a second interpretation is that Latino males with high depressive symptoms may experience lower BMI. Consistent with these findings, Anderson, Cohen, Naumova, & Must (2006) reported childhood depression in white males predicting lower BMI. However, the findings from Anderson and colleagues are longitudinal in nature while ours only examined one time point making it unclear how BMI is changing over time for Latino males and/or if there is weight loss. However, if lower BMI among Latino males in this sample is, in fact, associated with weight loss, support exists for decreased appetite and weight loss being valid indicators of depression during adolescence (Cole, Cho, Martin, Youngstrom, March, et al., 2012), and could point to important depression intervention efforts among this group. However, this direction cannot be concluded by our current finding given the cross-sectional design and the fact that we did not examine weight loss or weight gain. Future research that examines Latino adolescents over time should examine whether weight loss is characteristic of the pattern of depressive symptomatology for Latino males. Our findings from this Aim also suggested gender differences in the probability of an adolescent being overweight/obese versus not being overweight/obese, whereby White males were at increased risk for being overweight/obese when compared to White females in this sample. The increased risk for White males in this study is consistent with more recent nationally representative prevalence rates that show higher prevalence rates of obesity among White males than White females (Odgen & Carroll, 2010).

While it would have been preferred to examine the sociodemographic factors with the race/ethnicity interaction terms in order to determine whether sociodemographic factors accounted for ethnic differences in overweight/obesity, the sample size for the sociodemographic variables was too small to have reliable results. That is, Thompson & Levine (1997) caution against computing regression data with sample sizes that are too small as it may invalidly indicate large increases in regression coefficients when the new

variables are added to the regression equation and create suppression effects. Therefore, I opted to examine the effects of sociodemographic factors on the small subset of adolescents in a more conservative model, without interaction terms or comparisons across race/ethnicity. Importantly, after controlling for parent education and family composition (single parent vs. two parent) in the subset, adolescents with higher depressive symptoms also experienced higher BMI, even after accounting for sociodemographic factors. This finding is quite consistent with literature indicating being obese is a stigmatized status in much of western culture, particularly among the middle class (Adams, Sargent, Thompson & Richter, 2000). Moreover, since there is stability in youth depression and it has a high risk of relapse throughout the life-span (Hammen, 2009), our findings raise concern for adolescents experiencing higher levels of depression and point to the need for overweight prevention efforts among this group or, depression prevention among overweight youth. In addition, consistent with national prevalence rates (Odgen & Carroll, 2010), gender was a significant predictor in increased BMI, even after controls, where males have significantly higher BMI's, as well as increased risk of being overweight/obese, compared to females. Importantly, family composition was associated with weight status and results showed that youth who lived in a two-parent (married or co-habitating partners) household had lower BMI percentiles. This further supports previous studies that have found that children of single-parent households are significantly more overweight than those of two-parent households (Huffman, Kanikireddy, & Patel, 2010). It appears that family composition plays a role in determining youth weight status as two-parent households may serve as protective factors against obesity through associations such as increased household income and increased access to fresh quality foods, as well as greater probability of having family meals, and increased likelihood of living in safe neighborhoods with access to recreational facilities. Since this smaller subsample consisted of ethnically diverse adolescents (refer to Table 7), it implies that disparities in adolescent BMI weight status among racial/ethnic groups may exist independently of race/ethnicity. Further, it may be fruitful to address problems related to youth overweight/obesity by addressing disparities in family resources or evaluating whether reducing socioeconomic and other family-contextual disparities among racial/ethnic groups will result in improved

youth health and weight. That is, based on these findings, overweight/obesity prevention efforts could target youth of low-educated single parents.

Significance from Aim 2

Despite the high rates of both depressive symptoms and overweight/obesity among Mexican American youth, it has been unclear how the two are associated over time. Therefore, we conducted longitudinal path analyses to understand the direction of associations between depression and overweight/obesity in Mexican American children from the California Families Project. It was hypothesized that there would be a positive association over time such that increases in weight would relate to increases in depression. The findings suggest that depression and overweight/obesity both hold steady across time (5^{th}-7^{th} grade) for Mexican American youth. Prevention efforts aimed at Mexican American youth may place focus during the elementary school years to prevent overweight/obesity in adolescence. Further, results suggested overweight/obesity at Grade 6 was negatively associated with depression at Grade 7 among Mexican American youth. This stands in contrast to a previous study that showed that while there was no association at baseline, if obesity persisted over four time points between childhood and late adolescence, there was a slightly higher prevalence of depression among White adolescents (Mustillo et al., 2003). Differences between our findings and those of Mustillo and colleagues could be accounted for by racial/ethnic differences in cultural factors. That is, cultural attitudes that are accepting of larger body frames may serve as a protective factor for Mexican American youth against depression. As mentioned in the review, parents of Latino descent have been found to value higher weight among their children (e.g., Guendelman, Fernald, Nuefeld, & Fuenters-Afflick, 2010) and this preference may lead to cultural acceptance, even among children, of higher weight status. In addition, overweight/obese Mexican American youth in this sample may be receiving social support and cultural acceptance that buffers any psychological difficulties they may experience related to weight status. Moreover, it is possible that these youth do not experience dissatisfaction with their weight status or body size, and body dissatisfaction has been found to mediate the relationship between overweight and

emotional well-being (Mond et al., 2011). Findings from Ayala and colleagues (2007) provide further support for this contention. They found that among overweight Mexican American youth, body image dissatisfaction was highest among those who more strongly agreed with U.S. socially sanctioned standards of beauty (Ayala et al., 2007).

Another potential explanation for this contradictory finding is that being overweight or obese is the norm among this specific sample of Mexican American youth in Northern California (55%=overweight or obese in 5th grade) and therefore youth do not experience depressive symptoms resulting from their weight status. Lanza, Echols, & Graham (2013) found that deviation from the norm BMI of one's ethnic group was associated with higher levels of emotional maladjustment, and given that the BMI norm for this Mexican American sample was high, there may be less stigma, less weight-based discrimination, and lower levels of psychological distress in this sample due to the fact that the majority of these children already meet criteria for overweight/obese. In addition, Mexican American children who are overweight could also be facing other risk factors and stress exposures that are more associated with depressive symptomatology and weight status may, therefore, play little importance. For example, given the demographics of this sample, these youth may be faced with issues of poverty, economic stress, low resources, acculturative stress (individual and parental), and discrimination. In light of these other factors, being overweight or obese may have little contribution to their overall psychological well-being.

Furthermore, another potential contributor for the surprising findings may be related to what BMI is actually measuring in children and adolescents. In other words, since BMI does not specifically measure body fat contribution to body weight, those who were classified as overweight or obese (BMI percentile of 85 or higher) may include children who naturally have high lean body mass or are athletic and muscular in stature. These youth may be less likely to experience body dissatisfaction and psychological distress as a result of their weight status.

The prevalence for overweight/obesity in the California Families Project was an important finding in and of itself. The prevalence for being overweight/obese in 5th (55%) and 6th grade (45%) was significantly higher than the national average for 6-19 year olds of 33.2% (Ogden et al., 2012). The high

prevalence of Mexican American children who were classified as overweight/obese signifies the importance of developing and implementing interventions towards younger age groups of Mexican American youth. However, by the time these children reached 7th grade, the prevalence decreased (33.2%) towards the national average (35%). Other studies have also indicated that older Mexican American adolescents aged 15-19 years-old were less likely to be overweight or obese than their younger peers aged 5-14 years old (Hernandez-Valero et al., 2012). Perhaps, growth spurts during the pubertal process lead to decline in BMI such that they may be gaining height rapidly but not increasing in weight which could account for decreased BMI, or these youth may be engaging in behaviors that lead to leaner mass such as increased physical activity or increased sport participation.

Significance from Aim 3

In Aim 3 of the dissertation, I was particularly interested in risk factors, and mediating pathways, that may account for Mexican American children developing overweight/obesity into adolescence. Therefore, I also tested a model that examined environmental and cultural factors that have been found to determine child health. Evidence was not found in support of the full hypothesized model for development of overweight/obesity into adolescence for Mexican American children, however, noteworthy associations were found. First, a significant association between sleep and physical exercise was found in the model, indicating that more hours of sleep were associated with greater physical exercise at grade 6. Consistent with this finding, an inverse relationship was proposed by Taheri (2006) whereby low amounts of sleep led to tiredness, which in turn hampered physical activity and resulted in less exercise. The current finding supports this by depicting that greater amounts of sleep may provide the energy required for greater amounts of physical exercise among Mexican American youth.

Second, more hours of sleep were associated with higher depressive symptoms. This finding is consistent with reports that sleep disturbances, in either sleep deprivation or longer sleep, is a characteristic symptom of depressive disorders in youth (Rao, 2011). However, our findings stand in contrast to previous findings with Latino youth where children with reduced amounts of sleep (<=7.5

hrs/night) had higher risk of being depressed (Silva, Goodwin, Parthasarathy, et al., 2011). The differences found between this study and Silva and colleagues may be due to the way in which sleep was measures as their study examined sleep directly through a polysomnogram in Latino youth who were directly involved in a sleep study, whereas our study utilized youth self-report to calculate hours of sleep from a community sample of Mexican Americans. Further, the self-report nature in our sample may have led to youth either over or under reporting about when they went to bed and when they woke up, which may have influenced our findings and led to differences with Silva and colleagues' findings. Future research is needed among Latino youth in order to determine the direction of the sleep-depression association and whether it differs based on the methods used to measure sleep.

Third, stability paths were found for weight and depression at different time points measured in the model, which was consistent with findings from Aim 2 of this dissertation. Given that the sample from Aim 2 is the same as that for Aim 3, we expected to find this similarity.

Results, however, did not provide support for the hypothesized risk factors of maternal acculturation, maternal BMI, and neighborhood conditions, predicting higher overweight/obesity in children. While the lack of an association between maternal acculturation and child overweight stands in contrast to other studies that have found that more acculturated Mexican-origin women were more likely to have an overweight child (e.g., Hernández-Valero et al., 2007), the finding is parallel with results from Rosas and colleagues (2011) who, in a cross sectional examination of risk factors for overweight and obesity among Mexican American children, found that mother's length of stay in the U.S. was not associated with the probabilities of child overweight. Further, the lack of an association with maternal BMI and child overweight/obesity contradicts previous findings that maternal obesity is a determinant of child obesity among Mexican-origin families (Rosas et al., 2011). The fact that, in our sample, maternal BMI was based on mother report, and child BMI on child report, could influence the lack of an association found in this study and could have differed if the same reporter was used, or if direct BMI measurement was used. In addition, neighborhood quality and safety was not associated with child weight status in the model, which is consistent with other findings among Latino children, in that previous literature has found a lack

of an association with neighborhood hazards and higher child BMI (Romero, Robinson, Kraemer, et al., 2001). In interpreting this finding, it is important to note that the neighborhood variable used was based on maternal perception, and not child. Thus, it is possible that, even if mothers perceive the neighborhood as unsafe, children may still be playing outdoors when mothers are not around to supervise because they may not see it as a problem. Further, our neighborhood variable did not take into account access and availability to facilities in the neighborhood where children can engage in physical activity. In other words, even if neighborhood quality is perceived as being poor by mothers, children may be able to obtain physical exercise in local parks or community centers. In addition, the hypothesized model did not differ for boys and girls. However, it should be noted that gender differences were found in Aim 1, with a negative association between depression and weight status for Latino males. Differences could be attributed to the cross-sectional nature of Aim 1 whereas Aim 3 was longitudinal. Importantly, in the full model, the final outcome of adolescent obesity was not predicted by any of the hypothesized mediating factors. While the full hypothesized model was not supported, this dissertation contributes to the literature by suggesting that the factors examined here may not predict or relate to overweight/obesity status among Mexican American adolescents. Overall, the hypothesized model's components and their associations need further exploration and future research should examine other factors that may be contributors to overweight/obesity that were not examined here.

Strengths and Limitations

This dissertation has many strengths that are worth noting. First, Study 1 consisted of a large, ethnically-diverse, sample size of adolescents which allowed for comparisons across racial/ethnic groups. Additionally, the methods used in Study 1 consisted of direct height and weight measurement. This promotes more accurate BMI readings, and is more reliable than self-reported height and weight. Most studies that examine weight tend to rely on self-report, which could lead to inaccurate BMI calculations if the reporter does not know their weight, and self-report may present demand characteristics to bias one's estimates.

Study 2 also had many strengths including a large sample of Mexican American youth. Very few studies have been able to examine a large sample of Mexican American children and adolescents and given changes in demographics where Latinos are a growing segment of the population in the U.S., examinations that focus on this group are essential. Furthermore, the use of longitudinal data are a huge strength and provided an opportunity to examine the interplay between depression and obesity as children transitioned into adolescence.

While there are strengths, there are also several limitations that need to be addressed for this dissertation. First, for Study 1, the examination between depressive symptoms and BMI was cross-sectional in design and causality in the associations cannot be inferred. In addition, data on body image were not available for Study 1, and such data would be informative towards the associations found as previous research has suggested the importance of body image perception in the association between depression and obesity (Mond et al., 2011). However, data on experienced discrimination are available for Study 1, and future examination of this variable could greatly inform the findings on the association for White adolescents. Further, sociodemographic variables were not available for the entire sample of Study 1 and it could not be determined what effect, if any, these sociodemographic variables may have had in the findings suggesting differences in race/ethnicity. Lastly, while the sample size (N=1106) for Study 1 was ethnically diverse, the number of Black youth in the overall sample was relatively small (N=42) and a larger sample would have been ideal for more adequate comparisons with the other groups.

Study 2 also had limitations that need to be considered. First, the low numbers for BMI calculations across the time points are a significant limitation of Study 2, and impact both Aims 2 and 3. As was mentioned in the dissertation, BMI calculations were low for 5^{th} grade (N= 222) and 6^{th} grade (N=210), but improved at 7^{th} grade (N=420). While missing data were handled using appropriate maximum likelihood estimation techniques, it is possible that there was meaningful data in the missing BMI calculations that could have influenced our findings. Similarly, not all of the original subjects that participated in the first year of Study 2 (N=674) continued on to participate in the subsequent two years and, it is possible that important information could have been obtained from missing subjects.

Additionally, self-report height and weight were used for Study 2 and literature on BMI measurement has suggested potential misclassification in self-reports as opposed to direct measurement (Danubio et al., 2008; Rhew et al., 2008), and problems and inaccuracies in Mexican American adolescents' self-reported height and weight has been cited by other researchers (Davis & Gergen, 1994). While direct measurements would have been preferable, the data had already been collected for this sample and direct measurements could no longer be obtained. Similarly, the self-reported nature of sleep is a limitation as Mexican American youth may have incorrectly indicated what time they go to bed and what time they wake up, and could have resulted in inaccurate calculations of hours of sleep by the interviewers. Further, data on antidepressant medications for Study 2 was not available. It is possible that some of the pathways of interest for Aims 2 and 3 may be confounded by medication usage. However, given that data on antidepressant usage were collected for Study 1 and less than 1% (N=7) of adolescents indicated medication use in that diverse sample, it is likely that the prevalence would be low for the Mexican American sample in Study 2. Moreover, the percentage rate of Mexican Americans aged 12 and over who take antidepressant medication is 2.7% (Pratt, Brody, & Gu, 2011), and while the prevalence for usage among Mexican Americans children is unclear, it would be likely that usage among our sample would be lower, particularly given their younger age of 9-12 years old in 5th grade. Furthermore, given that the prevalence rates for overweight/obesity were relatively high among Mexican American children in Study 2, data prior to 5th grade would have been largely informative in that it would have allowed the examination of factors that contributed to the high prevalence seen among these children. Future studies should examine risk factors for overweight/obesity among younger Mexican American children as it appears that, by 5th grade, they already have high prevalence rates for overweight/obesity.

Another limitation for both Study 1 and Study 2 is that a number of important factors that could potentially be related to our outcomes of interest were excluded. These factors include number of hours spent watching television (Anderson, Crespo, Bartlett, Cheskin, & Pratt, 1998), pubertal status (Wang, 2002) or other factors that have previously found to be associated with being overweight among Mexican American youth such as dietary intake (Forrest & Leeds, 2007). Importantly, acculturation among Latinos

in Study 1 or Mexican Americans in Study 2 was not examined directly and youth acculturative factors may play an important role in the etiology of overweight/obesity. For example, acculturated Mexican American adolescents had 2-4 times higher odds of being overweight and obese than less acculturated adolescents (Liu, Chu, Frongillo, & Probst, 2012). Future examinations could incorporate youth acculturation into the analytic models in order to understand its role.

Conclusion

Notwithstanding these limitations, the results from this dissertation make an important contribution towards the study of the association between depression and overweight/obesity among ethnically diverse youth. The dissertation examined two different samples, one cross-sectional and one longitudinal, and important findings for Latino youth emerged across the samples. With regard to the association between depression and overweight/obesity, this dissertation found a lack of an association, or a negative association. That is, the cross-sectional study with Latino youth (Aim1) found that Latino males with high depressive symptoms had a lower BMI. Then, a longitudinal examination (Aim 2) found that there was no association across time points and that instead, there was a negative association from 6th to 7th grades where higher body mass predicted lower depression in Mexican American youth. Lastly, another longitudinal model using these data (Aim 3) further supported that an association was not present, even when taking into account multiple overlapping factors that could contribute to an association. Overall, it appears that depression and overweight/obesity may be a more distinct phenomenon among this ethnic group, in comparison to White populations where they appear to be interrelated comorbidities. Given the high prevalence for overweight/obesity among Latino youth, however, further research is needed in order to explore and modify cultural factors that may be contributing to poor health and attitudes towards overweight/obesity among Latino populations. That is, future research should explore the sources of the differential effects found for Latinos compared to Whites and examine whether differences are accounted for by cultural norms, beliefs, and social environmental factors. Overall, the current findings contribute to

research areas that target health disparities among Latino children and adolescents. Obesity prevention efforts for Latino youth, particularly those for Mexican American youth, should note that overweight/obesity co-morbidity may not include depression among late-childhood to early adolescent Latinos, and should not assume that overweight/obese Latino youth are experiencing high degrees of psychological distress.

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Figures

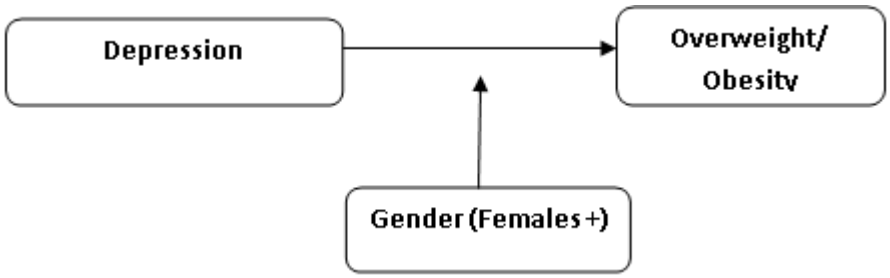

Figure 1. Cross-sectional model of the association between depression and obesity examined separately for White, Asian, Black, and Latino youth, and gender interacting within each ethnic group where females have stronger associations.

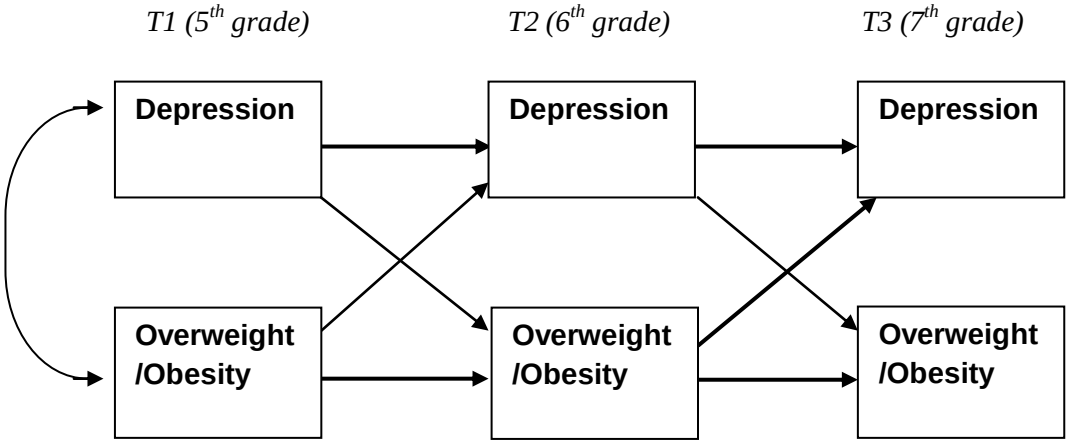

Figure 2 . Proposed structural model of the lagged associations among depression and obesity in Mexican American children as they transition into adolescence.

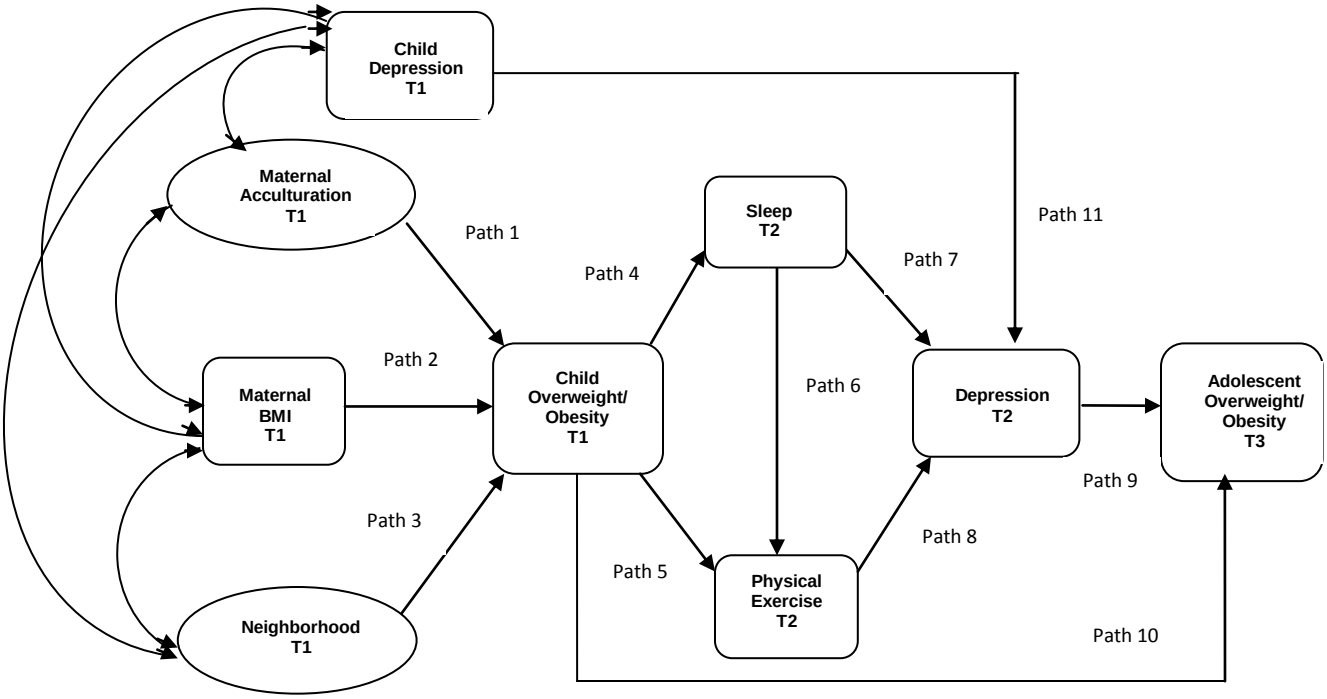

Figure 3. Hypothesized model of the risks for the development of overweight and obesity among Mexican American youth. Solid arrows indicate primary hypothesized influences. All T2 factors were estimated as covariates in the model (not depicted here for organizational purposes). T1=5th grade; T2=6th grade; T3=7th grade.

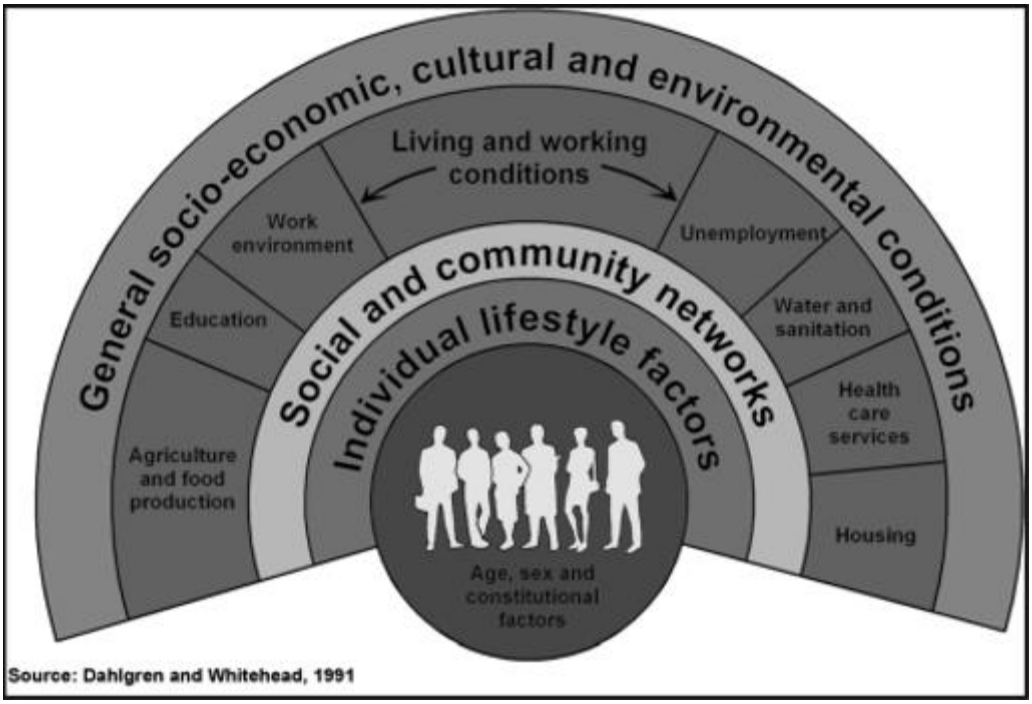

Figure 4. A social model of health (Dahlgren & Whitehead, 1991)

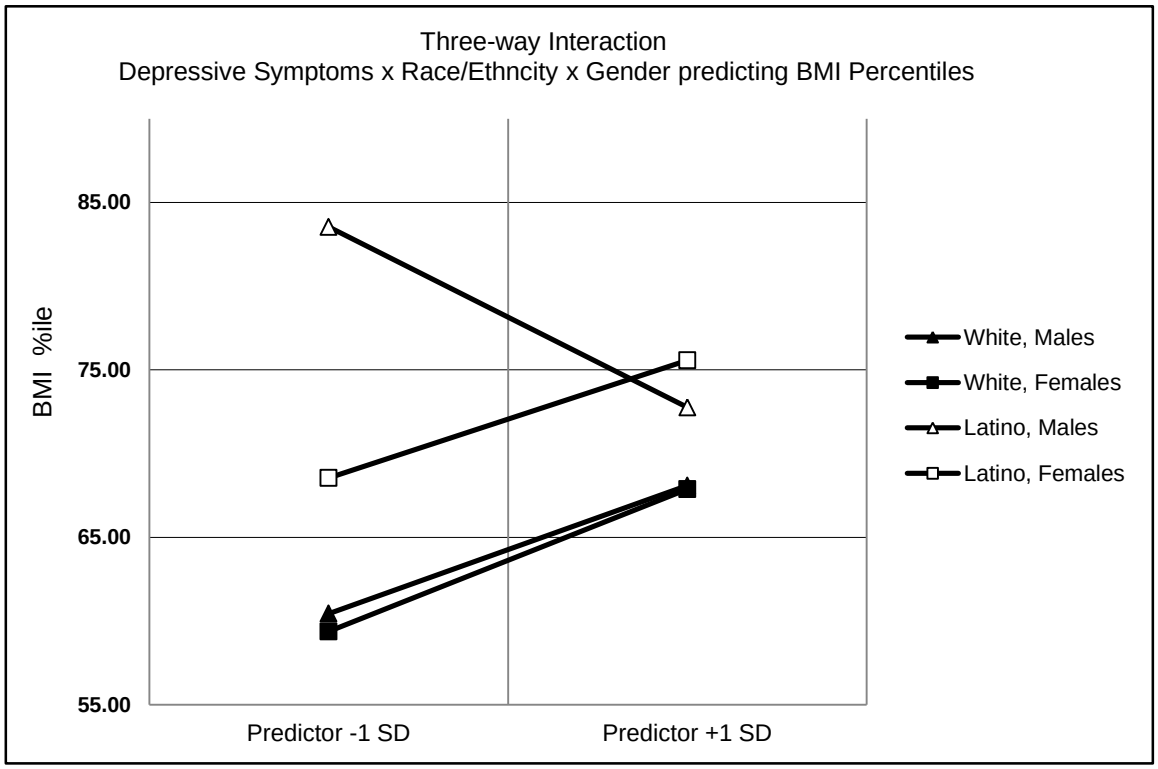

Figure 5. Significant three-way interaction for Study 1.
Predictor -1SD= Depressive Symptoms centered score -1 standard deviation;
Predictor +1SD= Depressive Symptoms centered score +1 standard deviation.

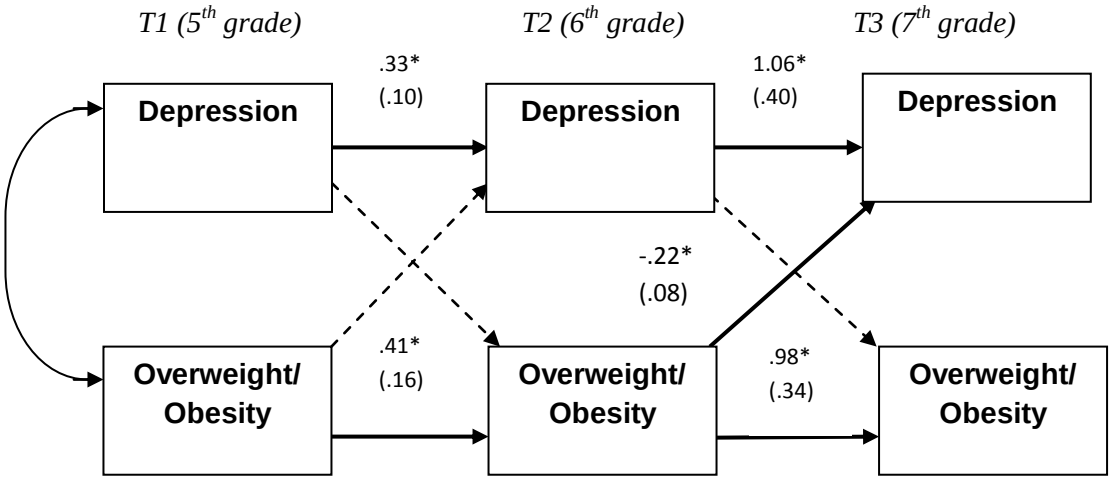

Figure 6 . Structural model of the lagged associations among depression and obesity in Mexican American children as they transition into adolescence. All paths were initially estimated, only significant paths are indicated using solid lines. Unstandardized estimates (standard error). * p <.05

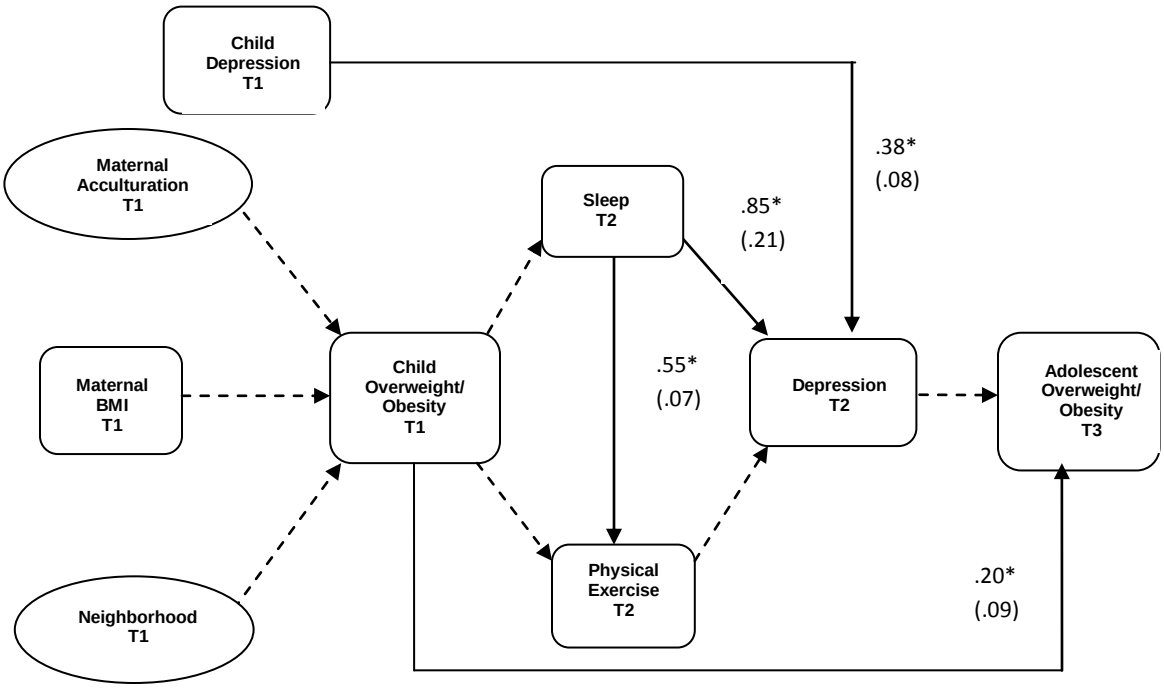

Figure 7. Results of the hypothesized/conceptual structural model of the risks for the development of overweight and obesity among Mexican American youth. All paths were initially estimated, only significant paths are indicated using solid lines; dashed lines indicate insignificant paths. Unstandardized estimates (standard error). * p <.05

Tables

Table 1

Clinical and community studies on the association between depression and obesity in youth

Authors	Age of Sample	Sample Demographics	Type of Study/ Sample	Association Found/ Directionality
Bardone et al., 1998	15 yrs	New Zealand	Prospective/ Community	N, Dep-›Obesity
Belue, Francis, & Colaco, 2009	12-17 yrs	U.S.-White, Black, Latino	Cross-sectional/ Community	Y
Benson et al., 2013	7-17 yrs	U.S.-Race/Ethnicity not reported	Cross-sectional/ Clinical	N
Britz et al., 2000	15-21 yrs	Germany	Cross-sectional/ Clinical	Y
Eremis et al., 2004	12-16 yrs	Turkey	Cross-sectional/ Clinical	Y
Goodman & Must, 2011	12-18 yrs	U.S.- White & Black	Longitudinal/ Community	Y, Obesity-›Dep, White only
Goodman & Whitaker, 2002	7-12th graders	U.S.-White, Black, Latino	Prospective/ Community	Y, Dep-›Obesity
Hasler et al., 2005	17 yrs	Switzerland	Prospective/ Community	Y, Dep-›Obesity
Halfon, Larson, & Slusser, 2013	10-17 yrs	U.S.-White, Black, Latino	Cross-sectional/ Community	Y
Isnard et al., 2003	12-17 yrs	France	Cross-sectional/ Clinical	Y
Martyn-Nemeth & Penckofer, 2012	9th-12th grade (*M*=16 yrs)	U.S.-White, Black, Latino	Cross-sectional/ Community	N
Merten, Wickrama, & Williams, 2008	Wave 1: 12-18yrs, Wave 3: 19-26yrs	U.S.- White & Black	Longitudinal/ Community	Y, Obesity-›Dep
Pine et al., 2001	6-17 yrs	U.S.-White	Longitudinal/ Clinical	Y, Dep-›Obesity
Richardson et al., 2003	11 yrs	Australia	Longitudinal/ Clinical	Y, Dep-›Obesity, girls only
Tanofsky-Kraff et al., 2004	6-13 yrs	U.S.- White & Black	Cross-sectional/ Community	Y
Vila et al., 2004	5-17 yrs	France	Cross-sectional/ Clinical	N

Y= association found; N= no association found

Table 2

Descriptive statistics of study variables (Study 1)

Variable	***M***	***SD***	**Range**
BMI Percentiles (CDC)	65.66	27.61	0-100
Depressive Symptoms (MFQ)	10.87	10.55	0-59
Age	12.80	0.71	11-15

Note: N=1106. Data from Middles School Matters Study

Table 3

Bivariate correlations of depressive symptoms with other covariates and the main outcome of BMI percentiles (Study 1) (N=1106)

	BMI Percentiles	Depressive Symptoms	Gender	Parent Education (N=109)	Family Composition (N=109)
BMI Percentiles	1	.09**	.03	-.16	-.22*
Depressive Symptoms	.09**	1	-.10**	.00	-.06
Gender	.03	-.10**	1	.15	.08
Parent Education (N=109)	-.16	.00	.15	1	.15
Family Composition (N=109)	-.22*	-.06	.08	.15	1

** $p<.01$

* $p<.05$

Table 4

Bivariate correlations among depressive symptoms, BMI percentiles, and gender, separated by race/ethnicity (Study 1)

Asian (N=235)

	Depressive Symptoms	BMI %	Gender
Depressive Symptoms	1	-0.00	-0.11
BMI %	-0.00	1	0.12
Gender	-0.11	0.12	1

Black (N=42)

	Depressive Symptoms	BMI %	Gender
Depressive Symptoms	1	0.28	-0.03
BMI %	0.28	1	-0.00
Gender	-0.03	-0.00	1

White (N=551)

	Depressive Symptoms	BMI %	Gender
Depressive Symptoms	1	.10*	-0.05
BMI %	.10*	1	0.01
Gender	-0.05	0.01	1

Latino (N=137)

	Depressive Symptoms	BMI %	Gender
Depressive Symptoms	1	-0.00	-0.04
BMI %	-0.00	1	0.10
Gender	-0.04	0.10	1

* $p<.05$

Table 5

Frequencies and percentages of race/ethnicity (Study 1)

Racial/Ethnic Group	Frequency	Percent
White	551	49.8%
Asian	235	21.2%
Black	42	3.8%
Latino	137	12.4%
Native American†	33	3.0%
American Indian†	40	3.6%
More than one race†	68	6.1%
Total	1106	100%

† Group not examined in study

Table 6

Frequencies and percentages of underweight/normal and overweight/obese BMI percentile categories, divided by race/ethnicity (Study 1)

	Underweight/Normal (BMI% <85)	Overweight/Obese (BMI% >=85)
White (N=551)	392 (71.1%)	152 (27.6%)
Asian (N=235)	159 (67.7%)	76 (32.3%)
Black (N=42)	25 (59.5%)	15 (35.7%)
Latino (N=137)	79 (57.7%)	56 (40.9%)

Table 7

Frequencies of race/ethnicity and gender among sociodemographic variables for subset sample (Study 1) (N=109)

	Family Composition	
Parent highest level of Education	**Single-parent**	**Two-parent (married or cohabitating)**
HS Diploma/Some college/AA	*Race/Ethnicity*: A= 3, B=2, W=11, L=1, N=1, I=5, M=1; *Gender:* F=18, M=6	*Race/Ethnicity*: A= 4, B=2, W=10, L=5, N=1, I=1, M=3; *Gender:* F=16, M=10
Bachelors Degree	*Race/Ethnicity*: A= 4, W=3, L=2, I=1; *Gender*: F=7, M=3	*Race/Ethnicity*: A= 3, B=2, W=19, N=1, I=2, M=1; *Gender*: F=15, M=13
Masters/Professional/Doctorate	*Race/Ethnicity*: A= 1, B=1, W=3, I=1, M=1; *Gender*: F=2, M=5	*Race/Ethnicity*: A= 4, W=5, L=2, N=1, I=2, M=2; *Gender*: F=8, M=6

Race/Ethnicity: A=Asian; B-Black; L=Latino; W=White; N=Native American; I=American Indian/Alaskan; M=More than one race

Gender: F=Female; M=Male

N=109

Table 8

Multiple Regression: depressive symptoms*race/ethnicity regression coefficients predicting BMI percentiles (Study 1)

Predictor	*B*	(SE)	β
Constant	63.94	1.04	
Depressive Symptoms (MFQ centered) (White)	0.38	.10	0.14**
Asian	0.54	2.06	.00
Black	8.48	4.53	.05
Latino	10.83	2.59	.12**
Depressive Symptoms*Asian	-.38	.20	-.06
Depressive Symptoms*Black	.21	.43	.01
Depressive Symptoms*Latino	-.39	.20	-.06

p<.05*

p<.01**

Table 9

Multiple Regression: depressive symptoms*race/ethnicity*gender regression coefficients predicting BMI Percentiles (Study 1)

Predictor	*B*	(SE)	β
Constant	63.63	1.40	
Depressive Symptoms (MFQ centered) (White)	.40	.13	.15**
Gender (White)	.64	2.12	.01
Asian	-2.44	6.23	.05
Black	8.43	3.36	.10
Latino	8.43	3.36	.10*
Depression*Asian	-.41	.26	-.07
Depression*Black	.21	.61	.01
Depression*Latino	-.07	.26	-.01
Depression*Gender	-.04	.21	-.01
Asian*Gender	6.26	4.17	.06
Black*Gender	1.16	9.10	.00
Latino*Gender	5.45	5.28	.04
Depression*Asian*Gender	.15	.42	.01
Depression*Black*Gender	.01	.86	-.00
Depression*Latino*Gender	-.80	.42	-.08†

$p<.06$†

$p<.05$*

$p<.01$**

Table 10

Multiple Regression on Latinos only: depressive symptoms*gender predicting BMI percentiles (Study 1)

Predictor	*B*	(SE)	B
Constant	72.07	2.67	
Depressive Symptoms (MFQ centered)	.32	.20	.17
Gender	6.09	4.22	.12
Depressive Symptoms*Gender	-.84	.32	-.28**

p<.05*

p<.01**

Table 11

Multiple Regression: depressive symptoms and gender coefficients predicting BMI percentiles, after adjusting for parent education and family composition in subset sample (Study 1) (N=109)

Predictor	*B*	(SE)	β
Constant	72.44	7.50	
Parent Education	-5.76	3.33	-.16
Family Composition	-11.70	5.20	-.20*
Depressive Symptoms (MFQ centered)	.57	.28	.18*
Gender	9.88	5.16	.17*

$p<.05$*
N=109

Table 12

Logistic Regression predicting odds of being overweight/obese (Study 1) (N=1106)

		95% CI for Exp B		
	B(SE)	Lower	Exp (B)	Upper
Predictor				
Constant	-.95		.38	
Depressive Symptoms (MFQ centered) (White)	0.01 (.01)	.99	1.01	1.03
Gender (White)	0.31(.16)†	.98	1.36	1.90
Asian	-.14 (.24)	0.53	.86	1.38
Black	-.00 (.51)	.36	.99	2.72
Latino	0.42 (.26)	.91	1.52	2.55
Depressive Symptoms*Asian	-0.01 (.02)	0.94	.98	1.02
Depressive Symptoms*Black	.004 (.04)	.91	1.00	1.10
Depressive Symptoms*Latino	.009 (.02)	.96	1.00	1.05
Depressive Symptoms*Gender	.009 (.01)	.97	1.00	1.04
Asian*Gender	.41 (.33)	.78	1.51	2.89
Black*Gender	.42 (.71)	.37	1.52	6.17
Latino*Gender	.10 (.40)	.50	1.10	2.44
Depressive Symptoms*Asian*Gender	.005 (.03)	.94	1.00	1.07
Depressive Symptoms*Black*Gender	-.02 (.06)	.85	.97	1.10
Depressive Symptoms*Latino*Gender	-.07 (.03)*	.87	.93	.99

$p<.06$†

$p<.05$*

Table 13

Logistic Regression predicting odds of being overweight/obese, after adjusting for parent composition and family education in subset sample (Study 1) (N=109)

		95% CI for Exp B		
	B(SE)	Lower	Exp (B)	Upper
Predictor				
Constant	-.35 (.62)		.70	
Parent Education	-.32 (.28)	.40	.72	1.26
Family Composition	-.46 (.43)	.26	.62	1.47
Depressive Symptoms (MFQ centered)	.006 (.02)	.96	1.00	1.05
Gender	.96 (.52)*	1.11	2.63	6.19

p<.05*

N=109

Table 14

Descriptive statistics of study variables (Study 2: Aim 2 & Aim 3)

Variable	*M*	*SD*	Range
BMI Percentile (T1)	22.05	5.43	0-48
Depression (T1)	5.49	4.09	0-21
BMI Percentile (T2)	19.99	5.64	0-36
Depression (T2)	3.67	3.75	0-17
BMI Percentile (T3)	20.40	5.93	0-39
Depression (T3)	4.02	3.79	0-18
Acculturation-Hazuda (T1)	8.45	2.66	6-18
Acculturation-MAAS (T1)	37.65	6.35	21-56
Enculturation-MAAS (T1)	84.54	7.37	50-96
Maternal BMI (T1)	20.54	14.78	0-64
Neighborhood Quality (T1)	16.76	4.42	6-24
Social Cohesion (T1)	7.21	2.25	3-12
Neighborhood Criminal Events (T1)	14.05	5.43	10-39
Sleep (T2)	9.95	2.11	7-20
Physical Exercise (T2)	3.60	.65	1-4
Child Age	10.39	0.6	9-12
Mother Age	36.7	5.93	26-57
Parent Education (Mother)	9.39	3.65	0-18

Note: N=674. Data from California Families Project (Study 2)
T1=5th grade; T2=6th grade; T3=7th grade

Table 15

Frequencies of BMI calculations (Study 2)

Child Reports	T1 5th grade (N=674)	T2 6th grade (N=569)	T3 7th grade (N=578)
Child estimate of Height	342	221	499
Child estimate of Weight	409	229	451
Total BMI Calculations (both height & weight reported)	N=222	N=210	N=420

Table 16

Prevalence of BMI percentile weight categories across the three time points (Study 2: Aim 2)

T1 (5th grade)	Boys	Girls	**Total**
Underweight (<5th %ile)	2%	4%	**3%**
Normal BMI (5th-85th%ile)	39%	45%	**42%**
Overweight or obese (>=85%ile)	59%	52%	**55%**
Obese (>=95%ile)	*41%*	*32%*	*36%*

N=222

T2 (6th grade)	Boys	Girls	**Total**
Underweight (<5th %ile)	1%	1%	**1%**
Normal BMI (5th-85th%ile)	51%	59%	**54%**
Overweight or obese (>=85%ile)	48%	39%	**45%**
Obese (>=95%ile)	*18%*	*17%*	*18%*

N=210

T3 (7th grade)	Boys	Girls	Total
Underweight (<5th %ile)	0%	3%	**2%**
Normal BMI (5th-85th%ile)	59%	67%	**63%**
Overweight or obese (>=85%ile)	40%	30%	**35%**
Obese (>=95%ile)	*16%*	*14%*	*15%*

N=420. Data from California Families Project (Study 2)

Table 17

Bivariate correlations of depression and weight across the three time points (Study2: Aim2)

	BMI (T1)	Depression (T1)	BMI (T2)	Depression (T2)	BMI (T3)	Depression (T3)
BMI (T1)	1	.17**	.27**	0.03	0.25**	0.12
Depression (T1)	.17**	1	-0.06	.47**	-0.04	.31**
BMI (T2)	.27*	-0.06	1	-0.12	.49**	-.16*
Depression (T2)	.03	.47**	-.12	1	.04	.42**
BMI (T3)	.25**	-.04	.49**	.04	1	-.02
Depression (T3)	.12	.31**	-.16*	.42**	-.02	1

$p<.05$*
$p<.01$**

Table 18

Bivariate correlations among the variables in the hypothesized model (Study 2: Aim 3)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Depression T1 (C)	-	0.01	0.02	-0.03	0.007	-.11**	-.04	.05	.17**	-.06	-.05	.47**	-.04
2. Acculturation-Hazuda T1 (M)	.01	-	-.18**	.05	.27**	.14**	.01	.06	-.06	.07	-.06	-.01	-.16**
3. Acculturation-MAAS T1(M)	.02	-.18**	-	.48**	-.06	.09*	.18**	-.06	.06	-.00	.01	-.01	.02
4. Enculturation-MAAS T1 (M)	-.03	.05	.48**	-	.02	.15**	.24**	-.02	.15*	-.00	-.05	-.02	.00
5. Maternal BMI T1 (M)	.00	.27**	-.06	.02	-	-.00	-.04	.08*	-.01	-.02	-.06	-.02	-.06
6. Neighborhood Quality T1 (M)	-.11**	.14**	.09*	.15**	-.00	-	.69**	-.60**	-.08	-.10	.07	-.00	-.07
7. Social Cohesion T1 (M)	-.04	.01	.18**	.24**	-.04	.69**	-	-.43**	-.03	-.08	.00	.02	-.03
8. Neighborhood Crime Events T1 (M)	.05	.06	-.06	-.02	.08*	-.60**	-.43**	-	.06	.14*	-.08	-.09*	-.00
9. Child BMI T1 (C)	.17**	-.06	.06	.15*	-.01	-.08	-.03	.06	-	-.02	.13	.03	.25**
10. Sleep T2 (C)	-.06	.07	-.00	-.00	-.02	-.10	-.08	.14*	-.02	-	-.05	-.02	.05
11. Physical Exercise T2 (C)	-.05	-.06	.01	-.05	-.06	.07	.00	-.08	.13	-.05	-	-.03	.14
12. Depression T2 (C)	.47**	-.01	-.01	-.02	-.02	-.00	.02	-.09*	.03	-.02	-.03	-	.04
13. Child BMI T3 (C)	-.04	-.16**	.02	.00	-.06	-.07	-.03	-.00	.25**	.05	.14	.04	-

Note. MAAS= Mexican American/ Acculturation Scale; T1=5th grade; T2= 6th; T3=7th grade; (M) =Mother report; (C) =Child report.
* p <.05, ** p <.01