Examining Physical Activity Levels of Pregnant Women of Mexican Origin in Detroit, MI: A Socioecological Approach

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Health Behavior and Health Education)
in the University of Michigan
2019

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Acknowledgements

Concluding my doctoral studies and research would not have been possible without the support, mentorship, friendship, and love of many persons. I would like to acknowledge my dissertation committee for their guidance in this research. To Dr. Amy Schulz and Edie Kieffer, words cannot express my endless gratitude for not only being the most supportive advisors and mentors a graduate student of color could have, but also for your unconditional support, patience, and friendship. With your example, you both expanded greatly my vision and action to promote health equity in community partnerships. Edie, I am grateful for your efforts to advance health outcomes among pregnant minority women. Data from the Healthy MOMs Study that you planned, developed, and implemented constitute the backbone of this dissertation research. Finally, to Dr. Graciela Mentz, Dr. Julia Seng, and Dr. Ritesh Mistry, thank you for providing me with valuable research skills during my doctoral studies and feedback on this dissertation.

I would also like to acknowledge Dr. Carolyn Sampselle for not only encouraging me to apply to the Health Behavior and Health Education Doctoral Program, but also providing the financial means to make it happened. Carolyn, you opened a door that for many people of color remains closed. I want you to know that despite how difficult and long this journey has been, remembering that you trusted that I was capable of doing it kept me going.

I would like to thank the faculty and staff of the Department of Health Behavior and Health Education. To Dr. Barbara Israel, thank you for your research and instruction in Community-Based Participatory Research, which has become the anchor of my research. To Dr. Cleo Caldwell, I am grateful for your research on racial disparities in health. To Dr. Paul Fleming, Dr. Gary Harper, and Dr. Mary Janevic for your instruction, support, and friendship. You all helped me shape my teaching and grant writing skills. Working with you as a graduate student instructor enabled my involvement with college- and master-level students, which has provided me with practical teaching and mentoring experience in community, culture and social justice, and health promotion programs. To the members of my doctoral cohort: Andi Eisman, Bill Lopez, Rebecca Mandell and Jorge Soler. I am grateful for our interactions throughout the

years and look forward to a continuing this relationship. To Candy Ellis, Jackie Cormany, and Jenny Crawford for their support along the way.

I would also like to thank the faculty of the English Language Institute and Sweetland Center for Writing, which provided writing consultation on various stages of this dissertation. To Drs. Louis Ciccarelli and Chris Feak, thank you for your valuable feedback on my writing.

I want to acknowledge my funding sources. I am thankful for the awards I received from the Rackham School of Graduate Studies including the Rackham Merit Fellowship, Rackham Summer Writing and Public Scholarship Awards. I also want to acknowledge the funding I received through the Sweetland Center for Writing Dissertation Institute, and the Center for the Education of Women. These funding sources provided not only financial support but also facilitated my connections with colleagues throughout the University of Michigan.

I would also like to thank my family and friends that have supported and encouraged me throughout this program. To my mother, Roberta, the love and support you have given to me and my sisters have made achieving our dreams so much easier. To my son, William Sebastian, thank you for being my greatest source of courage and happiness. To my husband, James, thanks for your love and support throughout all these years together. To my parents in law, William and Kathleen Militzer for adopting and loving me as a daughter since I immigrated to the United States. To my best friends Amel Omari, Angelica Snyder, Carolina Ibarra, Joanne Baily, Megan Eagle, Mike Lupo, Nayelly Mena, and Dn. Gabriel and Lupita Recendiz, thanks for your support and love.

Finally, to all immigrant women of color everywhere. Thank you for providing me with the best example of how to live and fight for what you believe in.

In Memory of:

Dr. Noreen Clark
Sra. Ausencia Sibaja
Sra. Guadalupe Solis
Sr. Mario Pichardo Solis
Mariam Carson, MPH
Sonny & Cici

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List of Abbreviations

BMI	Body Mass Index
CBPR	Community-based Participatory Research
CDC	Center for Disease Control and Prevention
CHASS	Community Health and Social Services Center
GDM	Gestational diabetes mellitus
GWG	Gestational weight gain
HLI	Healthy lifestyle intervention
HPE	Healthy Pregnancy Education
ICC	Intraclass correlation coefficient
MET	Metabolic Equivalent of Task
MI	Michigan
MICE	Multiple imputation by chained equations
NEW	Neighborhood Environment Walkability
NHB	Non-Hispanic Black
NHW	Non-Hispanic White
NS	Neighborhood safety
NSC	Neighborhood social cohesion
PA	Physical activity
RCT	Randomized controlled trial
REACH	Racial and Ethnic Approaches to Community Health
SEM	Socioecological Model
SES	Socioeconomic status
T2DM	Type 2 diabetes mellitus
US	The United States
VIF	Variance Inflation Factor
WIC	Women, Infants and Children Program
WMO	Women of Mexican origin

Abstract

Low levels of physical activity (PA) during pregnancy are associated with detrimental health outcomes, not only for the mother but also for her child. Pregnant WMO are less likely to meet recommended PA (20-30 minutes/day), most days/week. They have higher overweight (76.9%) and obesity (45%) rates compared to the US population, and face increased risk for excessive GWG, GDM and T2DM. Nonetheless, most research available on PA during pregnancy has focused on NHW women. Employing a socioecological approach, this dissertation built on literature describing pathways between PA-related beliefs, attitudes, subjective norms and perceived behavioral control (individual level), social support (interpersonal level), and neighborhood poverty, social cohesion, safety, walkability, presence/condition of parks/playgrounds, and car/truck traffic (neighborhood level) and PA among pregnant and non-pregnant NHW, and racial and ethnically minority women, and the literature on interventions aimed at increasing PA. However, these pathways and interventions have not been examined among pregnant and postpartum WMO. The purpose of this dissertation is to examine pathways that individual, interpersonal and neighborhood factors may influence PA and assess the efficacy of a behavioral intervention to reduce PA declines among pregnant and early postpartum WMO. The Theories of Planned Behavior and Social Support grounded this research. Using a dataset from an RCT of a behavioral intervention, first I examined independent and joint relationships of individual-level factors and PA intention/behavior; and social support moderating effects. Findings suggest significant associations between attitude and PBC with PA intention but not PA behavior. PA-social support did not moderate relationships of PBC-PA intention nor PBC-PA behavior. Independent associations between social support and PA behavior were significant. Joint relationships between TPB constructs and social support, and PA accounted for 6.8% of the variance in regression models. Second, I examined relationships of neighborhood characteristics and PA. I found positive significant independent and joint associations between neighborhood social cohesion, walkability, and presence/condition of parks/playgrounds, and PA. Neighborhood

poverty, safety and heavy car/truck traffic were not significantly associated with PA. Neighborhood safety perceptions moderated the neighborhood poverty-PA association. Associations of PA-Neighborhood characteristics accounted for 22% of the PA variance . Third, I examined the efficacy of a lifestyle intervention to reduce PA declines among pregnant and postpartum WMO. Findings suggested a significant PA decline from T_0(baseline) to T_1(follow up), and an increase from T_1 to T_2(postpartum), but still lower PA at T_2 compared to T_0. The PA-HLI group had significantly lower PA declines than the comparison group during pregnancy and early postpartum. Findings may inform public health interventions focusing on PA during pregnancy and postpartum, especially for WMO. This research provides quantitative evidence of associations between individual, interpersonal factors and neighborhood characteristics to be considered when designing interventions to address PA among pregnant and postpartum WMO. It provides evidence-based information to prenatal care providers, city planners, community leaders about the influence that these factors, and especially the neighborhood, may have on PA directly, and health outcomes indirectly. This study is a unique contribution to the literature on PA activity among WMO in the US. Further research on factors that may promote PA during pregnancy and the early postpartum, and testing additional intervention strategies for this population is needed. This research may contribute to ameliorating the increasing rates of low PA-associated metabolic diseases and improving the health of pregnant and postpartum WMO and their children.

Chapter 1

Introduction

Examining Physical Activity Levels of Pregnant Women of Mexican Origin in Detroit, MI: A Socioecological Approach

Low levels of physical activity (PA) and excessive weight gain during pregnancy continue to be a public health concern (ACOG, 2015). In the United States, nearly 55% of pregnant women with uncomplicated pregnancies do not meet the recommended ≥20-30 minutes/day of physical activity (leisure type or active transport) on most days/week during pregnancy (ACOG, 2015; Hesketh & Evenson, 2016). Low levels of PA and excessive weight gain during pregnancy are associated with detrimental outcomes not only for the mother but also for her child (ACOG, 2015; Pastorino et al., 2018). For the mother, it is linked to increased rates of preeclampsia (Dempsey et al., 2005), anxiety and depression (Rebar et al., 2015), cesarean delivery (Domenjoz et al., 2014), and an increased risk of inappropriate glycemic control, gestational diabetes mellitus (GDM) (Katon et al., 2012), and type 2 diabetes (T2D) within 5-7 years after delivery (Bao et al., 2014; Kim et al., 2002; Tieu et al., 2011). For the fetus, in-utero exposure to high levels of glucose has not only negative effects on the newborn during the perinatal period, but it also increases their risk of future obesity and T2D during childhood and adulthood (Crume et al., 2011; Walker et al., 2009).

Women of Mexican Origin (WMO; Mexican-born and Mexican American women) have the highest birth rate of any other ethnically minority group in the U.S. (Saelens et al., 2003). Yet, 67.5% of WMO of all ages fail to meet physical activity guidelines (Piercy & Troiano, 2018), and over 40% are classified as inactive (Pastorino et al., 2018). Further, WMO of childbearing age experience higher prevalence rates of obesity (45%) and overweight (76.9%)

when compared to the US population as a whole (Keller et al., 2014). Not surprisingly, higher rates of preeclampsia and GDM have been reported for pregnant WMO, compared to any other racial/ethnic groups in the US (Kim et al., 2013).

Studies of factors influencing PA during pregnancy and postpartum have provided guidance for the development of interventions aimed to promote PA during pregnancy among Latinas, predominantly WMO, in the US (Black et al., 2007; Fortner et al., 2011; Hausenblas et al., 2008; Kieffer et al., 2002; Thornton et al., 2006). Most of these studies have primarily focused on individual factors (e.g., sociocultural beliefs, acculturation) and interpersonal factors (e.g., social support) influencing PA patterns. Even though these studies have provided insight into what proximal factors should be addressed to obtain successful PA outcomes during the childbearing years among Latino or other racial and ethnic minority communities, researchers have called for strategies that account for the influence of environmental factors both at the neighborhood and organizational levels (Currie et al., 2013; Laraia et al., 2007; Schulz et al., 2013; Schulz et al., 2011; Thompson et al., 2017). These strategies have included efforts to identify what neighborhood characteristics--where PA takes place— are influencing PA behaviors (Schulz et al., 2013).

This dissertation research examines factors contributing to low PA levels during pregnancy and early postpartum among pregnant women of Mexican origin in Detroit, MI. Examining the processes associated with low PA levels may expand our understanding of one of the main factors contributing to increased risk of metabolic conditions during pregnancy and chronic disease later in life. It may help public health professionals target interventions more effectively toward factors that promote or deter PA during the childbearing year among WMO.

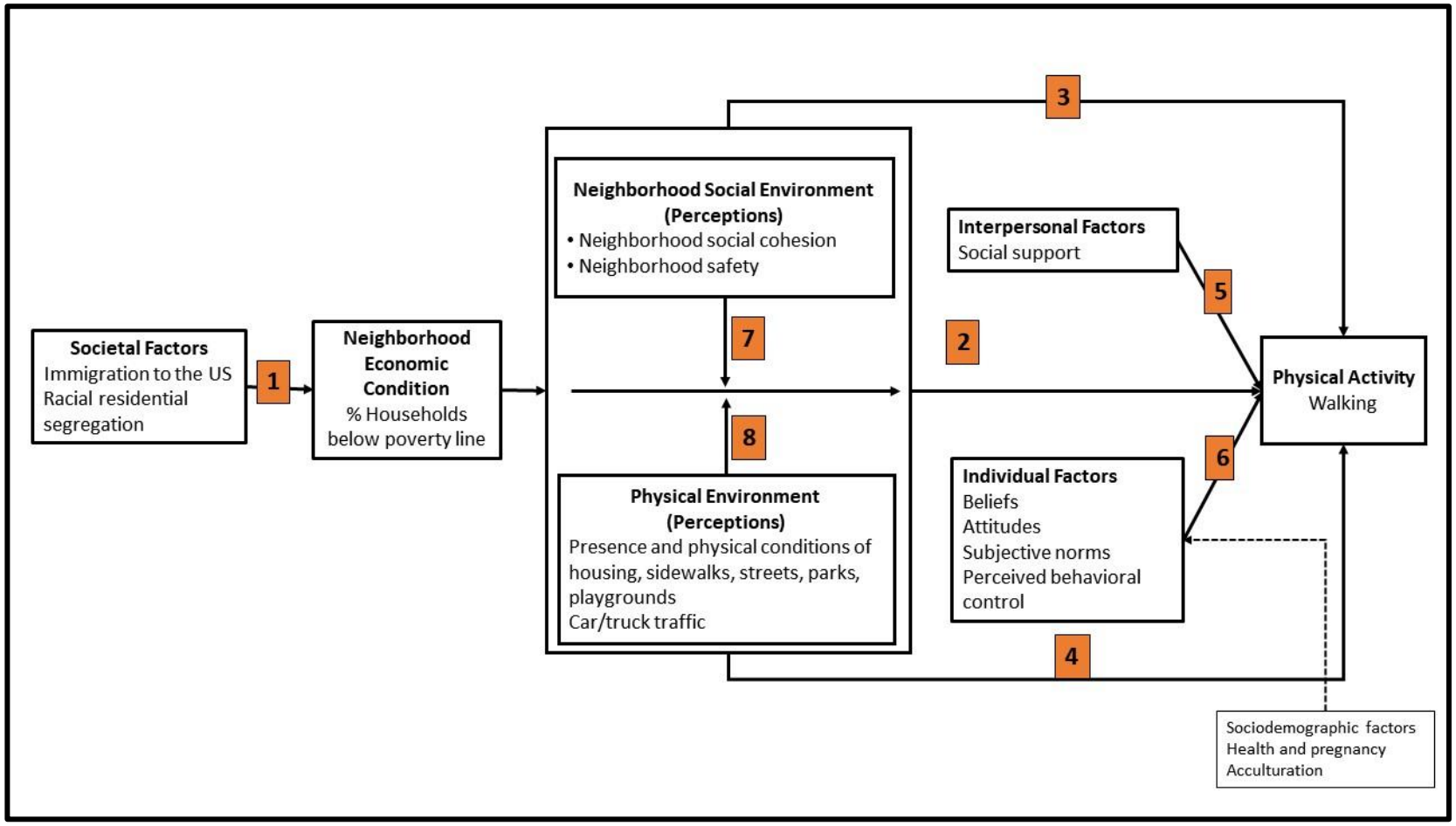
I. Conceptual Model

Guided by the Socioecological Model of Human Development (Bronfenbrenner & Morris, 2006), my conceptual model outlined below describes the theoretical pathways of societal factors and neighborhood characteristics, and their potential influence on physical activity among pregnant WMO. This conceptual model is presented as a way of theorizing relationships between economic hardship leading to immigration to the US, place of settlement

in the US, residential segregation, access to material and political resources, social discrimination, acculturation and pathways to PA behavior. Further, it depicts associations between these societal factors and neighborhood (e.g., neighborhood economic condition, and neighborhood physical and social environments), interpersonal relationships (e.g., social support), and individual factors (e.g., social norms, social support, beliefs, attitudes, and perceived behavioral control) and physical activity (e.g., walking).

Specifically, the conceptual model in Figure 1.1 posits that societal factors (e.g., implications of US immigration, acculturation, and racial residential segregation) contribute to shaping neighborhood socioeconomic conditions (e.g., neighborhood poverty) (Arrow 1). Moreover, this conceptual model suggests that pathways associated with neighborhood economic conditions are specified, influencing physical activity levels, above and beyond the effects of individual and interpersonal factors that directly influence physical activity (e.g., outdoor walking) (Arrow 2). Perceptions of the neighborhood social environment (e.g., social cohesion, safety) and physical environment (e.g., presence and condition of sidewalks, streets, parks and playgrounds) are pathways that influence physical activity (Arrows 3 and 4) above and beyond the effects of individual factors such as sociocultural beliefs and attitudes, social norms, and perceived behavioral control about physical activity during pregnancy and postpartum (Arrow 5); as well as interpersonal factors such as family social support (arrow 6). Further, this conceptual model posits that perceptions of the neighborhood social and physical environments moderate pathways between neighborhood socioeconomic conditions and physical activity (arrows 7 and 8). The dashed arrow represents a pathway to individual socioeconomic factors, which are also influenced by societal factors and associated to low levels of physical activity.

Figure 1.1 Conceptual Model of Physical Activity Levels of Pregnant Women of Mexican Origin in the US.



II. **Literature Review**

To better understand the context in which this dissertation conceptual model was developed, this section provides a short description of salient societal, neighborhood-level, interpersonal and individual factors that may be influencing PA among pregnant women of Mexican origin in the United States.

2.1 Societal factors

The following structural factors have been associated with neighborhood socioeconomic conditions where low income women of Mexican origin are likely to live after settling in the US. The following sections provide an overview of Mexican immigration to the US, acculturation, and racial residential segregation.

2.1.1 Mexican Immigration to the United States

After WWII, Mexico became the main supplier of migrant labor to the US (De Genova, 2004; Torres & Wallace, 2013). In the last 40 years, Mexican migration to the US escalated dramatically (US Census Bureau, 2010). According to the Pew Hispanic Center, from 1999 to 2005, more than 500,000 Mexican-born immigrants came to the US annually (Passel et al., 2012). After 2005, a decline in Mexican migration to the US was observed (Passel et al., 2012). This decline is attributed partly to the anti-immigrant sentiment and legislation passed in recent years (Archibold, 2010). Still, during the 2005-2010 period, a total of 1.4 million Mexicans migrated to the US (US Census Bureau, 2010). In more recent years, the PEW Hispanic Center estimates that approximately 12 million Mexican-born immigrants are living in the US, accounting for more than 30% of all current US immigrants (Brown & Patten, 2013; Massey et al., 2016) and of those, 44% are Mexican-born women at their childbearing years (Gonzalez-Barrera & Lopez, 2013). This immigration phenomenon has been shaped across time partly because of dire social and economic inequalities in Mexico, combined with a constant demand for low-waged labor in the US (De Genova, 2004; Torres & Wallace, 2013).

Trends in socioeconomic and health patterns among Mexican immigrants to the US have been described in the literature (Breslau et al., 2011; Gratton & Merchant, 2016; Massey et al., 2016). Research suggests that most prime-aged immigrants migrate to the US in search of better labor market opportunities and, because they have the motivation and resources to undertake a move, they are 'positively selected' –that is, they are more educated and in better psychological and physical health than non-immigrants (Breslau et al., 2011; Rubalcava et al., 2008). Yet, gender differences on the migration process and settlement in the US have been identified among Mexican immigrants (Lopez & Rohal, 2015; Yakushko & Chronister, 2005). Women of Mexican origin living in the US report more negative physical and mental health outcomes than their male counterparts (Fortner et al., 2011). According to Massey et al. (2016) WMO tend to report more depressive symptoms than Mexican American or Mexican-born men and US-born White women (Massey et al., 2016). In addition, WMO are more likely than Mexican-born men and non-Hispanic White women to be categorized as either overweight or obese and to report low levels of recreational PA (Austin et al., 2013).

2.1.2 Racial residential segregation

In the US, the process of racial residential segregation has led to a redistribution of economic resources and disinvestment in segregated areas (Kwarteng et al., 2011; Williams & Sternthal, 2010). Historically, racial discrimination targeting particularly ethnic minority communities led to the creation of policies that restricted access to educational, employment, and residential opportunities for residents of predominantly African American and Hispanic communities, while access to such resources was not restricted for nonminority residents of segregated White communities (Kaestner et al., 2009; Lee et al., 2012). These differences in access led to current differential access to material resources. For example, the federal government worked with the real estate and banking industry to establish and enforce housing policies like redlining to physically separate people of color from Whites resulting in race-based residential segregation (Darden et al., 2010; Landrine & Corral, 2009; Massey & Denton, 1989; Shapiro & Oliver, 1995; Williams & Williams-Morris, 2000).

The effects of racial or ethnic discrimination on differential access to economic, educational, or social resources have been documented among Hispanic populations (Keller et

al., 2009; Lopez & Rohal, 2015; Schulz et al., 2008). Among Hispanics in the US, people of Mexican origin and Puerto Ricans are more likely to face socioeconomic barriers to residing in more desirable neighborhoods than are other Hispanic groups (Keller et al., 2014). According to Larsen (2013), WMO are more likely to live in low-income urban neighborhoods with higher crime, fewer resources and worse environmental conditions than non-Hispanic White women (Lopez & Rohal, 2015). Thus, Mexican immigrants may face limited settling spaces based on their race or ethnicity, and SES within the US (Farley et al., 1994). It is not surprising that WMO are most likely to live in economically disadvantaged neighborhoods after settlement.

2.2 Neighborhood-level factors

Over 25% of WMO in the US live in poverty, compared with 12.3% of non-Hispanic Whites (Lopez & Rohal, 2015). Moreover, WMO have the highest poverty rates, the highest uninsured rates, the lowest educational attainment rates, and lowest political representation of any other Hispanic subgroup in the US (APA, 2012; Link & McKinlay, 2009). Further, WMO are more likely to live in economically disadvantaged neighborhoods than other Hispanic subpopulations (Ortiz-Hernandez & Ramos-Ibanez, 2010).

2.2.1 Neighborhood poverty

Economically disadvantaged neighborhoods are likely to influence PA patterns among low-income minority communities, above and beyond household socioeconomic status (Schulz et al., 2008). Associations between neighborhood sociodemographic composition (e.g., high neighborhood poverty levels) and health outcomes have been described in the literature (Boylan & Robert, 2017; Kwarteng et al., 2013; Schulz et al., 2008; Meyer et al., 2013). Moreover, evidence suggests that neighborhood socioeconomic status may directly influence PA levels and may partially influence these levels by means of the presence and physical condition of neighborhood infrastructure conducive to PA (Zhang et al., 2008). For example, in economically deprived neighborhoods, poorly maintained sidewalks and streets, physical deterioration of housing, lack of recreational areas (e.g. parks, playgrounds), are more likely to exist than in neighborhoods with higher socioeconomic status (Giurgescu et al., 2012; Schulz et al., 2013).

Moreover, Schulz and colleagues (2013) reported that physical deterioration of sidewalks was particularly correlated with low levels of PA among neighborhood residents, followed in importance by physical condition of streets, parks and playgrounds (Schulz et al., 2013). Moreover, in neighborhoods where recreational facilities exist, low income residents are more likely to lack the financial means to afford entrance fees to indoor recreational facilities, compared to non-Hispanic whites (Perez et al., 2016).

2.2.2 Neighborhood Social and Physical Environments

Physical activity takes place in specified environments, and a person's perceptions of those environments are likely to influence the type and extent of motivation and involvement in the activity. In other words, the place where people exercise is an important part of the person's response to PA participation (Larsen et al., 2015). Walking is one type of physical activity that takes place in the neighborhood, and often the only type of physical activity (both transport and/or leisure) among minority communities in poor neighborhoods. Thus, characteristics of the neighborhood social and physical environments are likely to influence physical activity patterns among residents of poor neighborhoods.

Even though there is significant research addressing neighborhood-level factors associated with PA in Latino communities and other communities of color, research on the influence of neighborhood-level factors on PA and pregnant WMO is scarce. For example, in a qualitative study of perspectives of low income pregnant and postpartum Latina women on physical activity and health, Kieffer and colleagues (2002) identified concerns about the poor physical conditions of sidewalks and car/truck traffic among pregnant WMO as a barrier to physical activity (Kieffer et al., 2002). In another study, Thornton et al., (2006) reported neighborhood safety as a barrier to engage in physical activity during pregnancy among WMO living in poor neighborhoods.

Characteristics of the social environment at the neighborhood level where pregnant women of Mexican origin may live, comprise power/race relations including social discrimination and fear of deportation (Larsen et al., 2013a), social, human and health services (Parra-Medina & Messias, 2011), cultural and religious practices (McNeill et al., 2006b), and beliefs or perceptions about place and community (Kwarteng et al., 2013; Schulz et al., 2013).

Neighborhood social cohesion is a characteristic of the neighborhood social environment described as the presence of trusting relationships among individuals who do not share familial ties (Fone et al., 2007). Strong trusting relationships among neighborhood residents has been associated with health benefits (Alegria, Sribney, & Mulvaney-Day, 2007). Further, social cohesion can emphasize the need for a shared sense of belonging to place or place attachment, a psychosocial factor that may play an important role among immigrants who have recently arrived to the US as traditional health behaviors may be maintained or challenged in their new places of settlement (Mielke & Gorman, 2015).

Despite of the positive effect that strong neighborhood social ties may have on physical activity, Mexican communities and other Spanish-speaking neighborhoods are also more likely to experience astringent social environments when detention and deportation raids are conducted by immigration authorities, which tremendously contribute to exacerbate a social climate of fear and anxiety that may inhibit outdoor PA (Larsen et al., 2013a).

Neighborhood safety is another characteristic of the social environment associated with low levels of PA among pregnant WMO (Kieffer et al., 2002; Thornton et al., 2006). In a systematic review of factors deterring PA among Latinas, Larsen (2014) reported that Hispanic women frequently mentioned being afraid to leave their homes because of safety issues (e.g., being robed or attacked), along with fearing of falling because of poorly maintained sidewalks (Larsen et al., 2013b).

Among the most cited features of the neighborhood physical environment associated with PA are the presence and physical conditions of sidewalks and access to recreational facilities as they may play an important role on facilitating or deterring PA among Hispanic communities, and among pregnant and postpartum WMO (Kieffer 2002, Thornton 2006). In addition, concerns about heavy car/truck traffic conditions for PA are disproportionately present among Hispanics and other ethnic minorities living in low income neighborhoods (Kwarteng et al., 2013; Larsen et al., 2015) as they suffer a higher rate of pedestrian rates and traffic accidents than non-Latino whites (Larsen, 2014).

Yet, despite the widely assessed and supported benefits of adequate levels of PA during pregnancy, little is known about the role that neighborhood poverty and the social and built environments may play in shaping PA patterns among pregnant WMO living in economically

disadvantaged places. Further research is needed to examine the influence that neighborhood characteristics may have on PA among this at-risk population.

2.3 Individual and interpersonal factors

During the last two decades, a modest number of studies conducted in the US has reported on several individual and interpersonal factors associated with low levels of PA among pregnant Latina women (Catalano, 2015; Chasan-Taber, 2012; Chasan-Taber et al., 2009). Similarly, a small number of qualitative studies have examined influences on PA among pregnant WMO (Kieffer et al., 2002; Lee et al., 2011; Thornton et al., 2006). For pregnant WMO in particular, cultural and normative beliefs regarding PA, as well as spousal support to exercise during pregnancy, have been reported as proximal factors associated with a risk of not achieving recommended PA levels guidelines during pregnancy (Chasan-Taber et al., 2007; Keller et al., 2014; Thornton et al., 2006). Specifically, acculturation, sociocultural beliefs, attitudes, social norms and lack of social support regarding PA have been suggested as contributing explanations for why low income WMO were less likely to exercise during pregnancy (Kieffer et al., 2002; Thornton et al., 2006). For example, a woman's negative attitudes (e.g., 'exercise may harm my baby'), and beliefs (e.g., 'exercise that involves lifting or carrying heavy things would hurt my baby,' or 'taking care of the house is all the exercise that I need') may lead to a decrease in the amount and type of PA a person is willing to do during pregnancy (Evenson et al., 2012; Gollenberg et al., 2008; Kieffer et al., 2002). Moreover, women may encounter unique barriers to PA because of their social roles as primary family caregivers, their household responsibilities, and consequent perception of lack of time to engage in physical activity (Buchanan et al., 1998; Kieffer et al., 2002; Thornton et al., 2006).

2.3.1 Acculturation

The impact of the immigration experience on health outcomes for Mexican immigrants in the US has received increasing attention in the literature (Arcia et al., 2007; Burchard et al., 2005; Cabassa, 2003; Detjen et al., 2007; Farley et al., 2005). Throughout this solid body of

research, acculturation has been associated with health outcomes among Mexican Immigrants (Murillo et al., 2014; Tovar et al., 2012).

Acculturation has been described as "A multidimensional process that involves changes in many aspects of immigrants' lives, including language competence and use, cultural identity, attitudes and values, food and music preferences, media use, ethnic pride, ethnic social relations, cultural familiarity, and social customs across time" (APA, 2012).

Despite the acculturation's multidimensional nature, some scholars have suggested that Mexican immigrants in the US may resist changing or adapting to their new environments, continuing to make health behavioral choices based on their culturally-based knowledge, attitudes, and beliefs (Austin et al., 2013; Hunt et al., 2004). A great deal of research has addressed the impact of acculturation on health behaviors and health outcomes on whether Mexican immigrants would adapt to the US mainstream culture or remain adherent to their traditional cultural-based lifestyles upon arriving and settling in the US (Aguila et al., 2013; Arcia et al., 2001; Austin et al., 2013).

Other researchers focusing on the implications of acculturation processes on changes in health status among Mexican immigrants have suggested that prolonged periods of time in the US may be associated with negative health behaviors and health outcomes for this population (Arcia et al., 2001; Barcenas et al., 2007; Genoni et al., 2011; Murillo et al., 2014). Low levels of PA, unhealthy eating, obesity, type 2 diabetes (T2D), hypertension, psychological distress, anxiety, depression, substance use/abuse, and other non-communicable health conditions among Mexican immigrants have been positively correlated with prolonged periods of time in the US (Finch & Vega, 2003; Kaestner et al., 2009; Schwartz et al., 2010). Indeed, prolonged periods of time in the US may be correlated with prolonged exposure to structural, socioeconomic, and environmental risk factors Mexican immigrants of low socioeconomic status –women in particular - may encounter upon arriving, settling, and adapting to the US (APA, 2012).

2.3.2 Sociocultural beliefs, attitudes and social norms

Mexican immigrants in the US have been described as more likely to adhere to traditional gender-role scripts regarding the expectations of the male and female roles in the household and in the working world (Alcántara, 2010; Aranda et al., 2001; Arcia et al., 2001; Cabassa, 2003).

Within this context, WMO's gendered role centers on meeting family needs, taking an active role coordinating the activities in the home, and keeping peace in their environments (Austin et al., 2013). Moreover, familism has been identified as a salient sociocultural factor preventing Mexican women from attaining recommended levels of PA (Larsen et al., 2015). These cultural constructs have been widely described in the literature and frequently used as gendered 'proxies' to describe Mexican immigrants of low socioeconomic status predominantly living in economically-disadvantaged communities in the US (Aranda et al., 2001).

2.3.3 Social support

A solid body of research has examined mechanisms of social support related to health behaviors and health outcomes for Hispanic residents in the US (Kieffer et al., 2013; Kieffer et al., 2014; Rhodes & Dickau, 2013; Shah et al., 2015; Thornton et al., 2006). Pregnant and postpartum WMO tend to view social support as essential to the maintenance of PA (Kieffer et al., 2002; Larsen et al., 2013a; Lynch et al., 2012; Rhodes & Dickau, 2013), to a greater extent than women of other ethnic groups (Keller et al., 2014). Moreover, social support has been cited as a moderator influencing associations between non-health related barriers (e.g., lack of time and/or motivation, or lack of information about safe exercise during pregnancy), and physical activity (Alegria, 2007), as well as other healthy behaviors for low-income, immigrant Latinas (Conn & Sells, 2016; Perez et al., 2016; Shah et al., 2015).

For example, Thornton and colleagues reported that pregnant WMO perceiving high levels of positive emotional support from their husbands were more likely to be physically active and that women who believed their husbands criticized and humiliated them because of their body weight, were less likely to report PA (Thornton et al., 2006). Moreover, female relatives were particularly influential in the development and maintenance of PA levels (Esakoff et al., 2011) as they may provide childcare and help for house chores to free time for exercise or even be available to provide companionship to engage in the behavior together (Thornton et al., 2006). For immigrant WMO, leaving their mothers and other female relatives in their countries of origin may be a prominent barrier that limits their access to childcare and companionship for exercise, and hence, deters their ability to maintain an adequate level of PA during and after pregnancy (Kieffer et al., 2002; Thornton et al., 2006; Tovar et al., 2009).

In sum, despite the above contributions to our understanding of what and how sociocultural beliefs, attitudes, subjective norms (e.g., the opinions of others), and social support may influence WMO's motivation exercise (Alegria et al., 2009; Kieffer et al., 2002; Thornton et al., 2006), limited research to date has been conducted specifically among pregnant women of Mexican origin, with gaps including an understanding of how sociocultural factors such as social support may contribute to low levels of PA among pregnant WMO.

Further research aimed at extending our understanding of societal, neighborhood, interpersonal and individual factors influencing PA patterns among pregnant WMO living in low income neighborhoods is of paramount importance if we are serious about decreasing health inequities in maternal and infant health among minority communities. Questions remain about how perceptions of the neighborhood social and physical environments may contribute to low levels of PA during pregnancy among WMO living in economically disadvantaged neighborhoods. Moreover, the additive effect of neighborhood economic condition and perceptions of the social and built environments may only be explained with any degree of validity by specifying more complex models that reflect the larger social structure and the dynamic social processes in which beliefs and behaviors are generated.

This dissertation examines the associations between neighborhood poverty and other indicators of the social and physical environments at the neighborhood level; the influence of social support (and sources of) at the interpersonal level; as well as sociocultural beliefs, attitudes, social norms, and motivation to exercise during pregnancy at the individual level among WMO. Moreover, this dissertation also assesses the efficacy of a community-based randomized trial designed to reduce risk factors for type 2 diabetes through a lifestyle intervention that had among its objectives to reduce decline of physical activity among women of Mexican origin during pregnancy and early postpartum by targeting interpersonal and individual-level factors mentioned above.

This research extends studies that have focused solely on individual and interpersonal level factors by examining the broader contexts within this behavior occurs. A better understanding of environmental characteristics and their influence on physical activity, above and beyond proximal factors, can help public health professionals target interventions more

effectively and advocate for policy change to improve environments where populations are expected to exercise.

III. The Healthy MOMs Study

3.1 Background

This dissertation study was derived from data collected as part of Healthy Mothers on the Move Study (Healthy MOMs), a prospective two-arm randomized control trial designed to reduce risk factors for type 2 diabetes by promoting healthy behaviors among pregnant and postpartum Latinas, predominantly of Mexican origin (Kieffer et al., 2013; Kieffer et al., 2014). Healthy MOMs had two main goals, (1) reduce intake of added sugars, percentage of total calories from added sugars, total fat, saturated fat, total calories from saturated fat, and total calories from solid fats and added sugars (i.e., saturated fat, trans-fat, and added sugars); as well as increase consumption of fiber, fruits, and vegetables; and (2) preventing declines in PA (e.g., walking) among women of Mexican origin during pregnancy and early postpartum (Kieffer et al., 2013; Kieffer et al., 2014).

The Healthy MOMs study was conducted between 2004 and 2006 in Southwest Detroit, MI, a mixed ethnic community, with predominantly low-income women of Mexican/Mexican American origin. Healthy MOMs was planned, developed and implemented using a community-based participatory research approach in affiliation with the Detroit Community Academic Urban Research Center and the REACH (Racial and Ethnic Approaches to Community Health) Detroit Partnership (Kieffer et al., 2013). The Healthy MOMs Steering Committee included WMO of childbearing age, and pregnant and postpartum WMO living in communities where the study was implemented, as well as representatives of academic and health-related organizations in the area (Kieffer et al., 2013; Kieffer et al., 2014; Kieffer et al., 2002). Specifically, members of the Steering Committee contributed their expertise to the Healthy MOMs study design, staffing plans, recruitment, retention, intervention, and evaluation methods and materials (Kieffer et al., 2013; Kieffer et al., 2013; Kieffer et al., 2014).

Community Health Workers (CHWs) conducted recruitment activities that targeted all pregnant Latina women in the area. Recruitment took place primarily at a local community

health center and Supplemental Nutrition Program for Women, Infants, and Children (WIC) clinics. Bilingual recruitment materials (English/Spanish) were distributed through Latino media, public locations and at several community partner organizations. Eligibility criteria included: (a) 18 years or older, (b) southwest Detroit residents, and (c) less than 20 weeks gestation at eligibility screening (Kieffer et al., 2013; Kieffer et al., 2014). 278 pregnant Latinas were recruited and consented. From this sample of Healthy MOMs enrolled participants, data from 251 participants who self-identified as Mexican immigrant and Mexican American (WMO) was selected for analysis in the three analytical chapters of this dissertation research. Table 1.1 describes this subsample of WMO participants.

Table 1.1. Demographic Characteristics of Pregnant Women of Mexican Origin (n=251). Healthy MOMs Study, 2004 – 2006

Characteristics	Mean	SD	Min	Max	Percent (n)
Age, years	27.24	5.25	18	41	-
Education, years	9.32	2.95	0	16	-
Less than high school	-	-	-	-	72.2 (186)
High school or higher	-	-	-	-	27.5 (69)
Country last educated, (1=Mex), % (n)	-	-	0	1	87.6 (220)
Number of people in the household	-	-	1	3	
1-2					10.8 (27)
3-4					61 (153)
5 or more					25.5 (64)
Country of origin (1=Mex), % (n)	-	-	0	1	97.2 (244)
Age at arrival in the United States, years	21.27	5.60	2	40	-
Years lived in the US, years	6.57	5.65	0	36	-
Occupation, homemaker (1=yes), % (n)	-	-	0	1	88.0 (221)
Household annual income (n=174)	-	-	-	-	-
< $10,000	-	-	-	-	35.1 (61)
$10,001 - $20,000	-	-	-	-	41.4 (72)
$20,001 - $30,000	-	-	-	-	17.8 (31)
>$ 30,000	-	-	-	-	5.7 (10)
Married, living with partner (1=yes), % (n)	-	-	0	1	59.8 (150)
Self-rated Health	2.92	.91	1	5	-
Poor/Fair, % (n)	-	-	-	-	19.9 (50)
Good, no. % (n)	-	-	-	-	53.4 (134)
Very Good/Excellent, % (n)	-	-	-	-	24.7 (62)
Gestational age, weeks	17.30	4.26	9	26	-
Body Mass Index (kg/m^2)	28.73	4.98	18	42	-
Parity, number	1.37	.84	0	6	-
Nullipara	-	-	-	-	25.1 (63)
Multipara	-	-	-	-	74.9 (188)
WIC participation (1=yes), % (n)	-	-	0	1	75.7 (190)

SD: Standard deviation;

3.2 Healthy MOMs Lifestyle Intervention (MOMs HLI)

The MOMs HLI considered the importance of family and other social and physical environmental influences on physical activity and diet, along with the expected pregnancy-related changes in diet and PA (Kieffer et al., 2013; Kieffer et al., 2014). Its methods were structured to help women with goal setting, problem solving and decision making, enabling them to become active participants in their own care. Along with information about pregnancy, exercise and healthy eating, participants developed a greater understanding of the benefits of and barriers to these healthy behaviors. They were also developed skills on how to make healthy behavioral changes, and solve problems that may result from these changes; how to set goals; how to assess their emotional reaction to pregnancy and manage its impact on their health-related behaviors; how to optimize their role as a decision-maker and participant in their self-care; how to acquire emotional and instrumental support, including the support of resources within their

community; and how to interact productively with health professionals and other members of the healthcare environment (Kieffer et al., 2013; Kieffer et al., 2014).

The MOMs HLI was led by Spanish-speaking CHWs, who were community residents who received extensive training as CHWs and on the MOMs HLI curriculum and methods, prior to participant recruitment. Specifically, the MOMs HLI curriculum consisted of 11 weekly 90-minute curricular meetings scheduled during pregnancy and 3 curricular meetings during early postpartum, primarily dedicated to promoting healthy eating, physical activity, and preparing for birth and infant care. These curricular meetings focused on healthy eating, physical activity, staying motivated to eat healthy and engage in physical activity during pregnancy and postpartum, as well as getting ready for labor and birth, infant care, and postpartum health care for the mother and infant. Data collection points occurred at baseline (3rd-4th months of pregnancy), follow up (8th month of pregnancy, on average) and early postpartum (~6 weeks after childbirth).

The MOMs Healthy lifestyle intervention effects on improved health behaviors and health outcomes include a significant decrease of added sugars, total fat and saturated fat, and significant increase of fruit, vegetables and fiber in participants' diet (Kieffer et al., 2014), as well as significant reductions of depressive symptoms during pregnancy (Kieffer et al., 2013). These health behaviors not only improved within participants in the HLI but there were also significant differences between the MOMs lifestyle intervention group compared to the comparison intervention group.

IV. Organization of Dissertation

The purpose of this dissertation is to help disentangle these complex sets of the associations between neighborhood-level, interpersonal and individual factors and physical activity levels of pregnant women of Mexican origin, as well as to assess the efficacy of a behavioral intervention in reducing declines of physical activity during pregnancy and early postpartum among women of Mexican origin.

This dissertation includes three analytical chapters aimed at filling three major gaps in the literature related to understanding factors that may influence physical activity levels of pregnant

women of Mexican origin in Detroit, MI. Building on this extant literature, in the remainder of the dissertation, I examine six main research questions:

Among pregnant women of Mexican origin in Detroit, MI:

Chapter 2:

- Are individual factors (beliefs, attitudes, social norms, perceived behavioral control toward physical activity) associated with PA levels?
- Does social support influence and/or moderate the association between perceived behavioral control and PA intention, or/and PA behavior?

Chapter 3:

- Are perceptions of the neighborhood social (social cohesion, safety) and physical (presence and condition of sidewalks, streets, housing, parks, heavy car/truck traffic) environments associated with physical activity levels?
- Is neighborhood poverty associated with physical activity levels, above and beyond perceptions of the social and built environments?
- Do perceptions of the neighborhood social and physical environment moderate the association between neighborhood poverty and physical activity?

Chapter 4:

- Did a community-based behavioral randomized control trial designed to modify individual and interpersonal factors reduce declines in PA levels among pregnant and early postpartum WMO in Detroit, MI?

Chapter 5:

This fifth and final chapter synthesizes the findings of the three analytical chapters and provides conclusions and recommendations for interventions. The analyses extend previous research by examining the associations between neighborhood poverty and physical activity in a urban sample of pregnant women of Mexican origin, above and beyond the influence of individual factors; testing whether aspects of the neighborhood social and physical environments moderate the association between neighborhood poverty and PA; evaluating if the Theory of Planned Behavior (TPB (Ajzen, 1985) constructs predict PA intention and PA behavior; examining the influence of social support on physical activity and whether social support moderates the association between perceived behavioral control and PA intention and PA

behavior. Lastly, it assesses the efficacy of the Healthy MOMS lifestyle intervention in a sample of predominantly pregnant women of Mexican origin in an urban community. Overall, Chapter 5 provides an assessment of implications of dissertation findings for future environmental, policy and interpersonal/individual intervention designs and methods.

Together, these findings may inform interventions aiming to increase physical activity levels and improve maternal and infant health outcomes, among pregnant Mexican immigrant and Mexican American women. In each chapter, I describe in greater detail why these questions are important to public health and how they may inform future interventions.

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Chapter 2

Predicting Physical Activity Intention and Behavior among Pregnant Women of Mexican Origin in Detroit, MI

I. Introduction

A large body of research documents the benefits of physical activity (PA) in all stages of life. During pregnancy, adequate PA levels are associated with better physical and mental health outcomes for both the mother and her newborn (Chasan-Taber, 2012a; Chasan-Taber et al., 2009; Downs, Chasan-Taber et al. 2012b). For the mother, adequate PA levels during pregnancy may lower risk of excessive weight gain and obesity (Renault et al., 2014; Weir et al., 2010), preeclampsia (Aune et al., 2014), gestational diabetes mellitus (GDM) (Chasan-Taber, 2012a), and psychological disorders (Rebar et al., 2015). For the newborn, maternal PA lowers risk of macrosomia (birth weight >4500 g) (Currie et al., 2014), and respiratory distress syndrome (McGillick et al., 2017), as well as lower risk of obesity and type 2 diabetes during childhood and adulthood (Austin et al., 2013; Crume et al., 2011; Giacco et al., 2014; Walker et al., 2009).

Despite its physical and mental health benefits during pregnancy, adequate PA levels among women with uncomplicated pregnancies in the United States (US) has not been achieved by many US women (ACOG, 2002, 2015; Evenson & Wen, 2010; Hesketh & Evenson, 2016). In a study of PA trends during pregnancy, Evenson et al. (2009) reported that approximately 55% of non-Hispanic white women and 20.7% of Hispanic women met the 2002 American College of Obstetrics and Gynecology (ACOG) guidelines recommending a minimum of 30 minutes of moderate PA a day on most days of the week during pregnancy (ACOG, 2002; Evenson & Wen, 2010). Several years later, Murillo et al. (2014), reported that over 60% of WMO of childbearing age failed to meet 2008 CDC physical activity guidelines for 150 minutes per week of moderate-to-vigorous intensity PA, and 46% were classified as inactive (Murillo et al., 2014). After the ACOG updated its guidelines for PA during pregnancy in 2015 (≥ 20

minutes of moderate PA per day for at least five days of the week (ACOG, 2015), Hesketh et al. (2016) reported that in a sample of diverse pregnant women in the U.S. (51% non-White), only 13.3% were physically active for 100 minutes per week. (Hesketh & Evenson, 2016).

Although low levels of adequate PA during pregnancy have been reported across the U.S., significant disparities in PA levels and related maternal-child health outcomes have been documented to affect ethnic minority and low-income populations. A solid body of research on PA levels and related health outcomes has provided evidence that low levels or lack of PA disproportionally impact health outcomes of low income, minority and immigrant communities (Kim et al., 2013; Marquez et al., 2009; Martin et al., 2015). Among minority and immigrant communities, Mexican-born and Mexican American women (from here on referred to as: women of Mexican origin, WMO) are more likely than non-Hispanic White (NHW) and non-Hispanic Black (NHB) women to begin their pregnancies overweight or obese and to report low levels of leisure-time PA before, during, and after their pregnancies (Austin et al., 2013; Black et al., 2007; Kieffer et al., 2001; Kieffer et al., 2006; Lynch et al., 2012). Not surprisingly, pregnant WMO have higher rates of preeclampsia and GDM than any other racial/ethnic groups in the US (Kim et al., 2013; Kieffer et al., 2001).

To address low levels of PA during pregnancy, several theoretical frameworks have been applied. These include the Social Cognitive theory (Bandura, 2004; Cramp & Brawley, 2009), the Health Belief model (Evenson & Bradley, 2010; Rosenstock et al., 1988), and the theory of Planned Behavior (Ajzen, 1985; Black et al., 2007). Among these behavioral theories, Ajzen's Theory of Planned Behavior (TPB) is a theoretical model that has proven beneficial for understanding PA behavior in a variety of populations and contexts (Ajzen, 1991). The TPB has also been used to explain PA patterns during pregnancy (Black et al., 2007; H. Hausenblas et al., 2011; Thompson et al., 2015; Weir et al., 2010). In general, the TPB proposes that a person's intention to perform a behavior is the central determinant of that behavior. The main constructs in the TPB include three conceptually independent variables: (1) Attitude(s), (2) Subjective norms, and (3) Perceived Behavioral Control (PBC) as antecedents predicting behavior intention. Attitude is reflected in a positive or negative evaluation of performing a behavior. Subjective Norm is intended to reflect the perceived social pressure that individuals may feel to perform or not perform a behavior. Lastly, PBC indicates the perceived ease or difficulty of performing a behavior and may have both direct and indirect effects on behavior (Ajzen, 1985). The main

proposition of the TPB in the PA domain is that persons will engage in PA when: (a) they intend to do so and have the required opportunities and resources; (b) they evaluate PA positively, believe that important others think they should exercise; and (c) they perceive it to be under their own control (Ajzen, 1985; Ickes & Sharma, 2012; Lynch et al., 2012).

Several studies have applied the TPB to better understand PA levels during pregnancy. In a systematic review of studies that applied TPB to increase PA during pregnancy, Thompson et al. (2017) reported that of 14 studies selected for the review, seven studies used the TPB to examine PA among pregnant women (Thompson et al., 2017). Of the seven TPB studies, three were qualitative studies, and four used a quantitative approach. For example, one of these studies showed that Attitude, Subjective Norm, and PBC explained 37% of the variance for PA Intention (Downs & Hausenblas, 2003). Another review reported that PBC and PA Intention together accounted for over 25% of the variance for PA behavior (Hausenblas & Symons Downs, 2004), with PA intention being statistically significantly associated with PA behavior in all studies (Thompson et al., 2017). Another important finding included in Thompson's review of the literature was the statistically significant association between PBC and PA behavior (Hausenblas et al., 2008; Hausenblas & Symons Downs, 2004).

Despite this important body of research highlighting the utility of the TPB constructs predicting PA during pregnancy, there are several limitations. One limitation arises when designing interventions to improve PA among minority and low-income pregnant women, as these studies were conducted primarily among non-Hispanic White, married, employed, highly educated, and middle/upper class, pregnant women. A second limitation is that most studies of TPB on PA only evaluated TPB constructs on predicting PA intention. Thus, we have limited understanding of the effectiveness of PA intention on predicting PA behavior.

Unlike the limited number of studies assessing the effectiveness of the TPB main constructs to predict PA intention and PA behavior, a larger body of research has highlighted social support as a significant predictor of PA intention and PA behavior (Courneya et al., 2000; Larsen et al., 2013a). Social support refers to the mechanisms by which interpersonal relationships may buffer one against a stressful environment by the provision of social resources that persons perceive to be available or that are actually provided to them in the context of both formal support groups and informal helping relationships (Cohen & McKay, 1984; Gottlieb & Bergen, 2010; Heaney & Israel, 2008). In the PA domain, researchers have identified social

support from different sources (e.g. spouse, relatives, friends) and types of social support (e.g. emotional, informational, instrumental) (Heaney & Israel, 2008), as critical factors promoting or hindering PA. In fact, some researchers have argued that social support may (a) be a more appropriate construct for understanding and predicting PA intention than Social Norms (Courneya, 2000); (b) predict PA behavior above and beyond PA intention (Courneya et al., 2000); (c) influence the association between PBC and PA behavior (Godin et al., 2010). Moreover, social support (or the lack of) has been reported as a moderating factor influencing associations between non-health related barriers (e.g. lack of time and/or motivation, or information about ways to safely exercise during pregnancy), and both PA intention (Black et al., 2007) and PA behaviors (Alegria, 2007) among minority populations (Conn & Sells, 2016; Perez et al., 2016; Shah et al., 2015).

Among pregnant Latinas, social support has been identified as a crucial determinant of PA during pregnancy (Kieffer et al., 2006; Kieffer et al., 2002; Larsen et al., 2013b; Lynch et al., 2012; Rhodes & Dickau, 2013; Thornton et al., 2006). For example, Chasan-Taber (2008), and Downs (2012), examined the PA patterns of pregnant women of Puerto Rican descent. These researchers reported a positive relationship between PA and social support levels, mainly from family members. Similarly, interviews with a sample of pregnant WMO in Detroit highlighted the lack of social support from their spouses/partners as the main sociocultural factor deterring PA (Thornton et al., 2006).

Despite our current understanding of the effectiveness of the TPB constructs and social support to explain PA intention and behavior during pregnancy, there are significant knowledge gaps concerning the efficiency of PA intention leading to PA behavior and the role that social support may have on PA levels throughout pregnancy. In fact, there is only one quantitative study of PA intention on physical activity conducted with pregnant WMO (Black et al., 2007) that I am aware of. These knowledge gaps limit the development of successful PA interventions designed to increase PA levels, which could ameliorate the increasing rates of metabolic diseases associated with inadequate PA levels during pregnancy. Given the burden of preventable diseases (e.g., preeclampsia, gestational diabetes, type 2 diabetes) disproportionally affecting minority pregnant women and especially pregnant women of Mexican origin, better understanding of which and how TPB constructs and social support may predict PA intention and PA behavior during pregnancy is warranted. In addition, there is a solid body of research on

associations of PA and health outcomes around the childbearing year that have not been included in intervention design and reporting. Further, interventions that have applied theoretically based strategies to promote healthy behaviors during pregnancy often utilize constructs from only one behavioral theory (e.g., TPB or social support), which limits our understanding of other factors and how these factors may interact and contribute to behavior adoption and maintenance (Evenson et al., 2012). Thus, limiting our ability to inform and enact successful interventions.

This chapter seeks to address these gaps in the literature. Specifically, it examines TPB constructs in conjunction with social support as predictors of PA among pregnant WMO. This dissertation chapter has four goals: **(1)** Examine the roles that Attitudes, Social Norms and Perceived Behavioral Control (PBC) may have in predicting PA intention; **(2)** Assess PA intention's performance in predicting PA behavior; **(3)** Evaluate the moderating effect that social support may have on the association between PBC and PA intention, and **(4)** Evaluate the moderating effect that social support may have on the association between PBC and PA behavior. This dissertation chapter not only builds upon previous research by increasing our understanding of the application of the TPB constructs to explain PA intention among low income pregnant WMO, but also contributes new findings by evaluating the TPB constructs on PA behavior and examining the moderating effect that social support may have on PA intention and PA behavior of pregnant WMO in Detroit, MI. To my knowledge, this is the first to examine the potential influence that social support may have on associations of PBC and intention to engage in PA, as well as the association between PA intention and PA behavior among pregnant WMO.

In the following section, I provide a review of the literature on salient factors associated with PA during pregnancy. This review was designed to provide insight into individual- and interpersonal-level factors that may influence PA through pregnancy among low-income women of Mexican origin.

II. Review of the Literature

A growing body of research and health interventions to promote PA during pregnancy has provided some guidance as to which individual and interpersonal factors may influence PA

among pregnant Latinas and WMO (Austin et al., 2013; Black et al., 2007; Chasan-Taber, 2012; Symons Downs & Hausenblas, 2003; Fortner et al., 2009; Kieffer et al., 2002; Marquez et al., 2009; Thornton et al., 2006).

2.1. Individual- Level Factors: Beliefs, Attitudes, and Social Norms

Research findings have highlighted several individual factors as contributing explanations for why WMO are less likely to exercise during pregnancy, including sociocultural beliefs, attitudes and social norms (Chasan-Taber et al., 2007; Kieffer et al., 2002; Leiferman et al., 2011; Thornton et al., 2006).

Several sociocultural beliefs have been identified to influence pregnant WMO's attitudes toward PA. Among WMO, these beliefs have been associated with (a) perceived risk that PA may harm the baby's well-being or that PA may prevent the baby from gaining enough weight; (b) perceived lack of time to exercise; c) perceived amount of adequate PA levels. For instance, a woman's beliefs such as 'Exercise that involves lifting or carrying heavy things would hurt my baby' may be associated with lower PA levels (Evenson et al., 2012; Gollenberg et al., 2008; Kieffer et al., 2002). Moreover, Chasan-Taber (2012), Kieffer et al (2002) & Thornton et al (2006) found that expecting Latina women, predominantly WMO, were highly influenced by sociocultural beliefs promoting increased gestational weight gain that led to a healthier baby, and/or the need for rest during pregnancy to protect the baby. For example, during these studies, some participants expressed their traditional approaches to physical activity during pregnancy "Our mothers have told us...that to do much physical activity maybe would affect the baby" or "If she doesn't eat what she craves, that might harm the baby" (Kieffer et al., 2002; Thornton et al., 2006). Similarly, women who perceive that "PA takes too much time" may be less likely to exercise for 30 minutes (Thornton et al., 2006). On the other hand, if a woman expects "To have more energy or feel better about myself if I exercise regularly" or believes that "Regular exercise may improve blood circulation and help with leg pain," she may be more likely to be physically active (Black et al., 2007).

Several researchers working with Hispanic populations have reported that social norms (e.g., familism) are particularly important factors affecting PA (Downs et al., 2012; Mendelson et al., 2008; Thornton et al., 2006). Familism, a traditional cultural belief system based on

women's gendered role as family caregivers has been negatively associated with PA among non-pregnant and pregnant Latina women (Austin et al., 2013; Harrison et al., 2018). In a literature review on PA patterns of Latina women of childbearing age, Larsen et al (2015) identified familism (e.g., house chores and childcare responsibilities) as leading sociocultural factors limiting PA levels (Larsen, Noble, Murray, & Marcus, 2015). These social roles may influence PA in different ways. One way is that women may prioritize their social roles as primary caregivers and their household responsibilities and/or think of PA as competing with their main responsibilities as caregivers (Buchanan et al., 1998; Kieffer et al., 2002; Thornton et al., 2006), A second way is that women may also perceive that taking care of the house or children provides all the exercise they need. Lastly, they may have perceptions of PA disapproval during pregnancy by family members. For example, from a qualitative study with pregnant WMO in Detroit, MI, Kieffer and colleagues (2002) reported that women may perceived that important people in their lives do not approve of engaging in PA while pregnant.

2.2. Interpersonal Level Factors: Social Support

Social support is described as an important health determinant that may affect health-related beliefs and behaviors (Israel et al., 2002). Social support refers to the aid, assistance, help, or support received from others (Cohen et al, 1985). There are different types of social support: Informational (e.g., advice or information about how to exercise), instrumental (e.g., help with housework or childcare to make time to exercise), and emotional (e.g., encouragement and exercise companion) (Cohen & McKay, 1984). Pregnant and postpartum WMO tend to view social support as essential to the maintenance of PA to a greater extent than women of other ethnic groups (Keller et al., 2014). Based on a qualitative study conducted in Detroit, MI, Thornton et al., (2006) found that husbands/partners were primary sources of emotional, instrumental, and informational support for weight, diet, and physical activity for WMO participants. In this research, women who reported high levels of positive emotional support from their husbands/partners were more likely to be physically active. On the other hand, women who believed their husbands criticized and humiliated them because of their body weight, were less likely to report PA (Thornton et al., 2006). Other studies have also identified female family members as particularly influential in the development and maintenance of physical activity patterns among Latina women (Esakoff, et al., 2011) as they provide childcare

and help for house chores to free time for exercise (instrumental support) or even are available to provide companionship when exercising (e.g., emotional support) (Thornton et al., 2006). For immigrant WMO, leaving their mothers or other female relatives in their countries of origin may be a prominent barrier that limits their access to childcare and companionship for exercise, and hence, deters their ability to maintain an adequate level of PA during and after pregnancy (Kieffer et al., 2002; Thornton et al., 2006; Tovar et al., 2009).

2.3. Sociodemographic Factors: Acculturation, Socioeconomic and Immigration-related Statuses

2.3.1 Acculturation

Acculturation status has been identified as a significant PA predictor with mixed results among immigrant communities (Evenson et al., 2002; Lynch et al., 2012; Murillo et al., 2014). Acculturation refers to "The degree to which individuals and communities retain their culture of origin alongside the extent to which they learn and/or add certain aspects of the dominant culture in their new country of residence" (Larsen et al., 2013a)(page 6). For example, Evenson and colleagues (2004) found that length of residence in the US was not associated with PA among Mexican American and Mexican-born women. In another study, Murillo et al. did find that longer length of residence was associated with both lower leisure PA and higher obesity rates among US-born Mexican Americans and Mexican immigrants who have lived in the US (Murillo et al., 2014). Moreover, other studies have shown that greater acculturation, based on English-language acquisition, was associated with higher PA levels among English-proficient Mexican immigrants (Larsen et al., 2013a).

2.3.2. Socioeconomic status

WMO with low socioeconomic status (low educational attainment, employment status and/or low income) in the US might engage in more moderate PA than non-Hispanic White women of similar SES due to ethnic and social class differences in occupational activity (Hernandez et al., 2003; Larsen et al., 2013a; Martin et al., 2015). Lower educational attainment level among these

Mexican-American women may lead them into occupations that require substantial PA (Harrison et al., 2018; Sallis et al., 2001).

2.3.3. Immigration status in the US

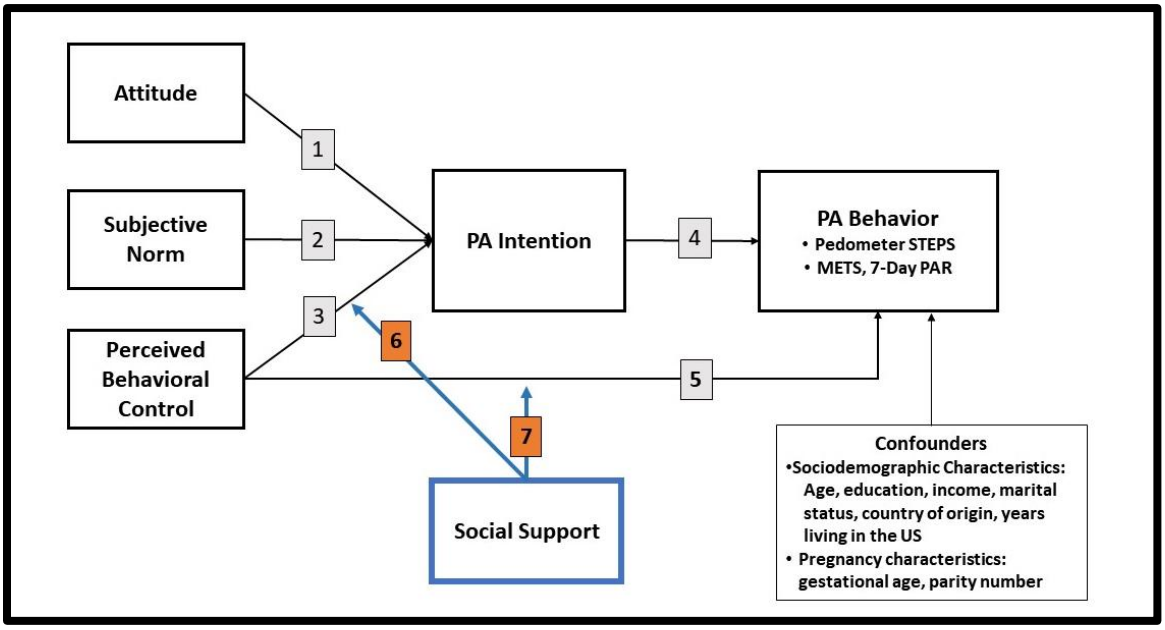
Another salient factor likely to influence PA attitudes among Mexican communities and other Spanish-speaking neighborhoods, is fear of detention or deportation raids conducted by immigration authorities (Larsen et al., 2013b; Martinez et al., 2009). In a qualitative study conducted by Martinez et al (2009) to elicit information about facilitators and barriers to PA, one of the focus group participants said that "Latinos don't usually use that park. We don't come to visit the park because they [other people] say that immigration goes there". Another woman stated, "if we don't have papers, they'll take us, and the kids, they just stay there (Martinez et al., 2009)(p.28). WMO in Detroit, MI have also reported similar fears to immigration authorities. In another qualitative study conducted in Detroit, Viruell-Fuentes and Schulz (2009) reported feelings of isolation and fear of deportation among undocumented WMO (Viruell-Fuentes & Schulz, 2009). Those feelings of isolation were fueled by a heightened sense of fear and loneliness, "When I first arrived, I felt awful... I would spend my time walled in because I didn't know anyone and they were always scaring us, [saying] ''Immigration (INS) is going to get you, you can't go out' (Viruell-Fuentes & Schulz, p. 2170). Thus, WMO are more likely to experience more astringent social environments when detention and deportation raids are conducted by immigration authorities, which contribute to a social climate of fear and anxiety that may inhibit outdoor PA (Larsen et al., 2013b).

III. Conceptual model

My conceptual model was informed by formative research conducted by Kieffer et al. (2002) and Thornton et al. (2006). These formative studies included in-depth individual interviews and focus groups conducted with pregnant and postpartum WMO in Detroit, MI (Kieffer et al., 2002; Thornton et al., 2006). Participating women identified PA beliefs and practices, and individual, family, social and community barriers and facilitators to adopting or maintaining healthy lifestyles during and after pregnancy (Kieffer et al., 2002; Thornton et al., 2006).

Drawing on the Theories of Planned Behavior (TPB; Ajzen, 2011) and Social Support (SS; Israel, 1982; Kaplan et al., 1977), the conceptual model (Figure 2.1) indicates hypothesized relationships between attitudes, subjective norms, and perceived behavioral control (PBC), with exercise intention and physical activity (PA) behavior. The model also depicts social support as a moderating factor influencing the strength of associations between PBC and PA intention, as well as PBC and PA behavior. Thus, Attitude toward PA reflects a positive or negative evaluation of performing the PA behavior *(path 1)*. For example, 'I will have more energy if I exercise regularly' or 'I will hurt my baby if I exercise regularly.' Subjective norm reflects the perceived social pressure that pregnant WMO may feel to engage or not engage in PA *(path 2)*. Specifically, subjective norm describes the perceived endorsement from partner and/or family members to engage in PA, and it is measured with respect to what others think one should do or whether others would approve of what one does. For example, 'While I am pregnant, people who are important to me approve if I exercise regularly.' Perceived behavioral control (PBC) indicates the perceived ease or difficulty of engaging in physical activity *(path 3)* and may have both direct and/or indirect effects on PA behavior (*path 5*). Examples of PBC measures include 'I can easily exercise for 30 minutes a day, most days of the week,' or 'I can exercise regularly even if I have family, childcare, or other work responsibilities.' Moreover, these TPB constructs determine a person's intention to engage in PA during pregnancy which, in turn, influences PA behavior *(path 4)*.

Figure 2.1 Theories of Planned Behavior and Social Support Predicting PA Intention and PA Behavior among Pregnant Women of Mexican Origin.



Although it may be important to know that others approve of one's engaging in PA (Subjective Norm), it may be unlikely that these TPB constructs would be enough manifestation of social influence in the PA domain, especially during pregnancy. It is plausible that additional factors, beyond those encompassed in the TPB may be important in shaping PA (Lee et al., 2016; Thompson et al., 2017). In fact, social support may play an important role in facilitating PA behavior during pregnancy, above and beyond PA intention (Harrison et al., 2018). Thus, social support is hypothesized to moderate the relationship between PBC and PA intention *(path 6)* to engage in PA. Moreover, PA is one of those health behaviors where PBC is likely influenced by social support and it may carry more weight than intention in execution on PA behavior *(path 7*) (Godin & Kok, 1996). Thus, social support may also influence the strength of the relationship of PBC and PA behavior.

IV. Specific Aim and Hypotheses

The purpose of this study is to examine the associations between attitudes, social norms and perceived behavioral control (PBC), and PA intention and PA Behavior among a sample of

pregnant women of Mexican origin in Detroit, MI. Further, this study proposes that social support plays a moderating role on **(a)** the association between perceived behavioral control and PA intention, and **(b)** the association between perceived behavioral control and actual exercise during pregnancy.

I hypothesize that, among pregnant WMO in Detroit, MI:

Hypothesis 1

Attitudes, social norms and PBC predict PA intention.

1.1 Positive attitudes toward PA during pregnancy predict PA intention (path 1)

1.2 Supportive social norms toward PA during pregnancy predict PA intention (path 2)

1.3 PBC predict PA intention (path 3)

Hypothesis 2

PA intention predicts PA behavior (actual exercise behavior).

2.1 PA intention is positively associated with baseline PA behavior during pregnancy (path 4)

Hypothesis 3

The strength of the association between PBC and PA intention will vary depending on the level of social support provided by WMO's husband/partner, mother/woman who raised her, and/or friend(s).

3.1 Social support (arrow 6) positively moderates the association between PBC and PA intention (path 3)

Hypothesis 4

The strength of the association between PBC and PA behavior will vary depending on the level of social support provided by WMO's husband/partners, mother/woman who raised her, and/or friend(s).

4.1 Social support (arrow 7) moderates the association between PBC and PA behavior, such that the association between PBC and PA will be strengthened for women with higher levels of social support.

V. Methods

5.1. Data Source and Sample Design

Data for this dissertation chapter was derived from the Healthy MOMs study, a prospective randomized controlled clinical trial designed to reduce risk factors for obesity and type-2 diabetes among pregnant and early postpartum Latina women in Detroit, MI (Kieffer et al., 2013; Kieffer et al., 2014). The Healthy MOMs study was planned, developed, and conducted between 2004 and 2006 in Southwest Detroit, using a community-based participatory research (CBPR) approach (Israel et al., 1998; Kieffer et al., 2013; Thornton et al., 2006). It was conducted in affiliation with the Detroit Community Academic Urban Research Center and the REACH Detroit Partnership. Pregnant Latina women were eligible to participate in this study if they were at least 18 years old, a resident of Southwest Detroit, and less than 20 weeks pregnant; had a pre-gravid BMI ≥18.9; and ability to read in English or Spanish. Exclusion criteria included a multiple gestation, diagnosis of type 1 or type 2 diabetes; incompetent cervix/cerclage; active thyroid, cardiac, vascular or pulmonary disease; or serious physical or mental illness or condition that would substantially interfere with participation in, or completion of, the entire intervention (Kieffer et al., 2013; Kieffer et al., 2014).

This dissertation chapter was conducted using baseline data collected from pregnant Latina women recruited from community health organizations such as the Community Health and Social Services (CHASS) Center, and the Supplemental Nutrition Program for Women, Infants and Children (WIC) Program offices, other community organizations and community settings, for participation in the Healthy MOMs study. 278 pregnant Latina women were recruited, consented, and completed baseline data. From this group of Healthy MOMs enrolled participants, the 251 participants who self-reported as Mexican immigrant and Mexican American were included for analysis in this study.

Baseline data was obtained during two face-to-face interviews conducted by a trained bilingual interviewer. The interviewer administered the study questionnaires at CHASS, or in the participant's home, in the participant's language of preference (Spanish or English) and recorded her answers. At the first baseline visit, participants answered the Healthy MOMs Questionnaires, which were designed to elicit data on PA-specific social support and PA-related TPB constructs; and received a pedometer (Omron HJ-720ITC, Shelton, CT) and detailed

information on how to use it. Also, participants received instructions about the 7-Day Physical Activity Recall (7-Day PAR; Sallis et al., 1985) available in English and Spanish. In a second baseline interview conducted seven days later, the interviewer collected pedometer data (number of steps walked) and administered the 7-Day PAR questionnaire. Each woman received incentive payments at each data collection point for their participation in the study (Kieffer et al., 2013; Kieffer et al., 2014).

5.2. Measures

5.2.1. Outcome Variables

Intention to Exercise During Pregnancy (PA Intention). The question 'During the next few months, while I am pregnant, I plan to exercise about 30 minutes a day most days of the week?' was used to assess PA intention. Response options range from 1=strongly agree to 5=strongly disagree. To facilitate interpretation of findings, item answers were reverse coded so that higher scores would reflect higher levels of agreement (1=strongly disagree; 5=strongly agree). Moreover, given the distribution of the five response options (results not shown), three categories were created, 1=No PA intention, 2=Moderate Agreement to plan to exercise, and 3=Strong agreement to plan too exercise (reference).

Pedometer steps (STEPS). This continuous variable was obtained from baseline raw data (total number of steps in a seven-day period) from the pedometer and assessed for skewness (Giacco et al., 2014), and outliers. The MAD (Median Absolute Deviation) method and Miller's rejection criteria (three standard deviations, SD) were applied to identify and delete outliers (Leys et al., 2013; Miller, 1991). As a result, One measure of <100 steps per week at baseline was excluded from analysis. Then, the raw number of steps for each participant was divided by 1,000 (e.g., number of steps in thousands) to facilitate interpretation of results.

Total number of METS per week (METS). The 7-Day Physical Activity Recall questionnaire (Sallis et al., 1985) is a validated instrument widely used in epidemiologic, clinical, and behavior studies to measure leisure and occupational PA (Blair et al., 1985; Jacobs et al. 1985). The 7-Day PAR was used to collect self-reported information about the number of minutes per day participants spent on moderate, hard, and very hard intensity PA such as aerobic exercise, work-

related activities, gardening, walking, and recreation. Participants reported their daily occupational, household, recreational, and sports activities for the last seven days prior to baseline data collection. Levels of PA included, a) Moderate PA for activities such as walking at a normal pace (it did not include stop-and-go walking) and any other PA activities that required a similar amount of physical effort as normal pace walking; b) Hard PA, those activities that required a larger amount of physical effort than normal walking; and c) Very Hard PA, such as running or aerobic exercise. It is important to note that only items related to PA from the PAR questionnaire were used to calculate the PA score. Following specific instructions available for adequate use of the 7-Day PAR (Sallis et al., 1985), a participant's total number of minutes spent per day were summed to estimate the total number of minutes per week spent in moderate, hard, and very hard intensity PA. Then, the total number of minutes per week for each PA intensity category was converted to hours (minutes/60). Further, the amount of hours spent on each PA intensity category per week was multiplied by an estimate of Metabolic Equivalent of Task (MET) energy expenditure units assigned to each category of activity. According to the PA intensity category (moderate, hard, very hard), an estimated amount of energy (one MET unit is estimated as 1MET= 1 kcal kg/hour) spent on engaging in PA, was utilized as follows: one hour of moderate intensity PA = 4 METs, one hour of hard intensity PA= 6 METs, and one hour of very hard intensity PA = 10 METs (Sallis et al., 1985). Finally, METS obtained from each PA category were summed to obtain the **total number of METs per week** per participant. This continuous variable was assessed for skewness (Giacco et al., 2014). The MAD (Median Absolute Deviation) method and Miller's conservative rejection criteria (three standard deviations, SD) were applied to identify and delete outliers (Leys et al., 2013; Miller, 1991). No outliers were identified. The METS measure used in this study was obtained at baseline.

5.2.2 Predictor Variables

Attitudes *t*oward PA during pregnancy (ATTITUDE). Thirteen scale items were used to assess MOMS participants' attitudes about exercise during pregnancy at baseline. The constructs used in these scales were based on the results of formative research (Kieffer et al., 2002). Some example items included 'Regular exercise will make my labor easier,' 'I will hurt my baby if I exercise regularly,' or 'I don't have the desire to exercise.' Items were measured with a 5-point Likert scale (1= strongly agree, 5=strongly disagree). To facilitate interpretation

of findings, item answers were reverse coded (1=strongly disagree; 5=strongly agree), where higher scores conveyed a more positive attitude toward PA during pregnancy. After conducting a Cronbach's alpha test for internal consistency (Gliem & Gliem, 2003), an exploratory factor analysis was conducted to assess the scale's dimensionality. After eliminating items with low factor loadings (<0.60) for small sample sizes (Worthington & Whittaker, 2006), five scale items were selected. These five scale items were selected to assess participants' attitude about both the psychological and physical benefits of exercise during pregnancy (e.g. 'Exercising during pregnancy will make me feel better about myself', and 'Regular exercise will make my labor easier'). Scale mean scores were reported for each participant if answers to a minimum of four items were available (minimum of 75% of total number of cases available per participant) (Worthington & Whittaker, 2006). (Cronbach's alpha= .75 for the 5-item scale)

Subjective Norm (SN). Subjective norm at baseline was assessed with the following item: 'While I am pregnant, people who are important to me approve If I exercise regularly.' Answer options ranged from 1=strongly agree to 5=strongly disagree (reverse coded). A single item to measure subjective norm is consistent with previous TPB and exercise research (Ajzen, 2002).

Perceived behavioral control (PBC). Originally, thirteen scale items were used to measure PBC at baseline. Some example items include, 'I can easily exercise 30 minutes a day most days of the week,' 'I can exercise regularly even if my partner, friends of family don't approve', and 'I can exercise regularly even if I have family, childcare or other work responsibilities.' Answers to items originally ranged from 1=strongly agree to 5=strongly disagree but were reverse coded to facilitate interpretation of findings. After testing these 13 items for internal consistency (Gliem & Gliem, 2003), an exploratory factor analysis was conducted to assess the scale's dimensionality. Consequently, three scale items were selected based on their intercorrelation values or loadings toward one dimension (Worthington & Whittaker, 2006). An example of a remaining scale item is: 'While pregnant, I can exercise regularly without desire to' and 'I can exercise regularly even if I am tired'). Finally, PBC scale mean scores were reported for each participant if answers to all three items were available (minimum of 75% of total number of answered items available per participant in relation to the number of scale items) (Worthington & Whittaker, 2006). Each participant's PBC toward PA was reported as the mean score of the three selected items. (Cronbach's alpha = .69). Table 2.1 describes reliability coefficients of all TPB measures.

Table 2.1 Description and Reliability Coefficients for Measures of the Theories of Planned Behavior and Social Support. Healthy MOMs Study, 2004 – 2006		
Measure	**No of Items**	**Cronbach Alpha[a]**
Attitude	5	.75
Subjective Norm (SN)	1	-
Perceived Behavioral Control (PBC)	3	.69
Physical Activity (PA) Intention	1	-
Social Support: Husband/Partner	5	.75
Social Support: Mother/Woman who raised you	5	.82
Social Support: Friends/Other	5	.78

[a](1951)

5.2.3. Moderator variables

Social support (SS) (Cohen & McKay, 1984)**.** Three series of nine scale items each were used to assess perceptions of social support toward exercise during pregnancy at baseline. Specifically, the scales assessed social support from each of three sources: (1) husband/partner (SS-HUB), (2) mother/woman who raised you (SS-MOTHER), and (3) friends (SS-FRIEND) Sample questions asked for each series started with "How often has your partner…?", "How often has your mother/woman who raised you….?" Or "How often have your friends…?" depending on the source of support. Each introductory statement was followed by a specific question such as "Helped with housework so that you could take time to exercise?" Response answers ranged from 1=never, to 5=always. Answers to questions such as "Refused to take care of the children so that you could take time to exercise?" were reverse coded so that a higher score would denote a higher level of social support. The scale's internal consistency (Cronbach's alpha), and dimensionality were assessed (Worthington et al., 2006). Five items were selected, which included ''Helped with housework so that you could take time to exercise' and 'Given you advice or information about how to exercise.' Each participant's level of social support toward PA was reported as the mean score for these five items **(Table 2.2)**.

5.2.4. Control Variables

Age (AGE). This continuous variable represents the participant's age in years at baseline data collection for this study.

Educational Attainment (EDU). Answers to 'What was the last highest grade of school you completed?' were used to construct this continuous variable to estimate the total number of years of education completed at baseline.

Country where last educated (COUNTRY-EDU). A dichotomous variable to indicate where a participant received her highest level of education (Mexico=1, Otherwise=0 (reference)) at baseline.

Years in the US after arrival (YEAR-US). A continuous variable that measures the number of years that MOMs participants have been in the US after arriving to the US if born in Mexico or another country.

Marital Status (MARITAL). A dichotomous variable at baseline (1=married or living with partner, 0=Otherwise (reference)).

Employment status (EMPLOYMENT). A baseline dichotomous variable was created to record respondents' employment status since becoming pregnant with current pregnancy. 1=Employed=1, Otherwise=0 (reference).

Household income (INCOME). This categorical variable was created from answers to the question to 'What is your household pre-tax income from all sources?' where 1= Under $10,000 (reference), 2=$10,000-$20,000, 3=$20,000-$30,000 and 4= over $30,000 at baseline.

Number of people living in household (PEOPLE). This baseline categorical variable included the total number of children of any age and adults living in the same home. It was constructed as follows: 1=1-2 (reference), 2=3-4, 3=5-6, and 4= ≥7 people.

Self-Rated Health (HEALTH). At baseline**,** participants were asked to rate their overall health using a 5-point Likert scale (1=Poor, 5=Excellent). Because of the answer distribution, three categories were created, 1=Poor/Regular (reference), 2=Good, and 3=Very Good/Excellent.

Body Mass Index (BMI). This continuous variable at baseline was obtained from study measurements of body weight (kg) and height (m) that were used to calculate BMI using the following formula: BMI=kg/m^2 (Index, 2015; Keyset al., 1972).

Live births (PARITY). This categorical variable was based on the total number of live births that a MOMs participant had had a baseline: 0=no previous deliveries (reference), 1=1-2, and 2=≥3.

Gestational age (GESTATION). This continuous variable corresponds to the estimated age of the current pregnancy in weeks at baseline, using all available self-reported and clinical data

reviewed by the Healthy MOMs perinatologist using a standard procedure to provide the most accurate estimate.

5.3 Preparing data for analysis

A series of diagnostic analyses (correlation matrices and estimation of Variable Inflation Factors (O'brien, 2007) were conducted on predictor, moderator, and control variables to identify potential issues of multicollinearity prior to proceeding with regression model fitting for all outcome variables (results not shown) (Alin, 2010). Multicollinearity was identified among moderator variables (social support from husband/partner, mother/woman who raised you, friend) and control variables (country where last educated, years living in the US, number of people in the household, marital status, employment status). To address the multicollinearity issue among social support from the mother/woman who raised you (VIF= 7.66), and the other two sources of social support, I fitted regression models that included one source of social support at a time. Moreover, to address multicollinearity among control variables country where last educated, years living in the US, marital status, employment status, and number of people in the household were excluded from the analyses.

Missing data was not deemed a serious issue for most of the outcome, predictor (TPB constructs), moderator, or control variables except for **(a)** data on number of pedometer steps (17% missing), **(b)** social support received from mother/woman who raised you (>25% of cases were reported as 'Does not Apply'), and **(c)** household income (approximately 30% of cases were reported as 'Don't know'). To assess if missing data for pedometer steps and social support from 'mother/woman who raised you' were missing at random, a series of Pearson's and Fisher's Chi square tests were performed using demographic data (e.g. age, health, education, marital status, parity) and dummy variables (1=any steps, or 1=any social support from mother/woman who raised you, 0=missing data). A *p*-value of 0.05 was deemed as statistically significant (results not shown). Only 'marital status' was statistically associated with number of pedometer steps (p-value= 0.027). This last result may have implications when assessing the moderating role that social support from husband/partner may have on the association between PBC and PA intention, and/or PBC and PA behavior. Missing data was not deemed as a serious issue for any of the outcome, predictor, or control measures except for data on number of pedometer steps (17.5% missing), and household income (approximately 30% of cases were reported as 'Don't

know'). Before proceeding to impute missing data, I assessed if missing data for pedometer STEPS and household income were missing at random, a series of Pearson's and Fisher's Chi square tests were performed using demographic data (e.g., age, health, gestational age, education and parity) and dummy variables (1=any steps, 0=missing data, or 1=any income, 0=no data). None of the demographic measures was significantly associated with pedometer STEPS or household income missing data. A p-value of .05 was deemed as statistically significant (tests not shown). Multivariate imputation by chained equations (MICE) was utilized to address missing data (Raghunathan et al., 2001; Royston & White, 2011). The MICE approach creates multiple imputations, as opposed to single imputations, and accounts for the statistical uncertainty in the imputations. This approach is very flexible and can handle variables of varying types as well as complexities such as survey skip patterns (Azur et al., 2011). All outcome, predictor and control variables of relevance were imputed. All multiple imputations and regression analyses were performed in STATA (version 15.1; Stata-Corp, College Station, TX, USA) with the procedures mi and regress, respectively (Royston & White, 2011).

5.4 Statistical Analysis

I conducted several multinomial logistic and linear regression analyses to test study hypotheses. To test Hypothesis 1, which states that (a) Attitude, (b) Social Norm, and (c) Perceived Behavioral Control predict PA intention, I fitted a multinomial logistic regression model (Model 1) to examine relationships between the predictor variables and the outcome variable ((1= No PA intention, 2=Moderate agreement, and 3=Strong agreement to exercise during pregnancy (reference)). All regression models were adjusted for the following confounders: participants' age, health, BMI, parity, level of education and gestational age.

Model 1:

$$\textbf{PA Intention} = \beta o + \beta_1 \textbf{ATTITUDE} + \beta_2 \textbf{SN} + \beta_3 \textbf{PBC} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 BMI + \beta_7 PARITY + \beta_8 EDUCATION + \beta_9 GESTATION$$

For Hypothesis 2 (PA intention predicts PA behavior), I fitted two multivariate linear regression models, where PA intention was measured as a binary variable (1=Strong PA intention, 0= otherwise) and regressed on pedometer STEPS (Model 2.1), and METS from the 7-Day PAR questionnaire (Model 2.2).

Model 2.1:

$$\textbf{STEPS} = \beta o + \beta_1 \textbf{PA Intention} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 BMI + \beta_5 PARITY + \beta_6 EDUCATION + \beta_7 GESTATION$$

Model 2.2:

$$\textbf{METS} = \beta o + \beta_1 \textbf{PA Intention} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 BMI + \beta_5 PARITY + \beta_6 EDUCATION + \beta_7 GESTATION$$

For Hypothesis 3, I examined the moderating effect of social support from Husband/partner, 'Mother/woman who raised you', and Friends on the association between PBC and PA intention in separate models. I followed recommendations by Aiken and West (1991) to create interaction terms to assess moderating effects. Interaction terms were created between PBC and (1) social support from husband/partner (PBC*SS-HUB), (2) mother/woman who raised you (PBC*SS-MOTHER), and (3) friends (PBC*SS-FRIEND). After I identified high levels of multicollinearity between social support from the mother/woman who raised you, and the other two sources of social support, I fitted three separate multinomial logistic regression models that included predicting variables (Attitude, Social Norms and PBC), one source of social support at a time and an interaction term (PBC*SS-HUB) (Model 3.1). The second multinomial logistic regression model was fitted with the same predicting variables, social support from the mother, and the interaction term (PBC*SS-MOTHER) (Model 3.2). Lastly, a multinomial logistic regression model was fitted with the same predicting variables, social support from friends, and the interaction term (PBC*SS-FRIEND) (Model 3.3).

Model 3.1:

$$\textbf{PA Intention} = \beta o + \beta_1 ATTITUDE + \beta_2 SN + \beta_3 PBC + \beta_4 SS\text{-}HUB + \boldsymbol{\beta_5 PBC*SS\text{-}HUB} + \beta_6 AGE + \beta_7 HEALTH + \beta_8 BMI + \beta_9 PARITY + \beta_{10} EDUCATION + \beta_{11} GESTATION$$

Model 3.2:

$$\textbf{PA Intention} = \beta o + \beta_1 ATTITUDE + \beta_2 SN + \beta_3 PBC + \beta_4 SS\text{-}MOTHER + \boldsymbol{\beta_5 PBC*SS\text{-}MOTHER} + \beta_6 AGE + \beta_7 HEALTH + \beta_8 BMI + \beta_9 PARITY + \beta_{10} EDUCATION + \beta_{11} GESTATION$$

Model 3.3:

PA Intention = $\beta o + \beta_1$ATTITUDE + β_2SN + β_3PBC + β_4SS-FRIEND + **β_5PBC*SS-FRIEND** + β_6AGE + β_7HEALTH + β_8BMI + β_9PARITY + β_{10}EDUCATION + β_{11}GESTATION

To test Hypothesis 4 (Strength of the association between PBC and PA behavior varies depending on differing levels of social support provided by WMO's partners, relatives, or friends), I fitted several linear regression models by regressing the predictor (PBC) and each source of social support (husband/partner, mother/woman who raised you, or friends) along with interaction terms created with PBC and each one of the sources of social support, on the two outcome measures. All models were adjusted for confounders.

Model 4.1.1:

STEPS = $\beta o + \beta_2$PBC + β_3SS-HUB + **β_4PBC*SS-HUB** + β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

Model 4.1.2:

STEPS = $\beta o + \beta_2$PBC + β_3SS-MOTHER + **β_4PBC*SS-MOTHER** + β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

Model 4.1.3**:**

STEPS = $\beta o + \beta_2$PBC + β_3SS-FRIEND + **β_4PBC*SS-FRIEND** + β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

Model 4.2.1**:**

METS = $\beta o + \beta_2$PBC + β_3SS-HUB + **β_4PBC*SS-HUB** + β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

Model 4.2.2**:**

METS = $\beta o + \beta_2$PBC + β_3SS-MOTHER + **β_4PBC*SS-MOTHER** + β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

Model 4.2.3**:**

METS = $\beta o + \beta_2$PBC + β_3SS-FRIEND + **β_4PBC*SS-FRIEND** β_5AGE + β_6HEALTH + β_7BMI + β_8PARITY + β_9EDUCATION + β_{10}GESTATION

VI. Results

Data from 251 pregnant WMO were included in this study. Sociodemographic characteristics of the Healthy MOMs sample are presented in **Table 2.2**. Overall, Healthy MOMs participants included in the study were 27.2 years old on average, most were born (97.2%) and educated (87.6%) in Mexico; over 70% had not completed high school and 75.7% were receiving WIC benefits; and expecting their first (25.1%), or second or third child (61%).

Descriptive statistics for outcome, predictor and moderator variables are presented in Table 2.2. Briefly, the mean values for outcome variables were 4.2 for PA intention (1=No PA intention, 5=Strong PA intention), 27,392 STEPS per week, and 112.7 METS. The mean values for predictor variables were 4.1 for Attitude, 4.6 for Subjective Norm (SN), and 3.4 for Perceived Behavioral Control (PBC). For moderator variables, the mean values for levels of social support (SS) were higher from husband/partner' (2.5), compared to levels of social support from

Table 2.2 Sample Characteristics, Predictor and Outcome Measures of Study Sample (n=251). Healthy MOMs Study, 2004 - 2006

Sociodemographic Characteristic	Mean	SD[b]	%(n)
Age, years	27.2	5.3	
Education, years	9.4	3.0	
≤ 6th grade, % (n)			34.7 (87)
7-11 grade, % (n)			37.5 (94)
≥ 12th grade, % (n)			27.5 (69)
Country last educated, % (n)			
Mainland United States			8.0 (20)
Mexico			87.6 (220)
Number of people in the household, persons	2.2	0.7	
Country of origin/birthplace, % (n)			
Mainland United States			2.8 (7)
Mexico			97.2 (244)
Age at arrival in the United States[c], years	21.3	5.6	
Years lived in the US	6.6	5.6	
English speaking ability, none, % (n)			79.3 (199)
Occupation, homemaker, % (n)			88.0 (221)
Married, yes, % (n)			59.8 (150)
Self-rated Health (1=poor, 5=excellent)	3.2	.9	
Poor/Fair, % (n)			19.9 (50)
Good, no. % (n)			53.4 (134)
Very Good/Excellent, % (n)			24.7 (62)
Gestational age, weeks	17.3	4.37	
BMI[d] (kg/m^2)	28.9	5.26	
Parity (number of lived births)	1.37	1.15	-
0= expecting first child			25.1 (63)
1-2			61.0 (153)
≥3			13.9 (35)
Mother received WIC services in past 6 months[e,f], yes			75.7 (190)
Outcome Variables[g]			
Intention to exercise during pregnancy			
No intention			11.6 (29)
Moderate agreement			41.4 (104)
Strong Agreement			44.6 (112)
Pedometer STEPS, 7-day period	27,392	17,066	-
METs from 7-Day PAR	112.7	50.1	-
Predictor Variables[g]			
TPB, Attitude	4.1	.5	-
TPB, Subjective norm	4.6	.9	-
TPB, Perceived Behavioral Control	3.4	1.1	-
Moderator Variables[g]			
Social Support: Husband/Partner	2.5	1.0	-
Social Support: Mother/Woman who raised you	2.1	1.0	-
Social Support: Friends	1.9	.9	-

[a] Numbers may not add to total due to missing data; [b] SD = Standard deviation; [c] Among women born outside of the United States; [d] BMI=Body Mass Index; [e] Special Supplemental Nutrition Program for Women, Infants and Children; [f] Includes those MOMs participants eligible only during pregnancy and delivery due to legal status; [g] Strongly Disagree=1 to Strongly Agree=5.

mother/woman who raised you or friends (2.1 and 1.9, respectively). All answer options for predictor and moderator variables were based on a Likert scale (Strongly disagree=1, Strongly agree=5), where a higher value signified a more positive Attitude, Social Norm, PBC, and social support toward PA intention and behavior.

Table 2.3 shows results from the multinomial logistic regression analyses fitted to test Hypothesis 1 (Attitude, Social Norm and PBC predict PA Intention). To facilitate interpretation of results, PA intention was categorized in three levels: **No PA-intention**, Moderate agreement with planning to exercise for 30 minutes for at least five days a week during pregnancy **(Moderate PA-intention);** and Strong agreement with planning to exercise for 30 minutes for at least five days a week during pregnancy **(Strong PA-Intention)**. Strong PA-intention was the referent category. Specifically, Attitude and PBC were significantly associated with PA intention. Results shows that the odds of having No PA-intention or Moderate PA-intention were significantly associated with Attitude and PBC toward PA during pregnancy. Specifically, the adjusted odds for Attitude in relation to No PA-intention were OR=0.02 (95% CI(0.00, 0.10), *p*-value=.000). For a one-unit increase in positive Attitude toward PA, a participant is 98% less likely to have No PA-intention to plan to exercise for 30 minutes for at least five days a week during pregnancy, relative to those with a Strong PA-intention, while controlling for other TPB constructs (SN and PBC) and confounders (age, health, gestational age, BMI and parity).

Moreover, the adjusted odds of having a positive Attitude in relation to Moderate PA-intention were OR=0.08 (95%CI (0.03, 0.22), *p*-value=.000), compared to Strong PA-intention, given that all other predictor and control variables are held constant. Hence, for a one-unit increase in positive Attitude toward PA, a participant is 92% less likely to have a Moderate PA-intention to plan to exercise for 30 minutes for at least five days a week during pregnancy, compared to those with a Strong PA-intention, when holding all other variables constant. To assess the association between Attitude and Strong PA-intention, I contrasted this association utilizing No PA-intention as referent category. The odds ratio for this association showed a significant association between Attitude and Strong PA-intention (OR=12.11, 95% CI (4.28, 17.23), *p*-value=.000). indicating that one-unit increase in positive Attitude toward PA is associated with a 12.11 increase in the odds of reporting a Strong PA-intention, compared to No PA-intention, given that all other predictor and control variables are held constant. In other

words, with a one-unit increase of positive Attitude toward PA, participants were 12.11 times more likely to strongly agree to plan to exercise for 30 minutes for at least five days a week during pregnancy, rather than not agreeing, when all other variables were held constant.

Table 2.3 Main Effects of Theory of Planned Behavior Constructs on Physical Activity Intention of Pregnant Women of Mexican Origin. Healthy MOMs Study, 2004 – 2006

	No PA-Intention[b]			Moderate PA-Intention[b]			Strong PA-Intention [c]		
Model 1	**OR**	**95% CI**	***p***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***p***
Theory of Planned Behavior constructs [a]									
Attitude	**0.02**	**(0.01, 0,10)**	**.000**	**0.08**	**(0.03, 0.22)**	**.000**	**12.11**	**(4.28, 17.23)**	**.000**
Subjective norm	0.80	(0.46, 1.39)	.43	1.02	(0.69, 1.51)	.93	0.98	(0.67, 1.47)	.96
Perceived behavioral control	**0.33**	**(0.17, 0.61)**	**.001**	0.94	(0.71, 1.25)	.67	**3.23**	**(1.68, 6.23)**	**.000**

Multinomial Regression Analyses; OR, odds ratio; CI, confidence interval.

[a] TPB constructs jointly regressed on PA intention, adjusted by age (years), health (1=poor, 5=excellent), gestational age(weeks), Body Mass Index, and education (years).

[b] Strong PA-Intention, referent category.

[c] No PA-intention, referent category.

The adjusted odds ratios for **Subjective Norm** in relation to 1) No PA-intention and 2) Moderate PA-intention were $OR_{SN\text{-}1}$= 0.80 (95% CI (0.46, 1.39), *p*-value =.43) and $OR_{SN\text{-}2}$= 1.02 (95% CI (0.69, 1.51), *p*-value =.93), respectively, relative to Strong PA-intention, while controlling for other TPB constructs (Attitude and PBC) and confounders (age, health, gestational age, BMI and parity). However, none of these ORs were statistically significant.

The adjusted odds ratios for the associations between **PBC** and 1) No PA-intention and 2) Moderate PA-intention were OR_1=0.33 (95% CI (0.17, 0.61), p-value=.001), and OR_2=0.94 (95% CI (0.72, 1.25), p-value=.672), compared to Strong PA-intention, respectively. The OR_1 indicates that for a one-unit increase in perceived behavioral control toward physical activity, a study participant is 67% significantly less likely to have No PA-intention, compared to those with a Strong PA-intention, while controlling for other TPB constructs (Attitude and SN) and confounders (age, health, gestational age, BMI and parity). The OR_2 for PBC in relation to Moderate PA-intention was not statistically significant. To assess the association between PBC and Strong PA-intention, I also contrasted this association utilizing No PA-intention as referent category. The odds ratio for this association showed a significant association between PBC and Strong PA-intention (OR=3.23, 95% CI (1.68, 6.23), *p*-value=.000). indicating that one-unit

increase in PBC toward PA is associated with a 3.23 increase in the odds of reporting a Strong PA-intention, compared to No PA-intention, given that all other predictor and control variables are held constant. Hence, with a one-unit increase of positive Attitude toward PA, participants were 3.23 times more likely to strongly agree to plan to exercise for 30 minutes for at least five days a week during pregnancy, rather than not agreeing, when all other variables were held constant.

Table 2.4 shows results from linear regression models fitted to test Hypothesis 2, that PA-intention was associated with PA behavior, using two different outcome measures (STEPS and METS). After adjusting for confounders, associations between Moderate PA-intention and STEPS (B=0.54, SE=3.93, *p*-value= .89) were in the expected direction, but not statistically significant. Similarly, Strong PA-intention was positively associated with STEPS (B= 0.62, SE=3.88, p-value= .87), but again not statistically significant. Similarly, after adjusting for confounders, Moderate PA-intention was associated with METS (B=18.69, SE=11.50, *p*-value= .11) in the expected direction, but this association did not reach statistical significance. Likewise, Strong PA-intention was positively associated with STEPS (B= 22.35, SE=11.45, p-value= .06), but this association was marginally significant.

Table 2.4 PA Intention Regressed on PA behavior (STEPS or METS)[a]. Healthy MOMs Study, 2004 - 2006

	STEPS[b]			METS[c]		
	B	**SE**	***P***	**B**	**SE**	***p***
Intercept	26.83	3.45	.000	42.06	33.33	.21
No PA-intention (Reference)	-			-		
Moderate PA-intention	0.54	3.93	.89	18.69	11.50	.11
Strong PA-intention	0.62	3.87	.87	22.35	11.45	.06

[a] Results from Linear Regression Analyses[a] adjusted by participants' age (years), health (1=poor, 5=excellent), Body mass index; gestational age (weeks), parity, education (years).
[b] Pedometer steps collected over a 7-day period; in thousands.
[c] METS, Metabolic Equivalent Task; obtained from 7-Day Physical Activity Recall Questionnaire.

Results from multinomial regression models testing Hypothesis 3 that social support (from husband, mother/woman who raised you or friend) moderates the relationship between PBC and PA intention are shown in **Table 2.5**. Social Support from either source did not moderate the association between PBC and any level of PA intention (No PA-intention and Moderate PA-intention; Strong PA-intention was used as referent category). ORs for interaction

terms measuring moderating effects of different sources of social support on the association between PBC and No PA-intention were PBC*SS-HUB (OR=1.22, 95% CI(0.94, 1.58), p-value=.13); PBC*SS-MOTHER (OR=1.05, 95% CI(0.78, 1.42), p-value=.75); and PBC*SS-FRIEND (OR=1.03, 95%CI (0.82, 1.43), p-value=.58), compared with Strong PA-intention and adjusting for confounders, but none of them was statistically significant. Likewise, ORs for interaction terms assessing moderating effects of social support on the association between PBC and Moderate PA-intention, relative to Strong PA-intention, were PBC*SS-HUB (OR=0.96, 95% CI(0.86, 1.08), p-value=.50); PBC*SS-MOTHER (OR=1.07, 95% CI(0.95, 1.22), p-value=.28); and PBC*SS-FRIEND (OR=0.94, 95%CI (0.82, 1.07), p-value=.35), but not statistically significant.

It is important to mention that I also analyzed the main effects of social support on PA Intention by fitting multinomial regression models where the outcome measure was PA Intention; predictor variables were Social Support (one source at the time) and adjusting for TPB constructs (Attitude, Social Norm, PBC) and confounders (see Table 2.5). From the three social support sources, none of the associations between social support and PA intention was statistically significant.

Table 2.5 Main and Moderating Effects of Social Support on the Association of Perceived Behavioral Control and Physical Activity Intention of Pregnant Women of Mexican Origin. Healthy MOMs Study, 2004 – 2006

	No PA-Intention [c]			Moderate PA-Intention [c]		
	OR	**95% CI**	***P***	**OR**	**95% CI**	***P***
Main Effects of Social Support [a]						
SS-Husband/partner (SS-HUB)	1.50	(0.84, 2.68)	.17	0.93	(0.66, 1.31)	.67
SS-Mother (SS-MOTHER)	1.12	(0.57, 2.29)	.74	1.25	(0.86, 1.82)	.24
SS-Friends (SS-FRIEND)	1.03	(0.57, 1.87)	.91	0.84	(0.58, 1.22)	.36
Moderating Effects of Social Support (Interaction PBC*SS) [b]						
PBC*SS-HUB	1.22	(0.94, 1.58)	.13	0.96	(0.86, 1.08)	.49
PBC*SS-MOTHER	1.05	(0.78, 1.42)	.75	1.07	(0.95, 1.21)	.28
PBC-FRIENDS	1.08	(0.82, 1.43)	.58	0.94	(0.82, 1.07)	.35

Multinomial Regression Analyses

[a] Sources of social support regressed one at a time on PA intention, adjusted by TPB constructs (Attitude, SN, PBC), and age (years), health (1=poor, 5=excellent), gestational age(weeks), Body Mass Index, and education (years).

[b] PBC-SS Interaction terms regressed one at a time on PA intention, adjusted by TPB constructs (Attitude, SN, PBC) and its respective social support source, and age (years), health (1=poor, 5=excellent), gestational age(weeks), Body Mass Index and education (years).

[c] Strong PA-Intention, referent category.

Moreover, I also examined the main effect of perceived behavioral support on PA behaviors. Linear regression models showed no significant associations between PBC and PA (results not showed). Hence, no significant associations were observed for associations between PBC and STEPS, or METS, adjusting for confounders.

For Hypothesis 4 (Social support moderates the relationship between PBC and PA behavior), linear regression analyses were fitted to examine the moderating effect of social support on the associations between PBC and PA behavior (pedometer STEPS or METS), by including social support measures from each source as well as an interaction term from each of them and PBC (PBC*SS-HUB or PBC*SS-MOTHER or PBC*SS-FRIEND). Overall, based on these results, I am unable to reject the null hypothesis of no moderation effect of Social Support from any source on the association between PBC and PA behavior (STEPS or METS). Results are shown in **Table 2.6.**

Table 2.6. Adjusted Moderating Effects of Different Sources of Social Support on the Association Between Perceived Behavioral Control and PA Behavior (STEPS and METS) of Women of Mexican Origin during Pregnancy. Healthy MOMs Study.

	STEPS [a]						METS [b]					
	Model 4.1.1		Model 4.1.2		Model 4.1.3		Model 4.2.1		Model 4.2.2		Model 4.2.3	
	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*
Intercept	33.82 (15.72)	.03	22.66 (17.67)	.15	27.58 (15.76)	.08	18.83 (41.87)	.65	50.41 (44.28)	.20	50.21 (44.24)	.26
Perceived behavioral control (PBC)	-1.85 (3.30)	.58	0.50 (3.33)	.88	2.59 (2.98)	.39	14.04 (8.97)	.12	-4.10 (8.31)	.62	-4.02 (8.31)	.63
Sources of Social Support (SS)												
SS-Husband/partner	-1.28 (3.55)	.72					12.13 (9.57)	.21				
SS-Mother/woman who raised you			1.78(4.47)	.69							0.64 (10.89)	.95
SS-Friends					3.82 (4.05)	.35			0.52 (10.90)	.96		
Interaction Terms												
PBC*SS-HUB	.72 (1.22)	.56					-3.64 (3.30)	.27				
PBC*SS-MOTHER			0.41 (1.55)	.99					4.03 (3.80)	.29		
PBC-SS-FRIENDS					-1.22 (1.55)	.99					3.98 (3.80)	.30

All linear regression models were adjusted by age (years), health (1=poor, 5=excellent), gestational age(weeks), Body Mass Index and education (years)

[a] Pedometer steps collected during a 7-day period.

[b] Metabolic Equivalent Task units obtained from the 7-Day Physical Activity Recall questionnaire.

Table 2.7 Adjusted Main Effects of Different Sources of Social Support on Physical Activity Behavior (METS) of Mexican Women of Mexican Origin during Pregnancy[a]. Healthy MOMs Study, 2004 – 2006

	METS[b]					
	B (SE)	***p***	**B (SE)**	***p***	**B (SE)**	***P***
Intercept	43.21 (35.56)	.23	31.02 (40.28)	.44	47.49 (37.28)	.20
PBC	4.79 (3.15)	.13	3.84 (3.59)	.29	3.60 (3.27)	.27
Social Support [c]						
SS-Husband/partner	2.37 (3.64)	.52				
SS-Mother			**11.31 (3.86)**	**.004**		
SS-Friends					5.94 (4.05)	.14

[a] Linear regression models
[b] METS, Metabolic Equivalent Task; obtained from 7-Day Physical Activity Recall Questionnaire.
[c] Each source of social support was independently regressed on PA while controlling for PBC and participants' age (years), health (1=poor, 5=excellent), Body mass index; gestational age (weeks), parity, education (years).

Table 2.7 shows the main effect of social support on PA behavior. The predictor variable was social support (with support from husband, mother and friends entered in separate models), controlling for PBC and confounders (results not shown). Based on these analyses, social support from the mother/woman who raised you and PA (METS) was statistically significant (β=11.31, SE=3.86, p-value=0.004). Sources of social support from husband/partner and friends were not significantly associated with STEPS (results not showed) or METS. In the discussion section, I address this finding in detail.

VII. Discussion

In this study, I examined the performance of **(1)** theory of Planned Behavior constructs (Attitude, Subjective Norm and Perceived Behavioral Control) in predicting PA intention; **(2)** PA intention predicting PA behavior; **(3)** Perceived Behavioral Control (PBC) in predicting PA behavior; **(4)** moderating effect of social support on the association between PBC and PA intention; and **(5)** moderating effect of social support on the association between PBC and PA behavior among pregnant WMO in Detroit, MI. This study yielded several findings. First, I found statistically significant associations between Attitude and PBC, and PA intention (level of agreement to plan to exercise during pregnancy). Second, the associations between PA intention and both PA behavior measures were not significant. Third, PBC was not associated with PA behavior. Fourth, Social Support did not moderate the association between PBC and PA

intention nor PA behavior, although social support from mother was significantly associated with physical activity measured as METS. I discuss each of these findings below.

7.1. Theory of Planned Behavior Constructs and PA Intention and PA Behavior

The Theory of Planned Behavior (TPB) (Ajzen, 1985), has been widely used to understand physical activity intention and physical activity behavior (Ajzen, 1985). In the PA domain, PA intention (the TPB's main outcome construct), is understood as the level of motivation a person may have to engage in PA (Ajzen, 1991). Contributing to the motivation levels a person may have to engage in PA, are the person's own attitude (evaluation of advantages and disadvantages of engaging in PA), subjective norm (approval/opinion of significant other(s) toward PA), and perceived behavioral control (PBC, assessment of ease or difficulty of engaging in physical activity (Ajzen, 1991). Moreover, according to the TPB, PA intention is typically the strongest predictor of PA behavior (Ajzen, 1991). In this cross-sectional study, I assessed the TPB performance in predicting PA intention and PA behavior. The TPB would suggest that A pregnant WMO in Detroit, MI would be said to have a strong motivation to engage in PA (PA intention) if she assessed that the advantages/benefits of PA surpass the disadvantages (positive Attitude), believed that her significant other thinks/approves that she should engage in it (Social Norm), and has a strong perception of control over her ability to engage in PA during pregnancy (PBC). A strong motivation to engage in PA (PA intention) would be theorized to lead to actual PA behavior, where PA intention was expressed as levels of agreement (moderate and strong) to plan to exercise for at least 30 minutes for five days a week during pregnancy and PA behavior was measured by pedometer steps and METS from the 7-DAY PAR questionnaire.

My study findings partially support the hypothesis (H1) that Attitude, Social Norm and perceived behavioral control measures were associated with physical activity Intention among pregnant WMO in Detroit, MI. Two of these measures, Attitude and perceived behavioral control, were significantly associated with PA intention. These findings are consistent with studies that have found statistically significant associations between Attitude and PBC, and PA intention during pregnancy among Latina women (Black et al., 2007), and NHW women (Symons Downs & Hausenblas, 2003; Hausenblas et al., 2008).

The remaining TPB measure, Subjective Norm (the opinion/approval of others) was not significantly associated with PA intention within this sample of pregnant WMO. This finding is consistent with those reported by Downs et al. (2003), Hausenblas et al. (2004 and 2008), and Black et al. (2007). More recently, in a review of the literature of PA behaviors during pregnancy, Thompson et al. (2017) reported that only one of three quantitative studies guided by the TPB reported Subjective Norm as a significant predictor of PA intention. Similarly, Harrison et al (2018), in a meta-analysis of PA during pregnancy, reported a weak association between Subjective Norm and PA intention. In contrast, a study of PA intention and PA behavior among Taiwanese pregnant women, Lee et al (2016) reported that Subjective Norm was a strong predictor of PA (Lee et al., 2016). In their discussion about why subjective norm was significantly associated with PA intention and PA behavior, these researchers attributed it to cultural and normative beliefs, as Subjective Norm reflects the influence of family members' and friends' viewpoints related to PA during pregnancy. Moreover, they concluded that their results were likely influenced by their sample's ethnic and cultural background.

This study's finding regarding the non-significant association between Subjective Norm and PA intention among pregnant women of Mexican origin may be of particular interest given that a robust body of qualitative research has consistently identified cultural beliefs and social norms to strongly influence PA intentions and PA behaviors among pregnant Latina women (Kieffer et al., 2002; Larsen et al., 2013a; Lynch et al., 2012; Thornton et al., 2006). For example, Familism, a traditionally important sociocultural descriptor used to characterize minority women from Latin-American countries (Austin et al., 2013), is frequently mentioned in PA-related research among pregnant WMO and other Latina women (Tovar et al., 2010). This sociocultural factor, which describes gendered-roles for women as family caretakers, and men as the breadwinners within the household (Austin et al., 2013), has consistently been identified as one of the main factors in qualitative and quantitative studies examining PA levels among pregnant WMO and other Latina women (Austin et al., 2013; Downs et al., 2012; Thornton et al., 2006). Manifestations of familism, such as WMO putting the needs of their family members before theirs, having limited time due to their responsibilities taking care of children and homes, and/or the need for approval from family members, have been commonly identified as barriers to engage in PA during pregnancy (Evenson, Moos, Carrier, & Siega-Riz, 2009). Moreover, these sociocultural and normative beliefs have informed the Subjective Norm construct in this study.

Yet, I did not find significant evidence to support that the Subjective Norm measure was associated with PA intention nor PA behavior, which in this sample of pregnant WMO, one could expect to be culturally as well as socially embedded. Findings reported here join results reported elsewhere (above) that do not provide support for this hypothesis. Further research is needed to determine whether there may be less influence of subjective norm on exercise behavior among WMO.

Findings of this study did not support the hypothesis (H2) that PA intention was positively associated with PA behavior. Even though associations between PA intention and PA behavior were in the expected direction these associations were not statistically significant. These study findings are consistent with those of only one study that examined the performance of PA intention in predicting PA among NHW women (H. A. Hausenblas & Symons Downs, 2004). These results contrast with several other studies that found a significant association between PA intention and PA behavior in two studies with predominantly NHW populations. For example, in a previous study, Downs and Hausenblas (2003) reported a statistically significant association between PA intention and PA behavior from a cross-sectional study conducted with mostly NHW women during their first trimester of pregnancy (Symons Downs & Hausenblas, 2003). In a later study, Hausenblass (2008) reported that PA intention was statistically significant predictor of PA behavior and accounted for 6% of the variance for PA behavior from a sample of NHW pregnant women. Even though these findings provide evidence to suggest that PA Intention is a strong predictor of PA behavior during pregnancy (Gaston & Cramp, 2011; Thompson et al., 2017), there is a growing agreement among researchers that a disconnect between the women's intention about PA and their PA behavior exists (Harrison et al., 2018; Hausenblas & Symons Downs, 2004). This growing agreement about weak association between PA intention and PA behavior is strengthened when factors additional to PA intention may influence PA behavior, such as socioeconomic status, education, and social support (Larsen et al., 2013a).

7.2 Performance of Social Support Moderating Associations between PBC and PA Intention

This study did not provide statistically significant evidence that social support from any source (husband/partner, mother/woman who raised you, or friends) positively moderated the

relationships between PBC and PA intention (H3). The moderating effect of social support was measured separately for each one of the three different sources.

Because of the lack of quantitative studies examining social support as a moderator of the associations between perceived behavioral control and PA intention, it is not possible to compare this finding with others. In this study, one possible explanation of why none of the sources of social support (husband/partner, mother/woman who raised you or friends) moderated the effect of perceived behavioral control on physical activity intention is that perceptions of emotional or informational social support may have been embedded in the Attitude, Subjective Norms and/or perceived behavioral control measures used to predict PA intention. For example, one item used in the shaping of the PBC measure was "I can exercise regularly even if my partner, friends or family don't approve." This item may denote different levels of disapproval from each family member, or that at least one of the family members may approve the behavior. To minimize this, I fitted additional multinomial regression models that included PA intention as the outcome variable, and only PBC and social support as predictor variables (adjusting for confounders). Each source of social support was included in the model separately as well as its corresponding interaction item. Yet, no statistically significant social support moderating effects were observed for any of the identified sources (results not shown).

7.3 Social Support Moderating Associations between PBC and PA Behavior

My final study findings relate to hypothesis 4, that social support from any source (husband/partner, mother/woman who raised you, friend) positively moderates the association between perceived behavioral control and physical activity behavior (STEPS or METS). Several linear regression analyses were fitted to assess these moderating effects, but no significant results were obtained for any of the sources of social support to reject the null hypothesis that these moderating effects were not different from zero. This was the case for each of the analyses conducted with each measure of PA behavior (STEPS or METS).

When examining the potential main effect of social support on PA behavior, associations between PA behavior (measured as METS) and social support from mother/woman who raised you was statistically significantly associated with PA behavior (METS). These findings are consistent with findings reported in both qualitative and quantitative studies of PA conducted

among pregnant Latinas (Chasan-Taber et al., 2014; Thornton et al., 2006). For example, Larsen et al (2013) systematically reviewed over 25 studies on PA among nonpregnant Latinas and Latinos and found that social support was described as an important motivator and salient factor predicting PA (Larsen et al., 2013a). Moreover, the majority of the studies included in this review reported statistically significant positive correlations of increased PA and PA-specific social support among Latina women, although these results did not specify any sources of social support (e.g. husband/partner, mother/woman who raised you, or friends) (Larsen et al., 2013a).

Other sources of social support examined in this dissertation study were social support from husband/partner and friends, but results did not show significant main effects on physical activity (results not shown). This finding is inconsistent with what has been reported in other studies. For example, Thornton et al. (2006) conducted a qualitative study on the influence of social support and PA behavior among pregnant Latinas (mostly of Mexican descendent). In this study, many participants said they would engage in physical activity *IF* their husband/partner would exercise with them or helped with home chores and/or childcare. In fact, one important difference between Thornton et al. findings from her qualitative study and my findings about social support and PA behavior is that social support from mother/woman who raised you, not husband/partner, was associated with PA behavior. Interestingly, and not surprisingly, data from my study indicate that perceived social support from husband/partner were higher (mean=2.5, SD=1) than from mother/woman who raised you (mean=2.1, SD=1). A possible explanation for this finding is that for PA behavior to be achieved among this sample of pregnant WMO, sources of instrumental social support (e.g., help with childcare or house chores, companionship) would be more important, which also may be more readily available from mothers or other female relatives frequently living in the same house or nearby, rather than support provided by husbands/partners. Thus, when pregnant women are motivated to engage in PA, they may draw more heavily on the amount of instrumental social support they anticipate from their close female relatives than on the support they may receive from their husbands/partners. Further empirical research should be conducted to test this conjecture.

VIII. Study Limitations

This study has several limitations. First, measures of several key predictor variables were based on one item (e.g., Subjective Norms and PA intention). This approach may reduce the reliability of the measures. Future research should use multiple-item scales for each of the key TPB constructs as well as social support. Second, even though this study provides important information on what sources of social support may be more important to support PA behavior among this sample of pregnant WMO in Detroit, it does not address what type(s) of social support (informational, material, emotional) are significantly associated to PA behavior. Third, although PA behavior measures included two sources of data (pedometer data and 7-DAY PAR), a significant amount of missing data was observed in both sources, which required that the data were imputed. Moreover, comparing these two PA measures (one objective and one subjective) was not feasible, thus the correlation between pedometer data and PA (e.g., walking), measured by the 7-DAY PAR is uncertain. A strength is that these two sources of data were collected for the same time period and that pedometer STEPS was an objective measure. Fourth, this cross-sectional dissertation study was conducted with baseline data, even though the Healthy MOMs study dataset could support future research of whether results from its behavioral intervention had an impact on TPB constructs including PA intention, and PA behavior later in pregnancy or early postpartum of pregnant women of Mexican origin in one urban community. Lastly, findings from this dissertation study may not be generalizable to other Latina subpopulations or other populations or settings.

IX. Study Strengths and Contributions

There are several strengths of this study. The strengths of this study include **(1)** Grounding in two theoretical models of behavioral change (theories of Planned Behavior and Theory of Social Support) and formative research; **(2)** Focus on a significantly under-represented minority population; **(3)** Use of two measures for physical activity. Data for these measures was collected with a pedometer (objective measure) and the 7-Day PAR questionnaire (self-reported data) in the same timeframe; **(4)** analysis of associations of TPB constructs and both physical activity intention and physical activity behavior; **(5)** Analysis of associations of three different

sources of social support and physical activity; and **(6)** Analysis of social support moderating effects on associations between physical activity and perceived behavioral control. Overall, this study contributes to the literature on the TPB and physical activity intention during pregnancy. Further, its contribution to our understanding of individual factors embedded in the TPB constructs, and interpersonal factors such as social support influencing PA behavior among women of Mexican origin during pregnancy is of unique importance.

This study contributes to the literature in different ways. First, it contributes to the small body of theory-informed, quantitative research on physical activity during pregnancy, as evidence has shown that using theory to design interventions can lead to improved effects compared to those without theory (Glanz et al. 2008). Second, it expands our understanding of what individual and interpersonal factors may influence physical activity intention and physical activity behavior among pregnant women of Mexican origin. This contribution is multi-faceted: **(1)** It provides insight into the effectiveness of the TPB constructs and social support to explain PA intention and behavior during pregnancy and the role that social support may have on PA levels throughout pregnancy; **(2)** It provides quantitative evidence to supplement the qualitative research conducted on this subpopulation and may help clarify what sources of social support may be more effective in enabling physical activity behaviors in this population; **(3)** Despite its cross-sectional nature and use of baseline data (prior to randomization and delivery of any intervention sessions), this study also suggests that other factors may be contributing to low levels of PA among pregnant women of Mexican origin, above and beyond individual and interpersonal factors, as physical activity intention was not associated with physical activity behavior in this sample (Courneya et al., 2000; Harrison et al., 2018; Hausenblas & Symons Downs, 2004; Thompson et al., 2017). Lastly, it highlights the need for further research on PA during pregnancy and the early postpartum. Given the increasing rates of metabolic diseases associated with inadequate PA levels during pregnancy greatly affecting women of Mexican origin, this study provides evidence that may inform behavioral interventions aimed at promoting physical activity during pregnancy.

IX. Conclusions

This study provides evidence on which theoretical constructs are useful tools for examining physical activity among pregnant women of Mexican origin. Findings from this study identified Attitude and Perceived Behavioral Control as specific TPB constructs were associated with physical activity intention of this unique subpopulation. These findings also highlight a weak association between PA intention and PA behavior, suggesting that, at least in this sample, factors beyond behavioral intention may influence behavior. Additionally, it provides insight about the main and moderating effects of three different sources of social support on physical activity intention and/or physical activity behavior. Overall, these findings not only may help clarify inconsistencies found in the literature regarding the TPB (PA intention in particular), and social support performance on physical activity during pregnancy, but it also calls attention to the need to investigate other factors that may be also influencing and/or interacting to deter physical activity among this subpopulation at increased risk of adverse maternal and infant outcomes associated with low levels of physical activity. These include, for example, characteristics of the neighborhoods or environments in which women may be seeking to be physically active that may influence activity (see Chapter 3).

Given the burden of preventable diseases (e.g., preeclampsia, gestational diabetes, type 2 diabetes) disproportionally affecting women of Mexican origin and other minority women during pregnancy, as well as their infants/children, better understanding of which and how TPB constructs and social support may predict PA intention and PA behavior during pregnancy is warranted.

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CHAPTER 3

Influence of the Perceived Neighborhood Social and Physical Environments on Physical Activity Levels of Pregnant Women of Mexican Origin in Detroit, MI

I. Introduction

Low levels of physical activity (PA) have been identified as a significant risk factor associated with detrimental health outcomes for both the mother and her child (Chasan-Taber et al., 2008; Kieffer et al., 2006). Low levels of PA have been associated with higher rates of preeclampsia and gestational diabetes mellitus (GDM) among pregnant women of Mexican origin when compared to any other racial/ethnic groups (Bao et al., 2014; Kim et al., 2013). In-utero exposure to high maternal glucose levels increases the risk of macrosomia (birth weight >4500 grs), shoulder dystocia, respiratory distress syndrome, and hypoglycemia, as well as increased risk of future obesity and type-2 diabetes mellitus (T2DM) during childhood and adulthood for the newborn (Austin et al., 2013; Crume et al., 2011; Giacco et al., 2014; Walker et al., 2009). According to the CDC (CDC, 2011), women who had GDM during pregnancy have a 20-50% higher likelihood of being diagnosed with T2DM within five to 10 years after that pregnancy, and a lifetime risk close to 80% (CDC, 2011).

For the last two decades, studies conducted in the United States have reported on several individual and interpersonal factors associated with low levels of PA among pregnant Puerto Rican and Central American women (Catalano, 2015; Chasan-Taber, 2012; Chasan-Taber et al., 2009). Several studies have examined psychosocial factors influencing PA patterns among pregnant WMO (Black et al., 2007; Kieffer et al., 2006; Kieffer et al., 2002; Lee et al., 2011; Thornton et al., 2006). For pregnant WMO, low socioeconomic status, negative attitudes and beliefs toward PA, as well as lack of social support to exercise during pregnancy, have been identified as among the most salient individual level factors associated with a risk of not

achieving recommended PA levels guidelines during pregnancy (Black et al., 2007; Chasan-Taber et al., 2007; Keller et al., 2014a; Thornton et al., 2006).

Solid evidence indicates that the places where people live are an important factor in driving and fostering health behaviors and outcomes (Blacksher & Lovasi, 2012; Blair et al., 1985; Fone et al., 2007; Link & Phelan, 1995; Schulz & Northridge, 2004). The social environment (e.g., perceived neighborhood safety), and physical environment (e.g., presence and physical condition of sidewalks or recreational areas, lighting, car traffic) in a given neighborhood are two salient aspects of place that are increasingly receiving attention. A growing body of evidence regarding their influence in shaping PA levels among neighborhood residents is described below.

A neighborhood's social environment may influence PA behavior by "shaping norms (e.g., neighbors walking or jogging around the block), enforcing patterns of social control (e.g., neighbors helping children in their way to school to cross streets), reducing or producing stress (e.g., noise), and providing or not providing environmental opportunities (crime) to exercise (e.g., placing constraints on individual choice)" (Institute of Medicine, 2003, p 45). The physical environment refers to the objective and perceived characteristics of the physical context in which persons spend their time (e.g., home, neighborhood, work), including aspects of urban design (e.g., presence and condition of streets, sidewalks), traffic density and speed, distance to and design of venues for physical activity (e.g., parks, playgrounds), and other neighborhood characteristics that promote recreational PA as well as active transport to work, school, or errands (Davison & Lawson, 2006).

During pregnancy, walking is the most common PA behavior recommended by the American College of Obstetrics and Gynecology (ACOG, 2015). As walking usually occurs outside the home (specially in low income neighborhoods), a pregnant woman's perceptions of the neighborhood social and built environments are likely to influence the type and extent of motivation and involvement in the activity (Roberts et al., 2018). Limitations of the social and physical environments have been found to influence individual perceptions that the neighborhood was not adequate for exercise (Giurgescu et al., 2012; Schulz et al., 2013). For example, concerns about neighborhood safety, limited access to safe and affordable spaces (social environment), and/or deteriorated sidewalks, parks or recreational areas, hazardous traffic conditions (physical environment) are some of the most common characteristics of the social and

physical environments deterring PA among pregnant women (Russo et al., 2015; Thornton et al., 2006), and non-pregnant women in low income minority neighborhoods (Kwarteng et al. 2013; Schulz et al., 2013; Schulz & Northridge, 2004).

Neighborhood socioeconomic conditions such as high poverty levels or demographic composition, have been associated with low PA levels during pregnancy among minority immigrant women (Keller et al., 2014b; Thompson et al., 2017). According to Lopez and colleagues (2015), WMO are more likely to live in low-income urban neighborhoods with higher crime, fewer resources and worse environmental conditions than non-Hispanic White (NHW) women (Lopez & Rohal, 2015).

Not surprisingly, pregnant WMO are less likely to meet the ACOG (2015) recommendations for 20 minutes/day of moderate PA , most days of the week, compared to their NHW counterparts (Chasan-Taber et al., 2008). Moreover, WMO are more likely than NHW and non-Hispanic Black (NHB) women to begin their pregnancies overweight or obese, and report lower levels of recreational PA before, during, and after their pregnancies (Austin et al., 2013; Golden et al., 2012; Keller et al., 2014a).

Despite our understanding of the negative impact that low levels of PA may have on birth outcomes and increased risk of illness later in life, little systematic research has been conducted about the influence that the social and physical environments, and neighborhood poverty may have in PA patterns among pregnant WMO living in economically disadvantaged places.

Past studies and health interventions have provided substantive information about environmental factors facilitating or deterring adequate levels of PA among minority communities (Foster & Giles-Corti, 2008; Kieffer et al., 2002; Kwarteng et al., 2013; McNeill, Kreuter, & Subramanian, 2006; Schulz et al., 2011). Neighborhood social cohesion (NSC), and low levels of crime and noise are among the most common features of the social environment reported as PA facilitators (Arcaya et al., 2016; Larsen et al., 2013). Green spaces, well-maintain parks and playgrounds, streets, sidewalks low traffic density have been identified as features of the physical environment positively associated with PA (Schulz et al., 2013; Unger et al., 2014).

Whether concern over less favorable social and physical environments at the neighborhood level prevents pregnant WMO from being physically active is still uncertain, as most quantitative studies have not included pregnant women as research participants. Indeed,

our understanding of the influence environmental factors may have on PA patterns among minority pregnant women is limited (for exceptions, see (Kieffer et al., 2002; Laraia et al., 2007; and Mudd & Evenson, 2015). Even less is known about how those influences affect PA patterns of WMO in low income neighborhoods.

Further research aimed at extending our understanding of PA levels among pregnant WMO requires consideration of the environmental characteristics of the neighborhoods where they live, such as (a) the neighborhood socioeconomic conditions (poverty level); (b) the social environment (social cohesion, safety conditions); as well as (c) the physical environment (presence and physical condition of sidewalks, streets, and recreational areas, car/truck traffic). To date, no studies of which I am aware have examined associations between neighborhood poverty and pregnant WMO's physical levels. Studies of the independent and joint contributions of perceived neighborhood environmental characteristics to physical activity levels of this at-risk population as well as their possible moderating effects on associations between neighborhood poverty and PA among pregnant WMO likely doesn't exist.

This dissertation chapter aims to fill this gap by focusing on the influence that perceived characteristics of the social and built environments, including the possibly moderating effects of neighborhood poverty, on the PA patterns of pregnant WMO in Detroit, MI. To my knowledge, I am the first to examine associations between neighborhood income and perceived characteristics of the social and physical environments, and PA levels of pregnant WMO. I hypothesize that, among pregnant WMO residing in low income neighborhoods in Detroit, MI: **(1)** Perceived characteristics of the social and physical environments are associated with PA levels; **(2)** Neighborhood poverty is associated with PA levels; and **(3)** Associations between neighborhood poverty and PA levels are moderated by perceptions of social and physical environments.

II. Theoretical Framework

The Social Ecological Model (SEM) is a theoretical framework that extends individual-based approaches that may attribute disease to individual-level factors, behaviors, and choices without an understanding of the context within which behaviors occur (Frohlich & Potvin, 2008). The SEM, described by Bronfenbrenner (1986) as a "Set of systems" (p.793), has been widely used in PA research (Bronfenbrenner & Morris, 2006). According to Sallis and colleagues

(2006), the SEM depicts multiple levels of influence on PA behavior, focuses on the interrelations between persons and their social and physical environments, and provides a framework for understanding how social determinants of PA behavior interact (Sallis et al., 2006). Specifically, the SEM acknowledges effects of biological, psychological, social, cultural, and organizational factors, as well as policy to disease causation (McLeroy et al., 1988). Moreover, the SEM allows the identification of more discrete factors that exist within a given level of influence, which in turn facilitates the operationalization and specification of the hypothesized effects of one model component on another (Bronfenbrenner & Morris, 2006; Suárez-Orozco et al., 2011).

Most interventions aiming to increase PA levels around the childbearing years tend to focus on personal and interpersonal factors, partly due to the complexity of addressing societal and neighborhood factors that contribute to health behaviors and health outcomes (Villalobos et al., 2016). Indeed, the rapidly emerging literature on how features of the social and physical environments may affect PA sheds light on the complex operationalization that takes place within and between different ecological levels of influence (Saelens, Sallis, Black, & Chen, 2003).

III. Literature Review

This section includes a review of the literature about the most salient factors associated with PA among pregnant Latina women predominantly of Mexican origin. It is organized to achieve these goals, **(1)** to reflect a social ecological view of PA behavior among pregnant WMO, and recognition of the interaction between persons and their environments; and **(2)** to describe how neighborhood socioeconomic conditions may have a direct effect on PA levels as these conditions are likely to influence perceptions of the social and physical environments among pregnant WMO in the exercise domain. In some cases, I referenced minority pregnant women because often studies of place and physical activity are conducted in multiethnic populations (e.g., NHB, Latino, and NHW populations).

Walking that happens outdoors (both transport and/or leisure) is highlighted through this review given that it is the recommended PA during pregnancy (ACOG, 2015), and it is also the most common type of PA among low income minority communities (Langer, 2018).

3.1. Societal Factors Associated with Neighborhood Socioeconomic Conditions

3.1.1. Racial Discrimination

The effects of racial or ethnic discrimination on differential access to economic, educational, or social resources have been documented at the neighborhood level (Keller et al., 2009; Lopez & Rohal, 2015; Schulz et al., 2008). Among Latinos in the US, people of Mexican origin and Puerto Ricans are more likely to face socioeconomic barriers to residing in more desirable neighborhoods than other Hispanic groups (Keller et al., 2014). Moreover, there is evidence that low income neighborhoods with higher concentrations of NHB and Latinos have higher levels of environmental pollutants compared to NHW neighborhoods of similar socioeconomic conditions (Schulz et al., 2008). In a series of studies conducted in Detroit, MI, Schulz and colleagues (2008) found that high levels of poverty at the neighborhood level were particularly associated with low levels of PA among NHB and Latino communities (Kwarteng et al., 2013).

Associations between neighborhood sociodemographic conditions and physical conditions of the neighborhood has been consistently described in the literature (Kwarteng et al., 2013; Schulz et al., 2008; Toker, 2015). For example, Toker (2015) reported that poorly maintained sidewalks and streets are more common in neighborhoods with low socioeconomic conditions than in neighborhoods with high socioeconomic levels. Similarly, strong evidence suggests that neighborhood socioeconomic status may directly influence PA levels and may partially influence these levels by means of the characteristics of the social and physical environments (Zhang, Zyphur, & Preacher, 2008). Moreover, in a study of the associations between characteristics of the physical infrastructure and PA in a multiethnic urban community, physical deterioration of sidewalks was particularly correlated with low levels of PA, followed in importance by physical condition of streets, parks and playgrounds (Schulz et al., 2013).

Another salient factor associated with less than ideal perceptions of the neighborhood among minority communities is that Mexican communities and other Spanish-speaking neighborhoods are more likely to experience more astringent social environments at the neighborhood and extended levels, due to federal immigration policies (Barcenas et al., 2007; Torres & Wallace, 2013). Enforcement of immigration policies are often carried out based on

racial and ethnic profiling, targeting neighborhoods where Spanish-speaking residents may live (Abrego & Menjívar, 2011). Immigration raids in workplaces and Latino neighborhoods, which usually end on detention and deportation of neighborhood residents, tremendously contribute to exacerbate a social climate of fear and anxiety that may inhibit outdoor PA (Abrego & Menjívar, 2011; Larsen et al., 2013).

As a result of place-related factors, residents may experience their neighborhoods differently, depending on their race or ethnicity, and SES within the US (Farley et al., 1994). It is not surprising that WMO may live in economically disadvantaged neighborhoods as they hold the highest poverty rates, the highest uninsured rates, the lowest educational attainment rates, and lowest political representation of any other Hispanic subgroup in the US (APA, 2012; Link & McKinlay, 2009).

3.2. Characteristics of the Neighborhood social and physical Environments associated with PA among minority and low-income communities in the US

3.2.1 Characteristics of the Neighborhood Physical Environment

Among the most reported features of the physical environment associated with PA are the presence and physical conditions of sidewalks, streets, vacant lots (Kwarteng et al., 2013; Schulz et al., 2013), access and condition of recreational facilities (Giles-Corti & Donovan, 2002), and car/truck traffic (Lee et al., 2012) as they may play an important role on facilitating or deterring PA in Latino neighborhoods. As in many minority communities, low income Latino neighborhoods often lack well maintained sidewalks, trails, parks, playgrounds, or other recreational spaces for exercise (Lynch et al., 2012). In other neighborhoods where recreational facilities exist, low income Latino residents are more likely to lack the financial means to afford entrance fees to indoor recreational facilities, compared to NHW residents (Perez et al., 2016). In other cases, even in neighborhoods where there is free access to recreational facilities, these facilities may not be well maintained, making PA difficult (Giles-Corti & Donovan, 2002).

Concerns about unsafe traffic conditions for PA are disproportionately present among Latino and other ethnic minorities living in low income neighborhoods (Kwarteng et al., 2013; Larsen et al., 2015) as they suffer a higher rate of pedestrian rates and traffic accidents than non-Latino whites (Larsen, 2014).

3.2.2. Social Environment: Social Cohesion and Neighborhood Safety

Characteristics of the social environment at the community and neighborhood levels comprise power/race relations including social discrimination and fear of deportation (Larsen et al., 2013b), social, human and health services (Parra-Medina & Messias, 2011), cultural and religious practices (McNeill et al., 2006b), and beliefs or perceptions about place and community (Kwarteng et al., 2013; Schulz et al., 2013), among others. A salient dimension of the social environment associated with PA is neighborhood social cohesion (NSC), which is conceptualized as a "collective characteristic measured by the levels of trust, norms of reciprocity and the formation of strong social bonds within the local social structure" (Fone et al., 2007)(p339). Moreover, NSC is characterized by the presence of trusting relationships among individuals who do not share familial ties (Fone et al., 2007). Living in a neighborhood where there is trust among residents has been shown to support informal interpersonal connections that have positive health benefits by promoting healthy behaviors (Alegria et al., 2007).

A robust body of research has identified relationships between NSC and positive health outcomes in communities and neighborhoods (Cradock et al., 2009; Echeverría et al., 2008; Kawachi & Berkman, 2000; Rios et al., 2011). For example, NSC often leads to behaviors such as monitoring children's playgrounds or organizing walking groups (Foster & Giles-Corti, 2008). Similarly, neighborhood residents who reported strong perceptions of social cohesion (e.g., exercise companionship) are more likely to enjoy a buffering effect against disorder, fear, and mistrust. Further, NSC can emphasize the need for a shared sense of belonging to place or place attachment, a psychosocial factor that may play an important role among immigrants who have recently arrived to the US as traditional health behaviors may be maintained or challenged in their new places of settlement (Mielke & Gorman, 2015). The protective effect of NSC may help immigrant residents keep a sense of belonging and self-esteem through strong formal or informal social networks, and the existence of opportunities versus social exclusion within the community (Kawachi & Berkman, 2000).

NSC may reduce the deleterious effect of neighborhood income deprivation or other neighborhood level stressors, especially among communities where residents share cultural values and social ties (Rios et al., 2011). In ethnic minority communities, neighborhood

socioeconomic conditions are often higher poverty rates and less residential stability than those observed in Non-Hispanic white neighborhoods (Schulz et al., 2008; Zhang et al., 2008). Yet, perceptions of the neighborhood social and physical environments may modify the effect that neighborhood poverty may have on PA levels. For example, in low income neighborhoods, high poverty levels may be translated into low real estate values and low collection of city taxes, which may cause or exacerbate the lack or irregularity of public services (e.g., trash removal) (Perez et al., 2016). In neighborhoods in which city services are absent and/or insufficient (Lee et al., 2012) neighborhoods may be transformed into trash/garbage collection sites. Despite the likelihood that residents and non-residents alike may use these trashed sites as an alternative to dispose their garbage given the absence of garbage pick-up services, often affected neighborhood residents implement strategies to prevent trash build ups such as neighborhood watch groups that not only help to keep their neighborhood safe but also clean (Fennelly & Perry, 2018). Strong social ties among neighborhood residents may enable collective action to prevent and/or act upon neighborhood deterioration. Keeping the neighborhood's sidewalks, streets, vacant houses and empty lots free of trash may enhance one's perceptions that the neighborhood is adequate for physical activity (Banay et al., 2017; Roberts et al., 2018; Schulz et al., 2013).

These associations suggest that indicators of NSC might be particularly useful in explaining PA behaviors at the neighborhood level. Yet, little is known about the influence that social cohesion at the neighborhood level may have on PA levels of pregnant WMO in the US. Further research is needed to examine the influence that social cohesion at the neighborhood level may have on PA among this at-risk population.

Another significant feature of the social environment associated with low levels of PA among pregnant WMO is neighborhood safety (Kieffer et al., 2002; Thornton et al., 2006). For example, Sallis et al (2002) reported that twice as many individuals of low socioeconomic status (31%) cited worry about safety (e.g., fear of being assaulted) as a barrier to PA in low income neighborhoods than did moderate-income respondents (15%) living in more affluent neighborhoods. Similarly, Larsen (2013) reported that Hispanic women cited being afraid to leave their homes because of safety issues, and that neighborhood safety was their main environmental barrier to PA. Further, Kieffer et al (2002) reported concerns about neighborhood safety among pregnant and postpartum WMO in Detroit, MI.

It has been discussed that PA may be more affected by one's perceptions of the social and physical environments compared to more objective neighborhood assessments, in which trained observers systematically document aspects of the neighborhood environment (Zenk et al., 2007). These perceptions may curb or promote PA given that most activity occurs within the bounds of families, neighborhoods, and communities (Foster & Giles-Corti, 2008; Schulz et al., 2008; Zhang et al., 2008). Further, less than ideal perceptions of the quantity and quality of elements of the social and physical environments by neighborhood residents have been correlated with low levels of PA (Foster & Giles-Corti, 2008).

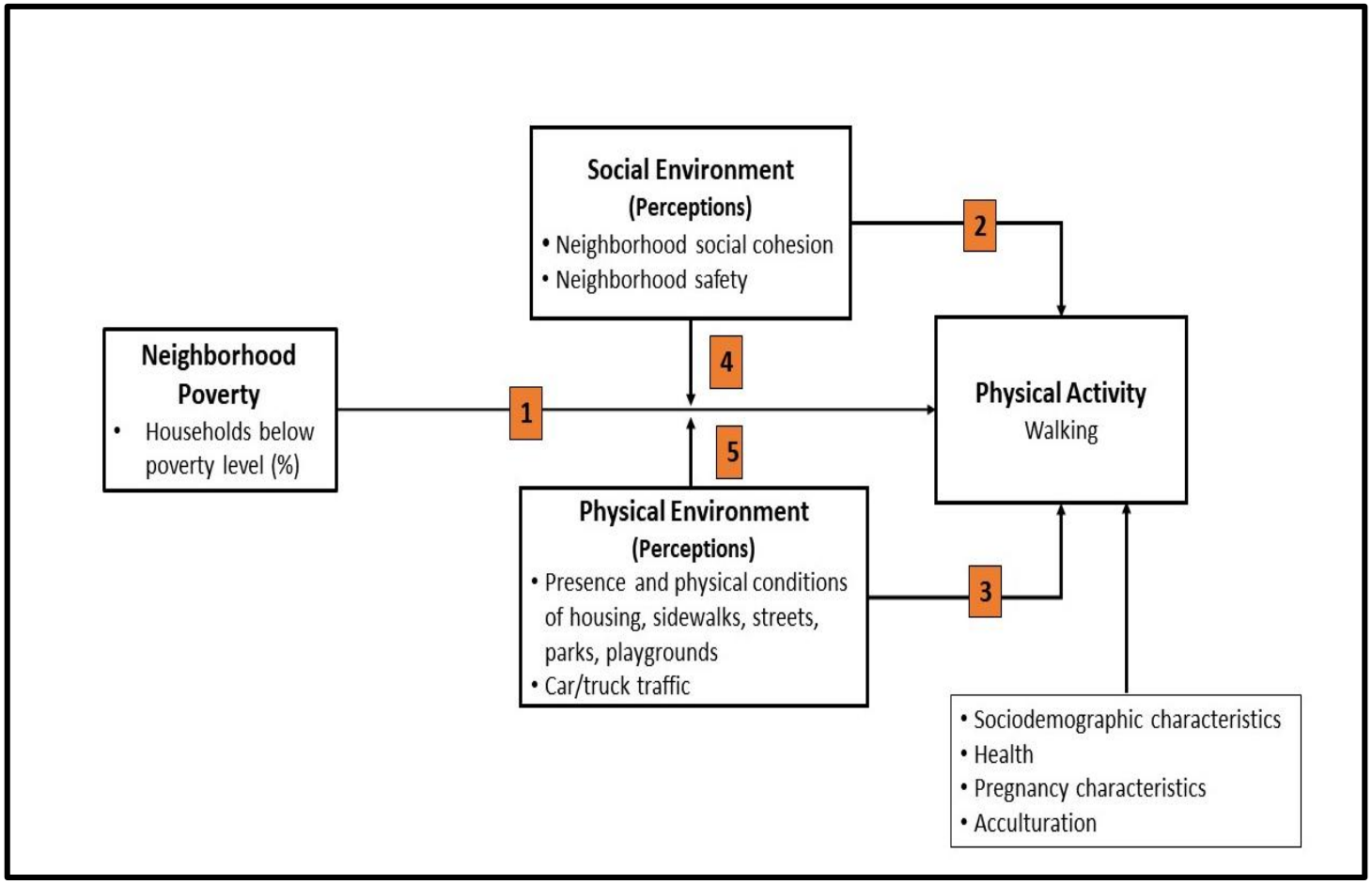
Even though there is significant research addressing neighborhood-level factors associated with PA in communities of color, there is limited research on the associations between neighborhood-level factors and PA among pregnant WMO.

IV. Conceptual Model

The conceptual model for this study reflects a socioecological view of health, and recognition of the interaction between persons and their environments. Most research on PA patterns of WMO of childbearing age tends to focus on personal and interpersonal factors, partly due to the complexity of addressing societal, social and physical environmental factors that may contribute to health behaviors and health outcomes (Villalobos et al., 2016).

This conceptual model identifies two levels of influence on physical activity of pregnant WMO in Detroit, MI. These two levels of influence affect physical activity directly and indirectly. One level is the neighborhood economic conditions and the other level refers to perceptions of the social and physical environments affecting physical activity levels of pregnant women of Mexican origin in Detroit, MI. **Figure 3.1** depicts these levels of influence: Arrow 1 indicates the direct influence that neighborhood poverty may have on physical activity (e.g., outdoor walking), outside of the hypothesized social and physical environmental characteristics, as well as individual and interpersonal factors. Arrows 2 and 3 indicate the potential associations that the neighborhood social and physical environments have on curbing or promoting PA among pregnant WMO above and beyond individual and interpersonal factors. Arrows 4 and 5 indicate the moderating effects that perceptions of characteristics of the social and physical environments may have on the association between neighborhood poverty and outdoor walking.

Figure 3.1. Conceptual Model of Associations between Neighborhood Poverty, Social and Physical Environments, and Physical Activity of Pregnant Women of Mexican Origin in Detroit, MI



V. Specific Aim and Hypotheses

The purpose of this study was to examine the relationship between neighborhood economic conditions as well as the influence that perceived characteristics of the neighborhood social environment (social cohesion, safety), and physical environment (access and physical condition of sidewalks, playgrounds, housing, car/truck traffic), may have on PA levels of pregnant WMO living in Detroit, MI. Further, this study proposed that perceived neighborhood environmental characteristics may moderate associations between neighborhood economic conditions (percentage poverty levels) and PA.

This research aims to contribute to a growing body of literature by expanding our understanding of the influence that neighborhood social and physical environments may have on PA levels of pregnant WMO. Better understanding of what and how characteristics of the social and physical environments influence physical activity during pregnancy may lead to design health promotion interventions that: **a)** Help pregnant WMO engage in PA within their environments in ways that modify the effect of those barriers, and/or surmount barriers in ways to improve their PA, and **b)** Advocate for change in those environments to reduce barriers to PA among pregnant WMO in the US.

Hypothesis 1:

Neighborhood poverty levels are associated with physical activity levels among pregnant women of Mexican origin in Detroit, MI.

1.1. The percentage of households below the poverty level as reported at the 2000 US Census tract level will be inversely associated with PA.

Hypothesis 2:

Perceived characteristics of the social and physical environments at the neighborhood level are associated with physical activity levels among pregnant women of Mexican origin in Detroit, MI.

2.1. Perceptions of the physical environment (physical condition of sidewalks, streets, housing, vacant lots, presence and physical conditions of parks and playgrounds, and traffic density) will be associated with physical activity.

2.1.1. Self-reported good physical conditions of sidewalks, streets, vacant lots will be positively associated with PA.

2.1.2. Self-reported presence and good physical conditions of neighborhood parks and playgrounds (neighborhood walkability) will be positively associated with PA.

2.1.3. Self-reported concerns of heavy car or truck traffic will be inversely associated with PA.

2.2. Perceptions of the social environment (e.g., social cohesion and neighborhood safety) will be associated with physical activity.

2.2.1. Self-reported neighborhood social cohesion will be positively associated with PA.

2.2.2. Self-reported concerns about neighborhood safety will be inversely associated with PA.

2.3. Perceptions of the social and physical environments will be concurrently associated with physical activity.

2.3.1 Self-reported perceptions of the neighborhood social and physical environments will be jointly associated with PA.

Hypothesis 3:

Associations between neighborhood poverty levels and physical activity among pregnant women of Mexican origin in Detroit, MI are moderated by perceptions of the neighborhood social and physical environments.

3.1. Positive perceptions of neighborhood safety will modify associations between neighborhood poverty and PA.

VI. Methods

6.1. Data Source and Sample Design

Healthy Mothers on the Move (Healthy MOMs), was a prospective randomized controlled clinical trial designed to reduce risk factors for obesity and type 2 diabetes among

Latina pregnant and early postpartum women in Detroit, MI (Kieffer et al., 2013; Kieffer et al., 2013; Kieffer et al., 2014). The Healthy MOMs study was planned, developed, and conducted between 2004 and 2006 in Southwest Detroit, MI using a community-based participatory research (CBPR) approach in affiliation with the Detroit Community Academic Urban Research Center and the REACH Detroit Partnership (Israel et al., 1998; Kieffer et al., 2013; Thornton et al., 2006). Pregnant Latina women were eligible to participate in this study if they were at least 18 years old; a resident of Southwest Detroit; less than 20 weeks pregnant; had a pre-gravid BMI ≥18.9; and ability to read in English or Spanish. Exclusion criteria included multiple gestation, a diagnosis of type 1 or type 2 diabetes; incompetent cervix/cerclage; irregular thyroid function; cardiac, vascular or pulmonary disease; or serious physical or mental illness or condition that would substantially interfere with participation in, or completion of, the entire intervention (Kieffer et al., 2013; Kieffer et al., 2014).

This dissertation chapter was conducted using baseline data collected from pregnant Healthy MOMs participants recruited from community health organizations such as the Community Health and Social Services (CHASS) Center, and the Supplemental Nutrition Program for Women, Infants and Children (WIC) Program offices, other community organizations and community settings, for participation in the Healthy MOMs study. 278 pregnant Latina women were recruited, consented, and completed baseline data collection. From this group of Healthy MOMs enrolled participants, the 251 participants who self-reported as Mexican immigrant and Mexican American were included for analysis in this study. Baseline data were obtained during two face-to-face interviews conducted by a trained bilingual interviewer. The interviewer administered the study questionnaires at CHASS, or at the participant's home, in the participant's language of preference (Spanish or English) and recorded her answers. During the first baseline visit, participants answered the Healthy MOMs questionnaires; received a pedometer (Omron HJ-720ITC, Shelton, CT) and detailed information on how to use it. In addition, participants received instructions about the 7-Day Physical Activity Recall questionnaire (7-Day PAR). Seven days later, the second baseline interview took place. During this second interview, the interviewer collected pedometer data (number of steps walked per week) and administered the 7-Day PAR questionnaire. Each study participant received monetary incentives at each data collection point for their participation in the study (Kieffer et al., 2013; Kieffer et al., 2014).

6.2. Sociodemographic Characteristics of Southwest Detroit: Zip Codes 48209, 48210, and 48216

Most study participants (93.3%, n=251) reported living in zip codes 48209 and 48210 in Southwest Detroit, which along with zip code 48216, comprise the area currently known as Mexican Town. The origins of Mexican Town can be traced back to the beginning in the 20th century, when the first Mexican immigrants came to Detroit seeking economic opportunities that the automobile industry offered (Rodríguez, 2011). Between the 1920's and 1940's, many more Mexican immigrants settled in the area where Bagley and Vernor streets are currently located (Rodríguez, 2011). Most of the housing units still remaining in Mexican Town were built by the end of the 1930's. By the beginning of the 1950's, approximately 17,000 US-born Mexican Americans and 12,000 Mexican-born immigrants lived in Mexican Town (Gordillo, 2010). In the 1970's and 1980's, Mexican Town residents experienced some economic disinvestment, loss of the auto industry jobs and outmigration.

The study data were collected between 2004 and 2006, when Detroit was, once again, experiencing the negative effects of a national economic recession, jolted by the terrorist attacks of 9/11/01 (Acharya & Richardson, 2009). By 2010, the estimated population for Mexican Town (zip code 48209) was approximately 31,017, a 20% decrease from the year 2000 (US Census Bureau, 2010). Salient sociodemographic characteristics of residents in this zip code were:

Table 3.0 Sociodemographic Characteristics of Population in Zip Code 48209.

	2000 US Census	**2010 US Census**
Population	38,895 (100%)	31,017 (100%)
Mexican origin	17,951 (46.2%)	18,610 (57%)
Median Age	27 years	27.8 years
< High school completion	56.2%	48.8
>High school completion	43.7%	51.0%
Median Household income ($)	$25,546	$22,856
Foreign-born residents	28.8%	26.0%
People that speak English not well/not at all	30.5%	29.14%
Poverty rate[a]%	40.1%	42.5%

[a]Percentage of households under poverty line.

6.3. Measures

Data were derived from Healthy MOMs individual questionnaires, the 7-day PAR questionnaire, and pedometer steps obtained at baseline. After data cleaning and checking original sources for missing and out-of-range values, the following outcome, independent, and control variables were selected:

6.3.1 Outcome Measures

Pedometer Steps per week (STEPS). This continuous variable was obtained from the raw data (total number of steps in a seven-day period) provided from the pedometer and assessed for normality of distribution and outliers. One measure of <100 steps per week at baseline was excluded from analysis. Then, the raw number of steps per week for each participant was divided by 1,000 (e.g., number of steps per week in thousands) to facilitate interpretation of results. This STEPS measure was obtained at baseline.

7-Day Physical Activity Recall (METS). The 7-Day Physical Activity Recall questionnaire (Sallis et al., 1985) was used to collect self-reported information about the number of minutes per day participants spent on moderate, hard, and very hard intensity PA, such as aerobic exercise, work-related activities, gardening, walking, and recreation. It is important to note that only items related to PA from the PAR questionnaire were used to calculate the PA score. Following specific instructions available for adequate use of the 7-Day PAR (Sallis et al., 1985), a participant's total number of minutes spent per day at each PA category were summed to estimate the total number of minutes per week spent in moderate, hard, and very hard intensity PA. Then, the total number of minutes per week for each PA intensity category was converted to hours (minutes/60). Further, the amount of hours spent on each PA intensity category per week was multiplied by an estimate of Metabolic Equivalent of Task (MET) energy expenditure units assigned to each category of activity. According to the PA intensity category (moderate, hard, very hard), an estimated amount of energy (one MET unit is estimated as 1MET= 1 kcal kg/hour) spent on engaging in PA, was utilized as follows: one hour of moderate intensity PA = 4 METs, one hour of hard intensity PA= 6 METs, and one hour of very hard intensity PA = 10

METs (Sallis et al., 1985). Finally, METS obtained from each PA category were summed to obtain this continuous variable total number of METs per week per participant at baseline.

6.3.2 Predictor Measures

Neighborhood Social Cohesion (NSC). An adapted version of the Neighborhood Cohesion Index (Robinson & Wilkinson, 1995) was used to create this continuous variable. Seven items were selected including 'People in the neighborhood share the same values as me,' 'I feel at home in this neighborhood,' 'People in this neighborhood generally know each other', 'I expect to live in this neighborhood for a long time.' These seven items were selected because they captured the collective-level attribute of sense of community as it existed specifically in a neighborhood context. Each item consists of a five-point response scale, where 'strong agreement' scores as 1 and 'strong disagreement' as 5. These items were reversed coded so that a high score indicated high levels of social cohesion. Each participant's sense of neighborhood social cohesion was reported as the mean score for the seven items. (Cronbach alpha=.838)

Neighborhood Safety (NS). One item of the Neighborhood Safety Stress Measure (Villalobos et al., 2016) was used. The question 'How often do you worry about your safety in your neighborhood?' reports frequency of safety concerns, where response categories ranged from always=1, never=5. This variable was reverse coded for the analyses reported here, such that a high score indicated high levels of concern about neighborhood safety**.**

Heavy Car/Truck Traffic (TRAFFIC): One item from the Healthy MOMs baseline questionnaire was used for this variable. Levels of agreement to the statement 'There is heavy car or truck traffic in my neighborhood' were used. Originally, response categories ranged from always=1, never=5. After examining the proportions of answers and noting that no study participants chose 'Nor agree/disagree' (response category 3), original values 1 and 2 were used to create a binary variable: 1= Yes heavy car/truck traffic; 0=otherwise (original values 4 and 5).

Neighborhood Environment Walkability (NEW) (Saelens et al., 2003). Two items of the NEW scale were selected to construct this continuous variable. These items assessed the overall condition of the built infrastructure conducive to outdoor walking such as the physical condition of neighborhood streets, sidewalks, housing and vacant lots. Specific items were 'Streets, sidewalks, and vacant lots are generally well maintained, and 'Houses in my neighborhood are

well maintained.' Responses were scaled from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating a more favorable value of the environmental characteristic. Each participant's sense of neighborhood walkability was reported as the mean score for the two items. (Cronbach's alpha= 0.61)

Presence/Condition of parks, and playgrounds (PARKS). A continuous variable was constructed to indicate the presence and physical condition of parks and playgrounds. Answers from two items were used: 'Are there any parks or playgrounds within a half a mile from your home? (1=Yes, 0=No), and 'How would you rate the condition of these parks or playgrounds overall? (1= Poor, 2= Regular, 3= Good, 4= Excellent). Values from these two items were combined to create a composite variable: 1=No parks/playgrounds present in the neighborhood; 2= Parks/playgrounds are of poor condition; 3= Parks/playgrounds are of regular condition; 4= Parks/playgrounds are of good condition; and 5=Parks/playgrounds are of excellent condition.

Neighborhood Poverty (POVERTY). Neighborhood poverty was a continuous measure reflecting the percent of households below the federal poverty line in the tract in which each respondent lived. Census tract poverty level was derived from the 2000 US Census data (Bishaw & Iceland, 2003).

6.3.3. Control Measures

Participant's age (AGE). This continuous variable represents the participant's age at baseline in years.

Education Attainment (EDU). Answers to 'What was the last highest grade of school you completed?' were used to construct this continuous variable to estimate the total number of years of education completed in years at baseline.

Country where last educated (COUNTRY-EDU). A baseline dichotomous variable to indicate where a participant received her highest level of education, Mexico=1, Otherwise=0 (reference).

Years in the US after arrival (AGE-US). A baseline continuous variable that measures the number of years that MOMs participants have been in the US after arriving to the US if born in Mexico or another country.

Marital Status (MARITAL). A dichotomous variable, 1=Married or living with partner, 0=Otherwise (reference), at baseline.

Employment status (EMPLOYMENT). A dichotomous variable was created to record respondents' employment status since becoming pregnant with current pregnancy. 1=Employed=1, Otherwise=0 (reference), at baseline.

Household income (INCOME). A baseline categorical variable referring participant's pre-tax household income from all sources, where 1= Under $20,000, 2=Between $20,000 and $30,000, and 3= Over $30,000 (reference).

Number of people living in household (PEOPLE). This categorical variable included the total number of children of any age and adults living in the same home. It was constructed as follows: 1=1-2 (reference), 2=3-4, 3= ≥5 people, at baseline.

Self-Rated Health (HEALTH). This baseline continuous variable used data from MOMs participants reporting their overall health using a 5-point Likert scale (1=Poor, 5=Excellent).

Body Mass Index (BMI). This baseline continuous variable includes data about body weight (kg) and height (m) used to calculate BMI= kg/m^2 (Index, 2015; Keys, Fidanza, Karvonen, Kimura, & Taylor, 1972).

Number of deliveries (PARITY). This continuous variable was based on the total number of deliveries a MOMs participant had at baseline.

Gestational age (GEST-AGE). This continuous variable corresponds to the estimated age of the current pregnancy in weeks at baseline, using all available self-reported and clinical data reviewed by the Healthy MOMs perinatologist using a standard procedure to provide the most accurate estimate.

6.4. Preparing Data for Analysis

A series of diagnostic analyses (correlation matrices and estimation of Variance Inflation Factors (O'brien, 2007)) were conducted on outcome, predictor, and control measures to identify potential issues of multicollinearity prior to proceeding with regression model fitting for all outcome measures (results not shown) (Alin, 2010). Multicollinearity was identified among predictor (neighborhood social cohesion and neighborhood safety) and control measures (country where last educated, years living in the US, number of people in the household, marital status, employment status). To address multicollinearity among predictors, I fitted regression models that only included one predictor measure at a time. Multicollinearity issues between control

measures ‘country where last educated’, ‘years living in the US’, ‘marital status’, and ‘number of people in the household’ were addressed by excluding these control measures from the analyses.

Missing data was not deemed as a serious issue for any of the outcome, predictor, or control measures except for data on number of pedometer steps (17.5% missing), and household income (approximately 30% of cases were reported as ‘Don’t know’). To assess if missing data for pedometer STEPS and household income were missing at random, a series of Pearson’s and Fisher’s Chi square tests were performed using demographic data (e.g., age, health, education, marital status, parity) and dummy variables (1=any steps, 0=missing data, or 1=any income, 0=no data) before proceeding to impute the missing data. None of the demographic measures was significantly associated with pedometer STEPS or household income missing data. A *p*-value of .05 was deemed as statistically significant (tests not shown). Multivariate imputation by chained equations (MICE) was utilized to address missing data (Raghunathan et al., 2001; Royston & White, 2011). The MICE approach creates multiple imputations, as opposed to single imputations, and accounts for the statistical uncertainty in the imputations. This approach is very flexible and can handle variables of varying types as well as complexities such as survey skip patterns (Azur, Stuart, Frangakis, & Leaf, 2011). All multiple imputations and regression analyses were performed in STATA (version 15.1; Stata-Corp, College Station, TX, USA) with the procedures mi and regress, respectively (Royston & White, 2011).

6.5. Statistical Analysis

To test Hypothesis 1 (neighborhood poverty is inversely associated with PA), I fitted two linear regression models. I regressed the value of the percentage of households below the federal poverty level at the census tract level for each participant (2000 US census tract poverty) , on each of the two measures of PA (STEPS or METS) adjusting for study participant’s self-reported age, health, gestational age, and education.

Model 1.1:

$$\textbf{STEPS} = \beta o + \boldsymbol{\beta_1}\textbf{POVERTY} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$$

Model 1.2:

$$\textbf{METS} = \beta o + \boldsymbol{\beta_1}\textbf{POVERTY} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$$

For Hypothesis 2, that characteristics of the social and physical environments are associated with PA, I fitted two sets of linear regression models (one each for each dependent variable, STEPS and METS) to test the main effects of each neighborhood environmental characteristic on physical activity. In each set, the following independent variables were entered individually: Neighborhood social cohesion (NSC), neighborhood safety (NS), neighborhood environment walkability (NEW), presence and condition of parks (PARKS), and Heavy car/truck traffic (TRAFFIC). All linear regression models were adjusted for participants' age at baseline (AGE), health (HEALTH), BMI, gestational age (GEST-AGE) and level of education (EDU). After running models with each independent variable individually, I also ran two models to test their joint effects by regressing all independent variables together on each PA measure (STEPS or METS).

SET 2.1 = STEPS

Model 2.1.1:

STEPS = $\beta o + \mathbf{\beta_1 NSC} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.1.2:

STEPS = $\beta o + \mathbf{\beta_1 NS} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.1.3:

STEPS = $\beta o + \mathbf{\beta_1 NEW} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.1.4:

STEPS = $\beta o + \mathbf{\beta_1 PARKS} + V\beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.1.5:

STEPS = $\beta o + \mathbf{\beta_1 TRAFFIC} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.1.6:

STEPS = $\beta o + \mathbf{\beta_1 POVERTY + \beta_2 NSC + \beta_3 NS + \beta_4 NEW + \beta_5 PARKS + \beta_6 TRAFFIC} + \beta_7 AGE + \beta_8 HEALTH + \beta_9 GEST\text{-}AGE + \beta_{10} EDU$

SET 2.2 = METS

Model 2.2.1:

METS = $\beta o + \mathbf{\beta_1 NSC} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.2.2:

METS = $\beta o + \mathbf{\beta_1 NS} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.2.3:

METS = $\beta o + \mathbf{\beta_1 NEW} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.2.4:

METS = $\beta o + \mathbf{\beta_1 PARKS} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.2.5:

METS = $\beta o + \mathbf{\beta_1 TRAFFIC} + \beta_2 AGE + \beta_3 HEALTH + \beta_4 GEST\text{-}AGE + \beta_5 EDU$

Model 2.2.6:

METS = $\beta o + \mathbf{\beta_1 POVERTY + \beta_2 NSC + \beta_3 NS + \beta_4 NEW + \beta_5 PARKS + \beta_6 TRAFFIC} + \beta_7 AGE + \beta_8 HEALTH + \beta_9 GEST\text{-}AGE + \beta_{10} EDU$

Lastly, to test Hypothesis 3 that states that characteristics of the social and physical environments moderate the association between neighborhood poverty and PA among pregnant WMO in Detroit, I followed recommendations by Aiken and West (1991) to create interaction terms to assess moderating effects. Interaction terms were created between neighborhood poverty and (1) neighborhood social cohesion (POVERTY*NSC), (2) neighborhood safety (POVERTY*NS), (3) neighborhood environment walkability (POVERTY*NEW), (4) presence and condition of parks and playgrounds (POVERTY*PARKS), and (5) neighborhood traffic (POVERTY*TRAFFIC). Then, I fitted two sets of linear regression models (one each for each outcome variable, STEPS and METS). In each set, I regressed the predictor (POVERTY) and each one of the characteristics of the social and physical environments along with their respective interaction term, on the outcome variable. All models were adjusted for participants' age, health, gestational age, and level of education at baseline.

SET 3.1 = STEPS

Model 3.1.1:

STEPS = $\beta o + \beta_1 NSC + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NSC} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.1.2:

STEPS = $\beta o + \beta_1 NS + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NS} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.1.3:

STEPS = $\beta o + \beta_1 NEW + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NEW} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.1.4:

STEPS = $\beta o + \beta_1 PARKS + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*PARKS} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.1.5:

STEPS = $\beta o + \beta_1 TRAFFIC + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*TRAFFIC} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

SET 3.2 = METS

Model 3.2.1:

METS = $\beta o + \beta_1 NSC + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NSC} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.2.2:

METS = $\beta o + \beta_1 NS + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NS} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.2.3:

METS = $\beta o + \beta_1 NEW + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*NEW} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.2.4:

METS = $\beta o + \beta_1 PARKS + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*PARKS} + \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

Model 3.2.5:

METS = $\beta o + \beta_1 TRAFFIC + \beta_2 POVERTY + \mathbf{\beta_3 POVERTY*TRAFFIC} + \beta\ \beta_4 AGE + \beta_5 HEALTH + \beta_6 GEST\text{-}AGE + \beta_7 EDU$

VII. Results

Demographic characteristics of the Healthy MOMs sample (n=251) are presented in **Table 3.1**. Overall, Healthy MOMs participants included in the study were 27.2 (SD=5.2) years old on average, most of them were born (97.2%) and educated in Mexico (87.6%); and had been living in the US for an average of 6.6 (SD=5.6) years. The number of years of formal education averaged 9.38 (SD=2.9) years, and only 27.5% of participants completed high school or higher (n=69). Over 78.1% participants reported good, very good or excellent health. Data available on household income (n=174) showed that more than 75% of households had an annual income less than $20,000, while 17.8% had an annual income between $20,000 and $30,000. Approximately 30% of household income data was missing.

Outcome measures averaged 27,400 STEPS and 112.6 METS. Proportions for predictor measures indicate that 57% of participants reported perceiving that there was heavy car/truck traffic in their neighborhoods, while only approximately 42% reported perceptions of being safe in their neighborhoods. Neighborhood poverty averaged 31% across the sample.

Table 3.1. Sample Characteristics and Outcome and Predictor Measures (n=251). Healthy MOMS Study. 2004 – 2006

Characteristics	Mean	SD	Min	Max	Percent (n)
Age, years	27.24	5.25	18	41	-
Education, years	9.32	2.95	0	16	-
Less than high school	-	-	-	-	72.2 (186)
High school or higher	-	-	-	-	27.5 (69)
Country educated, (1=Mex), % (n)	-	-	0	1	87.6 (220)
Number of people in the household	-	-	1	3	
1=1-2					10.8 (27)
2=3-4					61 (153)
3=5 or more					25.5 (64)
Country of origin (1=Mex), % (n)	-	-	0	1	97.2 (244)
Age at arrival in the United States, years	21.27	5.60	2	40	-
Years lived in the US, years	6.57	5.65	0	36	-
Occupation, homemaker (1=yes), % (n)	-	-	0	1	88.0 (221)
Household annual income (n=174)	-	-	-	-	-
1= < $10,000	-	-	-	-	35.1 (61)
2= $10,001 - $20,000	-	-	-	-	41.4 (72)
3= $20,001 - $30,000	-	-	-	-	17.8 (31)
4= >$ 30,000	-	-	-	-	5.7 (10)
Married, living with partner (1=yes), % (n)	-	-	0	1	59.8 (150)
Self-rated Health	2.92	.91	1	5	-
Poor/Fair, % (n)	-	-	-	-	19.9 (50)
Good, no. % (n)	-	-	-	-	53.4 (134)
Very Good/Excellent, % (n)	-	-	-	-	24.7 (62)
Gestational age, weeks	17.30	4.26	9	26	-
Body Mass Index (kg/m^2)	28.73	4.98	18	42	-
Parity, number	1.37	.84	0	6	-
Nullipara	-	-	-	-	25.1 (63)
Multipara	-	-	-	-	74.9 (188)
WIC participation (1=yes), % (n)	-	-	0	1	75.7 (190)
Outcome measures					
Pedometer STEPS (in thousands)	27.40	17.06	.386	80.40	-
METS, 7-Day PAR questionnaire	112.6	50.13	9	272	-
Predictor Measures					
Social Cohesion Scale	3.18	1.04	1	5	-
Neighborhood Safety, (1=yes)	-	-	0	1	41.8 (105)
Neighborhood heavy truck/car traffic (1=yes)	-	-	0	1	57.0 (143)
Neighborhood Environment Walkability	3.11	1.23	1	5	-
Neighborhood Parks presence and condition	2.16	.05	1	3	-
1=No parks	-	-	-	-	21.1 (53)
2=Parks of poor/regular condition					41.0 (103)
3=Parks of good/excellent condition					33.1 (83)
Neighborhood poverty (%)[a]	31.00	5.92	4.6	50.1	-

SD: Standard deviation; [a] Percentage of households under poverty line, 2000 US Census tracts.

Results from adjusted regression models fitted to test **Hypothesis 1** that the percentage of households under the poverty level as reported by the 2000 US Census tracts were associated

with PA, are reported in **Table 3.2, Model 1.1.** There was a positive association between neighborhood poverty and PA measured per thousand STEPS (B=.37, SE=.21, *p*-value=.075), after accounting for confounders (participants' age, self-reported health, gestational age, and educational attainment). While not statistically significant at the $p<0.05$ level, the positive trend shown in this model suggests that for each one percent increase in neighborhood poverty, the number of steps is expected to increase by 370 steps on average, while all other variables in the model are held constant.

Similarly, **Table 3.2, Models 2.1.1 to 2.1.5** report results from adjusted linear regression models fitted to test **Hypothesis 2** that characteristics of the neighborhood social and physical environments are associated with physical activity measured as pedometer STEPS. In each model I regressed one environmental characteristic at a time on physical activity (measured in thousand STEPS), adjusting for the participant's self-reported age, health, gestational age, and educational attainment. Models 2.1.1 and 2.1.2 show regression coefficients for neighborhood social cohesion (SNC) (β_{SNC}= 0.85, SE= 1.21, *p*-value=.481) and safety (NS) (β_{NS}= 2.26, SE= 2.56, *p*-value=.378) respectively. Associations between these characteristics of the social environment and PA trended in the expected direction but were not statistically significant at the $p<0.05$ level.

In contrast, neighborhood walkability (Model 2.1.3) (β_{NEW}= 3.08, SE= .98, *p*-value=.002) was significantly associated with STEPS per week. The adjusted regression coefficient for neighborhood walkability indicates that for each one-unit increase in perceived neighborhood walkability, physical activity is expected to increase by 3,080 steps on average, while all other variables (age, health, gestational age, and education) in the model remain constant. In other words, with each incremental one-unit improvement in perceptions of the physical condition of sidewalks and streets, one could expect an increase in the amount of walking by 3,081 steps on average. Similarly, neighborhood parks (the presence/condition of parks and playgrounds in the neighborhood) (Model 2.1.4) was significantly associated with PA (β_{PARKS}= 3.71, SE= 1.64, *p*-value=.025), indicating that each one-unit change in the presence or condition of parks and playgrounds was associated with an increase of 4,710 steps on average, while holding other variables constant.

As theorized, heavy car/truck traffic in the neighborhood ($\beta_{TRAFFIC}$= - 4.77, SE= 2.43, *p*-value=.051) was negatively associated with PA (in thousand STEPS) (Model 2.1.5). Study

participants who reported that there was heavy car/truck traffic in the neighborhood, took 4,770 fewer steps per week, on average, compared with participants whose do not perceive that there is heavy traffic in their neighborhood, while adjusting for participant's age, health, gestational age, and educational attainment.

Lastly, to test **Hypothesis 2.3** that neighborhood social and physical characteristics are concurrently associated with physical activity, I fitted the adjusted regression model 2.1.6 (Table 3.2) that included all neighborhood environmental characteristics together, which were regressed on PA (STEPS in thousands). Despite small changes in the regression coefficients for neighborhood walkability and presence/conditions of parks and playgrounds, they remained significantly and positively associated with PA. A large change in the regression coefficient for neighborhood social cohesion was noted in the joint effects regression model. The NSC regression coefficient changed from B=0.85 (SE=1.21, *p*-value=.481) when social cohesion was independently regressed on STEPS (main effect), to B=4.51 (SE=1.58, *p*-value=.005) when all other environmental characteristics were included in the model (joint effect).

Table 3.2 Physical Activity (STEPS[a]) Regressed on Characteristics of the Neighborhood Social and Physical Environments[b]. Healthy MOMs Study (n=251).

	Model 1.1		Model 2.1.1		Model 2.1.2		Model 2.1.3		Model 2.1.4		Model 2.1.5		Model 2.1.6	
	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*
Intercept	11.16 (11.81)	.34	18.42 (10.54)	.08	19.21 (10.39)	.07	10.57 (10.54)	.32	11.16 (11.81)	.34	23.49 (10.19)	.02	15.02 (12.68)	.238
Poverty[c] (%)	0.37 (0.21)	.08												
Neighborhood Social Environment														
Social Cohesion			.85 (1.21)	.48									**4.51 (1.58)**	**.005**
Safety (yes)					2.26 (2.56)	.38							3.61 (3.15)	.254
Neighborhood Physical Environment														
Walkability							**3.08 (.98)**	**.002**					**3.88 (1.16)**	**.001**
Parks									**3.71 (1.64)**	**.025**			**3.87 (1.62)**	**.018**
Car/truck traffic											-4.77(2.43)	.051	-3.60 (2.35)	.127

[a] **In thousands; controlled by age (years), health (1=poor, 5=excellent), gestational age(weeks), and education (years).**

Another noticeable change was observed with heavy car/truck traffic and its marginal association to STEPS. In the main effects model (2.1.5), the marginally significant regression coefficient was -4.77 (SE=2.42, *p*-value=.051); while in the joint effects model (2.1.6), the association between heavy car/truck traffic and STEPS was no longer significant (B=-3.60, SE=2.35, *p*-value=.127).

Together, the neighborhood social and physical characteristics (including neighborhood poverty rate), accounted for 22% of the variance in the regression model of joint associations, while controlling for confounders.

To test the study hypotheses utilizing METS as measure of PA, I fitted another set of adjusted regression models. Results obtained from these linear regression models fitted to assess main and joint effects of characteristics of the neighborhood social and physical environments on physical activity measured in METS are shown in **Table 3.3**.

To test **Hypothesis 1**, METS per week was regressed on neighborhood poverty and adjusted for control variables. The association between neighborhood poverty and METS was not statistically significant (adjusted β=.09, SE=.56, *p*-value= .878). Testing **Hypothesis 2** (neighborhood environmental characteristics are associated with physical activity) involved regressing one environmental characteristic at a time on the outcome measure METS, and adjusting for the participant's self-reported age, health, gestational age, and educational attainment. From the different regression models fitted to assess independent and joint effects of social and physical characteristics of the neighborhood on METS as the PA outcome measure, none of the models showed a statistically significant association between any of neighborhood environmental characteristics and PA. Yet, all regression coefficients showed that the directionality of associations was as expected, including a negative association between presence of heavy car/truck traffic in the neighborhood and PA (METS).

In addition, Table 3.3 shows results from the regression model fitted to test the joint effects of the neighborhood environmental characteristics on physical activity measured in METS (Model 2.2.6). In contrast to models run using STEPS as the dependent variable, after adjusting the model for confounders, none of the neighborhood characteristics was significantly associated with physical activity measured in METS.

Lastly, several regression models were fitted to test Hypothesis 3 that characteristics of the social and physical environments moderate the association between neighborhood poverty

and physical activity (STEPS or METS). Each environmental characteristic, along with the interaction term created to measure the moderating effect of such characteristic, were regressed on the outcome measure, adjusting for confounders (participant's age, health, gestational age, and education).

Table 3.3. Physical Activity (METS[a]) Regressed on Characteristics of the Neighborhood Social and Physical Environments[b]. Healthy MOMs Study (n=251).

	Model 1.2		Model 2.2.1		Model 2.2.2		Model 2.2.3		Model 2.2.4		Model 2.2.5		Model 2.2.6	
	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*	B(SE)	*p*
Intercept	40.4 (31.84)	.20	30.9 (29.05)	.29	41.76 (28.32)	.14	50.82 (29.39)	.09	42.37 (30.55)	.17	44.24 (27.99)	.16	32.22 (41.60)	.44
Neighborhood poverty[c]	0.09 (0.56)	.88											0.17 (0.60)	.78
Neighborhood Social Environment														
Social Cohesion			3.02 (3.30)	.36									3.48 (4.57)	.45
Safety (yes)					0.92 (6.89)	.89							9.02 (9.16)	.33
Neighborhood Physical Environment														
Walkability							2.44 (2.77)	.38					3.55 (3.49)	.31
Parks									1.00 (4.64)	.83			1.62 (4.73)	.73
Car/truck traffic (yes)											-3.75(6.68)	.57	-4.45 (6.99)	.53

[a]7-Day PAR questionnaire; [b]Adjusted by age (years), health (1=poor, 5=excellent), gestational age(weeks), and education (years); [c]2000 US Census tracks, % of households under poverty rate.

Results from regression models in which the outcome measure was pedometer STEPS (in thousands) indicate that only neighborhood safety moderated the association between neighborhood poverty and STEPS after adjusting for confounders (**Table 3.4**). The regression coefficient for the interaction item Safety*Poverty was statistically significant (β= 0.92, SE=.42, p-value=.028). Thus, at the same level of neighborhood poverty, study participants who perceived their neighborhoods to be safe would walk an additional 920 steps, compared to study participants living in neighborhoods at the same level of poverty who perceived their neighborhoods to be unsafe. None of the other neighborhood environmental characteristics modified associations between neighborhood poverty and PA measured as STEPS (Results not shown).

Table 3.4 Moderating Effect of Neighborhood Safety on the Association Between Neighborhood Poverty [a] and Physical activity (STEPS[b]). The Healthy MOMs Study. 2004 – 2006

	B	SE	β[c]	*p*
Intercept	27.4	13.67		.047
Neighborhood safety (1=yes)	30.44	13.23	.78	.021
Neighborhood poverty [a] (%)	-.87	.31	-.025	.006
Safety*Poverty	.92	.42	.771	.028

[a] Percentage of households under the poverty line based on 2000 US Census tracts; [b] In thousands; [c] Standardized regression coefficients; Regression model adjusted by participant's age, health, gestational age, and education level.

Regression models fitted to assess the moderating effects of the characteristics of the neighborhood social and physical environments on the relationship between neighborhood poverty and physical activity measured in METS, showed that none of the environmental characteristics had a moderating effect (results not shown).

VIII. Discussion

Based on the premise that neighborhood socioeconomic status and the neighborhood social and physical environments might help to explain level of physical activity (PA) during pregnancy, this dissertation chapter aimed at examining the independent and joint associations between of neighborhood poverty and characteristics of the neighborhood social and physical environments with PA. This dissertation chapter also examined whether social and physical

environmental characteristics moderated the theorized associations between neighborhood poverty and PA levels. Specifically, I assessed associations between neighborhood poverty and walking, the most common type of exercise recommended during pregnancy (ACOG, 2015). Moreover, I examined the independent effects of perceived neighborhood social cohesion and neighborhood safety (neighborhood social environment), as well as neighborhood walkability (presence/condition of sidewalks, streets, housing, and vacant lots), presence/condition of parks and playgrounds, and presence of heavy car/truck traffic (physical environment), on physical activity levels of pregnant women of Mexican origin in Detroit, MI. Lastly, I evaluated the moderating effect that both social and physical environments may have on the association between neighborhood poverty and physical activity.

Associations between neighborhood poverty and physical activity were in the expected direction but were not statistically significant. Several measures of neighborhood characteristics, including **(1)** presence and physical condition of sidewalks, streets and (walkability); **(2)** presence and physical condition of parks and playgrounds, and **(3)** neighborhood safety, were significantly associated with physical activity measured by pedometer STEPS and METS from the self-reported 7-Day PAR questionnaire. In models that include each neighborhood environmental measure independently, **(4)** neighborhood social cohesion and **(5)** heavy car/truck traffic were not significantly associated with PA using either STEPS or METS **(6)** However, this study found significant joint effects of neighborhood social cohesion, perceived neighborhood walkability, and presence/condition of parks and playgrounds on physical activity (STEPS). Further, I also found that **(7)** perceptions of neighborhood safety moderated the effect of neighborhood poverty on physical activity (STEPS). I discuss these findings in greater detail below.

8.1 Neighborhood Poverty

I sought to examine associations between neighborhood economic condition and physical activity among pregnant women of Mexican origin living in Southwest Detroit, where the average neighborhood poverty level was 31%, almost three times the poverty rate in the state of Michigan (10.5%) and over two times the federal poverty levels (11.3%) in the year 2000 (2000 US Census tracts). While the association between neighborhood poverty levels and physical

activity trended in the expected direction, these associations were not statistically significant. One potential explanation for this lack of a significant association may be that over 65% of participants were in 2000 Census tracts with over 30% poverty rates, while only 1.6% of them were in tracts with less than 16% poverty rate (e.g., Michigan's poverty rate). The limited range of poverty rates, and small proportion of study participants who lived in neighborhoods with lower poverty, may have limited the ability to test associations between neighborhood economic conditions and physical activity.

A solid body of research supports that neighborhood socioeconomic status significantly contributes to disparities in cardiovascular disease, type 2 diabetes, mental health conditions, among others (Diez-Roux et al., 2016; Saelens et al., 2003; Unger et al., 2014; Bosch & Sang, 2017; Zenk, Schulz, & Odoms-Young, 2009). The associations between physical activity and these health disparities are also well established (Roberts et al., 2018; Schulz et al., 2013; Bosch & Sang, 2017). For example, Boylan and Robert (2017) reported that low-income persons living in low income neighborhoods had higher prevalence of cardiovascular disease, compared to those low-income individuals with access to better-resourced neighborhoods. These authors argued that the lack of resources in the neighborhood that might support PA was a significant risk factor underlying this differential (Boylan & Robert, 2017). Similarly, Diez-Roux (2010) reported a negative association between neighborhood poverty and PA in a review of studies conducted as part of the Multi-ethnic Study of Atherosclerosis (MESA) (Diez Roux et al., 2010). Conversely, Ross et al. (2000) found that residents in disadvantaged neighborhoods were more likely to walk, despite reporting a fear of being victimized (Ross, 2000). This might be partially explained by the likelihood that low-income residents may not own a car nor have access to other means of transportation (Lee et al., 2012). Nonetheless, most studies on the effect of neighborhood poverty on PA have been done with non-pregnant women (Boylan & Robert, 2017; Hesketh & Evenson, 2016; Lee et al., 2012). For example, in a study of energy expenditure and physical activity among low income female residents in economically deprived neighborhoods, women reported more energy expenditure but less vigorous PA compared to women with higher income (Boylan & Robert, 2017). It is possible that women with lower household incomes may be expending calories in moderate PA that do not fit traditional definitions of vigorous exercise (i.e. going to the gym, or attending structured PA classes such as aerobics, swimming, etc.). I was able to identify only one quantitative study that examined

neighborhood socioeconomic status and PA during pregnancy (Laraia et al., 2007). Laraia and colleagues studied PA levels of mostly non-Hispanic Black pregnant women in low income neighborhoods (2007). Their findings that low income pregnant NHB women in poor neighborhoods were more likely to engage in PA than women with higher incomes are consistent with those reported in this study with WMO living in low to moderate income neighborhoods. Low income women who reside in neighborhoods with high poverty may engage in activities with higher energy expenditure from daily life activities, such as work and/or house chores such as housecleaning, laundry, walking to the store, walking their children to and from school, and climbing stairs among others (Kieffer et al., 2002; Larsen et al., 2013).

According to the US Census, a Census tract is a small geographic unit designed to be relatively a homogeneous unit with respect to population characteristics (education, income, occupation and non-White population), and living conditions at the time of establishment (Bishaw & Iceland, 2003). However, some researchers have objected to the assumption that the tract constitutes an appropriately sized spatial unit for measuring health outcomes where race or ethnicity may be an important factor, such as racial and/or ethnic segregation (B. A. Lee et al., 2008). Lee and colleagues argue that "This assumption obscures potential variation among regions (e.g., metropolitan areas) … because tract measures cannot distinguish regions in which the racial composition changes over short distances from those in which differences in composition occur between large subareas … and that the scale to which the census tract corresponds can in fact be ascertained, thanks to the standardized, stable nature of tracts." (p. 767) (Lee et al., 2008). In this dissertation chapter, the use of US Census tracts to examine the association between neighborhood poverty and physical activity may be problematic given the limited variability in the neighborhood poverty measure as most study participants lived in Census tracts with poverty rates between 31% and 40%. Moreover, the allocation of public resources that sustain outdoor physical activity (e.g., public safety, well maintained streets and sidewalks) is likely to be low in areas with high poverty rates. Future studies examining the influence of neighborhood economic conditions should be conducted with greater variation in census tract poverty rates within the sample.

Another finding relevant to this discussion is that perceptions of neighborhood safety moderated the association between neighborhood poverty and physical activity. I found that pregnant women of Mexican origin who lived in poor neighborhoods and perceived their

neighborhoods as unsafe were likely to walk less, while those living in poor neighborhoods who perceived their neighborhoods as safe walked more. I address this finding in more detail in section 8.3.2 below.

The findings reported here contribute to the limited literature on the effect of neighborhood poverty and PA levels during pregnancy. In addition, these findings also uniquely contribute to the literature of WMO during pregnancy. In my review of the literature, I located several qualitative studies suggesting a synergistic effect of neighborhood poverty on other neighborhood characteristics more likely to directly influence PA. For example, the effects of neighborhood poverty may be seen on the existence and/or the lack of, and condition of the built infrastructure (e.g., dilapidated sidewalks, streets, parks, etc.) and social environment (e.g., neighborhood safety and crime) that may inhibit physical activity among pregnant Latinas in low income neighborhoods (Chasan-Taber et al., 2008; Kieffer et al., 2002; Thornton et al., 2006). In a qualitative study of perspectives of low income pregnant and postpartum Latina women on physical activity and health, Kieffer and colleagues (2002) identified concerns about dilapidated sidewalks and heavy traffic among pregnant WMO as a barrier to physical activity (Kieffer et al., 2002). Similarly, Thornton et al., (2006) reported neighborhood safety as a barrier to engage in physical activity during pregnancy among women of Mexican origin living in poor neighborhoods. Thus, findings from this dissertation study confirm and extend the results of qualitative studies --with an objective PA measure-- regarding the direct and synergistic effects of neighborhood poverty on physical activity of pregnant women of Mexican origin in Detroit, MI.

8.2 Neighborhood Physical Environment

In this study, positive perceptions of the characteristics of the physical environment such as walkability (presence and physical condition of sidewalks, streets, vacant lots and housing) and presence and physical condition of parks and playgrounds were theorized to contribute to an atmosphere conducive to outdoor walking among pregnant WMO.

Regarding neighborhood walkability, I found that positive perceptions of neighborhood sidewalks, streets, housing, and vacant lots were independently and significantly associated with PA. This relationship remained significant after other neighborhood environmental

characteristics were added to the regression model and controlled for participant's age, health, gestational age, and education. In this regard, findings from this study are similar to those reported in the literature for multi-ethnic enclaves and non-pregnant Latina women (Kwarteng et al., 2013; A. Schulz et al., 2013; Schüz et al., 2017). For example, Larsen (2013) in a review of the literature of physical activity patterns among adult Latinos/Latinas, highlighted the influence of the physical infrastructure on PA (Larsen et al., 2013). These authors reported that negative perceptions that arise from deteriorated sidewalks, streets, housing were associated with low levels of physical activity of non-pregnant Latinas. Moreover, in a qualitative study of barriers, Kieffer and colleagues (2002) reported that nonexistent or deteriorated sidewalks, streets, burnt housing and littered vacant lots in the neighborhood were perceived as barriers to engage in outdoor walking among low income pregnant Latinas in Detroit, MI (Thornton et al., 2006). Another study examined associations between presence and physical conditions of sidewalks in low-income neighborhoods in Baltimore (Laraia et al., 2007). The authors reported that pregnant residents of neighborhoods in which a greater proportion of sidewalks were in good or excellent condition had higher levels of physical activity, compared to residents of neighborhoods with lower proportion of sidewalks in good or excellent conditions (Laraia et al., 2007). Findings from my study provide quantitative evidence to and extend the results of qualitative studies of neighborhood environmental characteristics and PA during pregnancy.

The presence and condition of parks (parks and playgrounds) in the neighborhood are thought to provide residents with communal spaces where they could not only exercise but build relationships and strengthen ties. In this study, I hypothesized that the presence of well-maintained parks and playgrounds located within a half a mile from the study's participant home had a positive influence on engaging in PA during pregnancy among pregnant women of Mexican origin. Findings reported here were consistent with this hypothesis. Regression models fitted to measure the main and joint effects of the presence and condition of parks on PA indicated positive significant associations between this neighborhood physical characteristic and PA. This finding is consistent with several reviews of the literature (Arcaya et al., 2016; Bosch & Sang, 2017) that reported associations between the presence of parks, playgrounds and other recreational facilities and PA among youth (3-18 years)(Ding et al., 2013), adults (Owen et al, 2004), and African American adults (Kramer and Hogue, 2009). Similarly, Laraia et al., (2007) reported a positive association between parks and porches, and PA among NHB pregnant women

(Laraia et al., 2007). This dissertation finding is a unique contribution to better understanding of the influence that parks and playgrounds may have on PA levels of WMO during pregnancy.

8.3 Neighborhood Social Environment

In this study, characteristics of the neighborhood social environment such as social cohesion and neighborhood safety were hypothesized to be significantly associated with physical activity of pregnant WMO.

8.3.1. Neighborhood Social Cohesion

In this dissertation chapter, I examined the associations between neighborhood social cohesion (NSC) and physical activity among pregnant women of Mexican origin. I found a significant joint effect of NSC on physical activity (STEPS). The influence of NSC on physical activity and other healthy behaviors (e.g., healthy eating, low smoking prevalence) has been well established (Choiet al., 2017). However, there is limited research about the effect that neighborhood social cohesion may have on physical activity during pregnancy (Laraia et al., 2007). Despite this limitation, some research has been done on the effect of NSC on mainly health outcomes of non-pregnant women and men of Mexican origin and other minority populations (Kwarteng et al., 2013; Lee et al., 2012; Schulz et al., 2013). Neighborhood social cohesion has been significantly associated with lower risk of alcohol use, overweight/obesity, insulin resistance, cardiovascular disease (hypertension, lower cortisol values), and depression and depression symptoms (Diez-Roux et al., 2016). For example, in neighborhoods where there is a high density of Mexican immigrants and Mexican Americans, high NSC has been linked to decreased risk of mental health conditions, cardiovascular disease, and type 2 diabetes (Almeida et al., 2009; Ostir et al., 2003). A possible explanation for the protective role of NSC is that neighborhood social cohesion that arises from high concentration of Mexican Americans buffered the deleterious effects of neighborhood poverty on a variety of health outcomes (Ostir et al., 2003). Moreover, Rios and colleagues (2011) concluded that some aspects of social cohesion—shared cultural identify, sense of belonging— may be enabling residents to cope with

poverty, unemployment, social exclusion, and promote health among ethnic minority communities (Rios et al., 2011). This explanation may align well with the fact that most of the Healthy MOMS participants, comprising this dissertation study sample, lived in zip codes (48209, 48210, and 48216). According to the 2000 and 2010 US Census tracts, these zip codes had high densities of Mexican immigrants and Mexican Americans, with high rates of poverty due at least in part to the low levels of formal schooling and the unskilled manual and service occupations of many of their residents (US Census Bureau, 2010). Indeed, most of my study's participants had their households located on or near by Mexican-town, in Southwest Detroit, MI where persons of Mexican origin are the predominant ethnic group and have a long-standing settlement history.

8.3.2 Neighborhood safety

Findings from this study indicate a positive trend between neighborhood safety and PA levels among low income pregnant women of Mexican origin, although this association was not significant. Another important finding is that perceptions of neighborhood safety moderated associations between neighborhood poverty and physical activity. This finding suggested that among pregnant WMO in neighborhoods with similar poverty rates, those who perceived their neighborhoods to be safe were likely to walk 920 steps more on average, than women who perceived their neighborhoods to be unsafe, indicating that neighborhood safety may affect PA in several ways. These findings are consistent with findings reported by Kieffer and colleagues (2002) and Thornton et al, (2006) in their qualitative studies of perceptions of neighborhood environments among pregnant WMO (Kieffer et al., 2002; Thornton et al., 2006). For example, Kieffer et al., (2002) reported that among pregnant immigrant women from Mexico participating in focus groups about facilitators and barriers to physical activity, concerns about neighborhood safety negatively influenced activities such as bicycling or walking. Similarly, Thornton et al., (2006) noted that male partners of pregnant Latina women may be reluctant to provide instrumental support (e.g., caring for their children) if they feared about neighborhood safety. Moreover, in two reviews of the literature, the lack of neighborhood safety was identified as a barrier in all qualitative studies included in these reviews, suggesting that neighborhood safety becomes a more salient factor influencing PA, especially among low income pregnant women to

engage in outdoor walking (Laraia et al., 2007) than it is for men and non-pregnant women (Eschbach et al., 2004; Russo et al., 2015; Thompson et al., 2017).

Despite this available body of qualitative research extending their focus from individual and interpersonal factors to examine neighborhood factors influencing PA, there is a dearth of quantitative literature to directly measure associations between neighborhood environmental characteristics and PA identified by qualitative research. This dissertation study contributes to filling this gap in the quantitative research examining neighborhood factors and physical activity during pregnancy among WMO living in low income neighborhoods.

IX. Study limitations

This study has several limitations. First, I was not able to fit a multilevel regression model to analyze the influence of neighborhood poverty due to low intraclass correlation coefficients (ICC) and the structure of the data. I conducted separate analyses to obtain ICC's for each of the outcome measures (ICC_{STEPS}= 0.02 and ICC_{METS}=0.001). According to Koo et al (2016) the ICC should be no less .05 to increase the likelihood of capturing differences among study participants within and between neighborhoods (Koo & Li, 2016). This could be because only 24 census tracts were identified, and the average number of individual respondents within each census tract was eight, while a minimum of 30 individuals is recommended. Limitations on the number of groups and members within groups could lead to unreliable regression coefficients and standard errors (Bryk & Raudenbush, 1992; Koo & Li, 2016). Future studies examining the influence of neighborhood economic conditions should include samples with greater variation in census tract poverty rates within the sample. Second, even though this study provides important information on the influence of neighborhood poverty on physical activity among low income pregnant women of Mexican origin living in poor neighborhoods, limited variability in the household income measure may have precluded to observe any household income effects on PA levels, as over 50% of study participants lived in households with an annual income below $20,000. Thus, future research examining associations between household income and physical activity levels of pregnant WMO is needed. Last, this dissertation study did not account for any important local, state- or federal-level events that occurred immediately prior to and during the

2004-2006 period that may had influenced perceptions of neighborhood social and physical environments and, in consequence, impacted physical activity levels of pregnant women of Mexican origin in poor neighborhoods. For example, the creation of the Immigration and Customs Enforcement (ICE) in 2003 led to the deportation of more than 90,000 individuals during home raids conducted in both 2004 and 2005 (Thompson, 2008). Fear of deportation has been identified as a factor limiting physical activity in neighborhoods with high concentrations of Mexican immigrants and immigrants from other Central and South American countries. Enforcement of immigration policies are often carried out based on racial and ethnic profiling, targeting neighborhoods where Spanish-speaking residents may live (Abrego & Menjívar, 2011).

Despite these limitations, there are several strengths of this study. The findings presented here are consistent with a growing body of qualitative and quantitative evidence suggesting that the condition of the neighborhood social and physical environment is associated with PA. The findings of this study suggest that features of the neighborhood social and physical environments such as neighborhood social cohesion and safety, sidewalks, streets, parks and playgrounds could be potentially modified to facilitate healthy behaviors. Further, investments in improving neighborhood safety are likely to benefit pregnancy outcomes not only among women of Mexican origin but across neighborhoods where safety is a concern, regardless of the residents' ethnicity or socioeconomic status. Further, this study may be one of the first quantitative studies examining associations between characteristics of the neighborhood social and physical environment and PA behaviors during pregnancy among low income women of Mexican origin living in poor neighborhoods. As the proportion of women of Mexican origin of childbearing age and their infants and children continue to grow in the US population (Gonzalez-Barrera & Lopez, 2013), this dissertation research contribution becomes of major importance given a scarce body of literature centered on physical activity of women of Mexican origin during pregnancy and early postpartum.

In sum, because of the increased risk of adverse maternal and infant outcomes associated with excessive maternal weight and sedentary lifestyles, and the high prevalence of obesity, gestational diabetes mellitus and type 2 diabetes among women of Mexican origin, these findings may inform design and delivery of prenatal and postpartum interventions aimed at promoting the benefits of walking as an effective PA behavior, and policies and services aimed at promoting healthy environments. Further research aimed at extending our understanding of neighborhood

conditions on PA patterns among WMO, other Latinas and other minority pregnant women living in low income neighborhoods is of paramount importance if we are serious about decreasing health inequities in maternal and infant health.

X. Conclusions

Findings from this study provide support for the idea that investments that improve neighborhood environments can promote healthy behaviors during pregnancy among WMO. Further, this study lends support for increased awareness among community leaders, policy makers, prenatal care providers, and physical activity researchers among others, about the influence that neighborhood environmental characteristics may have on physical activity levels during pregnancy among minority low income pregnant women living in poor neighborhoods.

Prescribing outdoor walking in order to reduce excessive weight gain or obtain better glycemic control during pregnancy has been suggested by the American Committee of Obstetricians and Gynecologists (ACOG, 2015). Prescribing outdoor walking to low income pregnant patients living in unsafe neighborhoods with deteriorated sidewalks, streets and housing/vacant lots, and limited or inexistent recreational facilities may result in low adherence to recommendations and increased risk of falls, other injuries and adverse experiences. Failing to follow outdoor walking recommendations may be understood as a personal failure, as low-income pregnant women may blame themselves for not having what 'it takes', or not being motivated enough to improve their own health and their baby's health. Further, the apparent failure to follow PA recommendations may emphasize and perpetuate stereotypes or racial/ethnic/class bias that prenatal care providers, policy makers, city planners may have about minority women not caring enough for their health or the health of her child. Efforts to promote physical activity among women living in low income neighborhoods and/or those with poor social or physical infrastructure, must be paired with recognition of, and efforts to improve, the conditions in which women are attempting to be physically active. Thus, future research to expand our understanding of the influence of neighborhood conditions on PA patterns among WMO during pregnancy is warranted.

XI. Bibliography

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Chapter 4

Efficacy Evaluation of the Healthy MOMs Lifestyle Intervention to Promote Physical Activity during Pregnancy in Women of Mexican Origin

I. Introduction

The US National Research Council estimates that 48% of women gain more weight during pregnancy than recommended by the Institute of Medicine guidelines (IOM, 2010; Rasmussen et al., 2009). Excessive gestational weight gain and obesity are major risk factors associated with new and persistent maternal health conditions and can perpetuate a cycle of maternal-infant health complications with each subsequent pregnancy (ACOG, 2015). To decrease excessive weight gain and other risk factors during pregnancy, the American College of Obstetricians and Gynecologists has issued recommendations of at least 100 minutes of moderate to vigorous physical activity per week for pregnant women with low risk pregnancies (ACOG, 2015).

Achieving adequate levels of physical activity (PA) during pregnancy has been associated with healthy weight gain, psychological health, lower risk of gestational diabetes, preeclampsia, preterm birth, and lower postpartum weight retention (Coll et al., 2016; Thompson et al., 2015). Hence, having adequate levels of PA during pregnancy can have long term, positive impacts for both the mother and her child (IOM, 2010). Despite these benefits, pregnant women are less physically active than non-pregnant women (Langer, 2018; Russo et al., 2015).

Mexican immigrant and Mexican American women (hereafter women of Mexican origin, WMO) have the highest birth rate of any minority group in the US (Saelens et al., 2003). WMO are more likely to begin their pregnancies overweight (77%) or obese (45%) compared to the US female population as a whole (Keller et al., 2014). Further, WMO are at increased risk of gaining additional weight during their childbearing years, both during and following pregnancies (Tabb et al., 2017). High rates of overweight and obesity among pregnant WMO and other

Latina women increase their risk of metabolic conditions (e.g., gestational diabetes) linked with adverse birth outcomes (Mendez-Hernandez et al., 2009; Tovar et al., 2009). Yet, according to Austin et al (2013), pregnant WMO are less likely to meet recommendations for 30 minutes/day of moderate PA during pregnancy compared to non-Hispanic White (NHW) women (Austin et al., 2013). Low levels of PA among pregnant WMO have been associated with higher rates of preeclampsia and gestational diabetes mellitus (GDM), compared to their NHW counterparts (Golden et al., 2012; Hunsberger et al., 2010; Kim et al., 2013).

Most studies that examined the efficacy of lifestyle interventions on physical activity levels during pregnancy have been conducted with NHW women and their findings have been conflicting. For instance, a review conducted by Pearce et al. (2013), reported that only 3 of 9 studies found a statistically significant effect on physical activity levels among pregnant women (Pearce et al., 2013). Other systematic reviews reported similar findings (Currie et al., 2013; Pastorino et al., 2018). This limited reported success in increasing PA levels or decreasing the reduction of physical activity during pregnancy has been in studies conducted primarily in NHW populations.

The number of randomized controlled trials (RCT) promoting physical activity among pregnant minority women are limited (Chasan-Taber et al., 2014; Koniak-Griffin et al., 2015; Polley et al., 2002). In a systematic review of physical activity interventions in pregnancy, Choi and colleagues (2013) identified five RCTs conducted in the US between the years 2000 and 2011 (Choi et al., 2013). Among these RCTs only one, conducted by Polley et al., (2002), included low income minority pregnant women. Participants in Polley's study were overweight and obese non-Hispanic Black (NHB) (39%) and NHW (61%) pregnant women. Those in the intervention group received health education and behavioral strategies focused on physical activity and diet to reduce excessive weight gain during pregnancy. Results from this study showed that participants in the control group had higher weight loss than participants in the intervention group (Polley et al., 2002).

Over the last fifteen years, several behavioral lifestyle interventions with more ethnically diverse samples have been conducted to reduce (a) excessive weight gain (Gesell et al., 2015; Leite et al., 2017); (b) gestational diabetes (Russo et al., 2015), (c) metabolic syndrome (Mudd & Evenson, 2015); and (d) risk factors for type 2 diabetes (Kieffer et al., 2013); including (e) dietary practices (Kieffer et al., 2014); (f) delivery outcomes (Domenjoz et al., 2014); and (g)

offspring outcomes (Ehrlich et al., 2012; Pastorino et al., 2018). Physical activity has been an important component in all studies mentioned above. Although Latina women were included in these study samples, results were not disaggregated to assess the impact of these interventions on women of Mexican origin.

Among the few studies that have looked at Latina women specifically, Chasan-Taber and colleagues (2014) reported lower declines of physical activity levels among a sample of predominantly overweight and obese Latinas (60.2% of sample) in a behavioral lifestyle intervention versus physical activity declines in a minimal intervention group in a feasibility study (Chasan-Taber et al., 2014). Results from this study primarily reported results for Latina versus NHW women (Chasan-Taber et al., 2014). Similarly, Hawkins and Chasan-Taber et al. (2014) conducted a RCT among Latinas to assess the efficacy of a lifestyle intervention to increase physical activity during the second trimester of pregnancy (Hawkins et al., 2014). These researchers reported a smaller decrease in PA among women in the intervention arm, compared to women in the control arm after intervention delivery (Hawkins et al., 2014). In another lifestyle intervention, aimed to prevent excessive weight during pregnancy among a sample of Latina women, predominantly Mexican immigrants, Gessell and colleagues (2015) reported that participants in the study's intervention arm gained less weight during pregnancy compared to the study's control arm but differences were not significant. Lastly, Kieffer and colleagues reported the effects of the Healthy MOMs lifestyle intervention on depressive symptoms (2013) and improving dietary behaviors (2014) among pregnant and postpartum Latinas. Results from these two studies suggest that (1) pregnant Latina women in the Healthy MOMs lifestyle intervention group were less likely to be at risk for depression at follow up (immediately after intervention), compared to their counterparts in the comparison group. In addition, the authors reported significant declines in depressive symptoms from baseline to 6 weeks postpartum among participants in the intervention group, compared to women in the comparison group, while participants in the comparison group did not experience any change in their depressive symptoms during the pregnancy intervention period (Kieffer et al., 2013); and that (2) Latina women in the Healthy MOMs intervention group had significantly decreased consumption of added sugar, total fat, percentage of daily calories from saturated fat, solid fat and added sugar, and had increased vegetable and fiber consumption after intervention, compared to study participants in the comparison group. Although physical activity data are

available, these have not yet been reported. Further, none of these studies reported disaggregated results by Hispanic subgroups, which limits specific examination of intervention effects on WMO.

Despite the slowly growing body of research on lifestyle interventions focusing on improving health behaviors in general, and increasing, maintaining or reducing declines in physical activity during pregnancy in particular among Latinas, there is a gap in the literature on the impact of behavioral lifestyle interventions addressing physical activity during pregnancy and the early postpartum period among women of Mexican origin. The urgent need for effective lifestyle interventions focused on physical activity levels of pregnant and early postpartum women of Mexican origin remains.

This dissertation chapter uniquely contributes to the literature by providing a close examination of the effect of a longitudinal healthy lifestyle intervention on objectively measured physical activity levels among women of Mexican origin during pregnancy and early postpartum. It derives from the Healthy Mothers on the Move~*Madres Saludables en Movimiento* (Healthy MOMs) study, a randomized control trial aimed at reducing risk factors for type 2 diabetes by promoting healthy behaviors among Latina women pregnancy and the early postpartum (Kieffer et al., 2013; Kieffer et al., 2014). Healthy MOMs, a culturally and linguistically tailored, social support-based lifestyle intervention, aimed at (1) increasing consumption of fruits and vegetables, and (2) preventing declines in activity levels during pregnancy and early postpartum.

Specifically, this dissertation chapter focuses on the efficacy of the MOMs healthy lifestyle intervention in reducing the decline in physical activity levels among women of Mexican origin during pregnancy and the first six weeks postpartum in Southwest Detroit, MI.

II. Hypothesis

H1. Pregnant women of Mexican origin in Detroit, MI will have lower declines in physical activity levels after participating in the MOMs healthy lifestyle intervention during pregnancy and the early postpartum period compared to their counterparts assigned to a comparison group.

III. Healthy MOMs Study Background

Healthy Mothers on the Move~*Madres Saludables in Movimiento* (Healthy MOMs), a prospective two-arm randomized control trial, was designed to reduce risk factors for type 2 diabetes by promoting healthy behaviors among pregnant and postpartum Latinas, predominantly of Mexican origin (Kieffer et al., 2013; Kieffer et al., 2014). The Healthy MOMs study had two main goals: (1) reduce intake of added sugars (grams), percentage of total calories from added sugars, total fat (grams), saturated fat (grams), percentage of total calories from saturated fat, and percentage of total calories from solid fats and added sugars (i.e., saturated fat, trans-fat, and added sugars); and increase consumption of fiber (grams), fruits (servings), and vegetables (servings); and (2) prevent declines in PA (walking) among 278 pregnant and early postpartum Latina women (Kieffer et al., 2013; Kieffer et al., 2014).

Healthy MOMs was planned, developed and implemented in southwest Detroit, MI using a community-based participatory research approach in affiliation with the Detroit Community Academic Urban Research Center and the REACH (Racial and Ethnic Approaches to Community Health) Detroit Partnership (Kieffer et al., 2013). The Healthy MOMs Steering Committee included WMO of childbearing age, and pregnant and postpartum WMO living in southwest Detroit communities where the study was implemented, as well as representatives of community, academic and health-related organizations in the area (Kieffer et al., 2013; Kieffer et al., 2014; Kieffer et al., 2002). Specifically, members of the Steering Committee contributed their expertise to the Healthy MOMs study design, staffing plans, recruitment, retention, intervention, and evaluation methods and materials (Kieffer et al., 2013a; Kieffer et al., 2013b; Kieffer et al., 2014).

3.1. Healthy MOMs Formative Research

Healthy MOMs was informed by formative research that included in-depth individual interviews and focus groups conducted with pregnant and postpartum Latinas and organization and policy leaders in Detroit (Kieffer et al., 2013a; Kieffer et al., 2013b; Kieffer et al., 2014; Kieffer et al., 2002). This formative research informed Healthy MOMs in four specific ways. First, it provided a cultural framework that promoted respect for language preferences, cultural practices and community contexts of study participants. Second, participating women identified

weight, diet, and physical activity beliefs and practices during pregnancy and the early postpartum period; and individual, family, social and community barriers and facilitators to adopting or maintaining healthy lifestyles during and after pregnancy. Third, it highlighted the influence of the physical environment, (e.g., weather, traffic, crime, scarcity of healthy foods in nearby stores) in adopting and maintaining healthy behaviors. Although this study did not intend to alter this environment directly, it included ideas, skill development and discussion to guide and empower participants to create their own solutions, (e.g., group and "buddy" walks, healthy eating groups), to reduce barriers and increase their sense of control. Lastly, participants recommended a group program led by women "like us" with shared language, cultural and experiential characteristics. In response, the Healthy MOMs lifestyle intervention was led by community health workers (CHWs), who were Spanish-speaking, Latina community residents who received extensive training prior to recruitment activities (Kieffer et al., 2013a; Kieffer et al., 2013b; Kieffer et al., 2014; Kieffer et al., 2002).

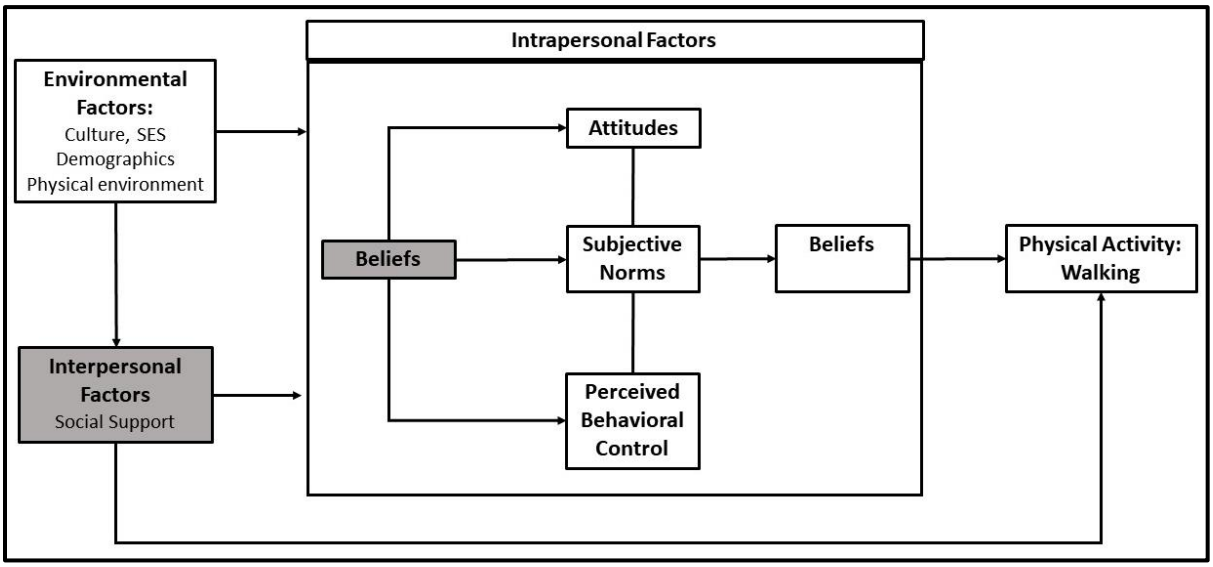
Healthy MOMs was supported by funding provided by several federal and state institutions and organizations such as the National Institute of Diabetes and Digestive and Kidney Diseases at the National Institute of Health (R18 DK062433 and DK020572), the Biostatistics and Measurement Cores of the Michigan Diabetes Research and Training Center; the Centers for Disease Control and Prevention, Division of Nutrition and Physical Activity (U48/CCUS1577S-/SIP 10); the Maternal and Child Health Bureau, Health Resources and Services Administration (R40 MC00115-03); the University of Michigan Vivian A. and James L. Curtis School of Social Work Research and Training Center, and in its pilot phase, by the Michigan Department of Community Health.

3.2. Healthy MOMs Study Theoretical Framework and Conceptual Model

The theories of Planned Behavior (Ajzen, 1985) and Social Support (Cohen & McKay, 1984) lent guidance to the design and implementation of the Healthy MOMs lifestyle intervention (Kieffer et al., 2013a; Kieffer et al., 2013b; Kieffer et al., 2014). **Figure 4.** shows the study's conceptual model (E.C. Kieffer, 2001). It depicts the expectancy that pregnant Latina women will develop the belief that they are capable of practicing healthy behaviors if their environment becomes supportive, and if they gain skills that reinforce and enable these behaviors. Instead of expecting a lack of support from their social environment, women will

expect its support – and this is an important resource in the achievement of self-control and empowerment.

Figure 4.1 MOMs Healthy Lifestyle Study. Conceptual Model – Physical Activity Component.



Shaded areas indicate points of intervention (Kieffer, 2001).

3.3. Healthy MOMs ~ Healthy Lifestyle intervention (HLI)

The MOMs HLI was designed to offer participants individual support and group activities to provide them with new skills, knowledge, and social support. The goal was to help them change dietary and PA-related attitudes, behavioral beliefs, and perceived behavioral control and subjective norms – and ultimately, to help them improve dietary outcomes and increase PA during and after pregnancy (Kieffer, 2001). The HLI sought to promote the development of social support, knowledge and core competencies.

These core competencies included behavior change strategies (e.g., by teaching and practicing goal setting, decision making, self-monitoring, and problem solving, while improving perceived behavioral control and preventing relapse). These strategies were focused on promoting healthy eating and physical activity, helping participants cope with stress and anxiety, and enhancing their communication, social skills, and assertiveness (Kieffer, 2001).

The HLI's core competencies were designed to change study participants' beliefs about (a) dietary practices and PA behavior during pregnancy and the early postpartum, in general; (b) the influence of others on diet and PA behavior; and (c) their self-control over their own diet and PA behavior. These changes were expected to result in more positive attitudes toward healthy diet and PA behavior, greater perceived social acceptability of these behaviors (subjective norms), and the improvement of participants' skills and resources to adopt and maintain a healthy diet and engage in PA (perceived behavioral control). In turn, these changes were expected to increase participants' intention to eat healthy and exercise and, consequently, boost their PA execution. Additionally, participants were encouraged to engage in peer-based social support through community health worker-led informal conversations to promote information sharing, problem solving, and effort recognition. CHWs were also a source of social support for participants. Moreover, the intervention aimed to enhance participants' perceived behavioral control by fostering successful experiences with the behavior (e.g., by helping them learn to exercise safely and practice activities during the intervention), offering emotional and informational support (e.g., by sharing ideas for barrier reduction), and directly reducing some environmental barriers (e.g., by organizing group walks and providing safe and supervised settings for exercise (Kieffer, 2001). **Table 4.1** provides an overview of theoretical constructs that informed the MOMs healthy lifestyle intervention activities.

Table 4.1 Healthy Lifestyle Intervention, Core Curriculum Activities[a]. Healthy MOMs Study, 2004 – 2006

Theoretical Construct	Intervention Activities
INTRAPERSONAL **Attitudes** Outcome beliefs Outcome evaluation	• Discussions and information about healthy diet and PA • Skills to increase PA • Teaching and role modeling CHW[b] • On-going activity groups, e.g., walking clubs • Promoting positive attitudes about exercise during pregnancy
Perceived Behavioral Control Control beliefs/perceived power: Self-monitoring, Goal setting, Problem-solving, Self-reward	• Discussion and problem solving in each meeting • Daily thought journal to record exercise plan. Use of specific self-contract to increase exercise • Goal setting and review of progress at each meeting • Recognition, encouragement, and performance feedback • Family activities (activity sessions, social events, graduation) • Practice exercise and food-related activities during and concurrent with meetings for reinforcement (e.g., cooking tasty family favorites • Group exercise and buying to reduce environmental barriers
SOCIAL ENVIRONMENT **Subjective Norm** Normative beliefs and motivation to adhere	• Support of other pregnant and postpartum women • Links to REACH[c] community activities and resources; local community people can help change community norms • Family activities (activity sessions, social events, graduation • Building on positive family attitudes about exercise • Dealing with negative family attitudes about exercise
INTERPERSONAL **Social Support** Emotional Instrumental Informational Appraisal	• Group meetings and women's support groups. • Group or "buddy"-system activities to support participation • Inclusion of participants' immediate social support system into intervention activities and establish new linkages • Childcare and transportation provision • Information and follow-up provided by CHW[b] team • Discussion of health behaviors • Feedback, reinforcement by other participants, facilitators, referents • Role modeling by CHW[b] and other participants • Facilitation of community problem identification and problem solving. • Links to REACH[c] social support and community activities

[a]Adapted from Kieffer et al, 2001); [b]CHW, Community Health Worker; [c]REACH (Racial and Ethnic Approaches to Community Health) Detroit Partnership.

IV. Methods

4.1. Study Setting, Participant Eligibility and Recruitment, and Sample Size

The Healthy MOMs study was conducted between 2004 and 2006 in Southwest Detroit, MI, a mixed ethnic community, with predominantly of Mexican/Mexican American origin, and low-income residents (US Census Bureau 2000). Community Health Workers (CHWs) conducted recruitment activities that targeted all pregnant Latina women in the area. Recruitment took place primarily at the Community Health and Social Services (CHASS) Center, a federally qualified health center, and Supplemental Nutrition Program for Women, Infants, and Children (WIC) clinics. Bilingual recruitment materials (English/Spanish) were also

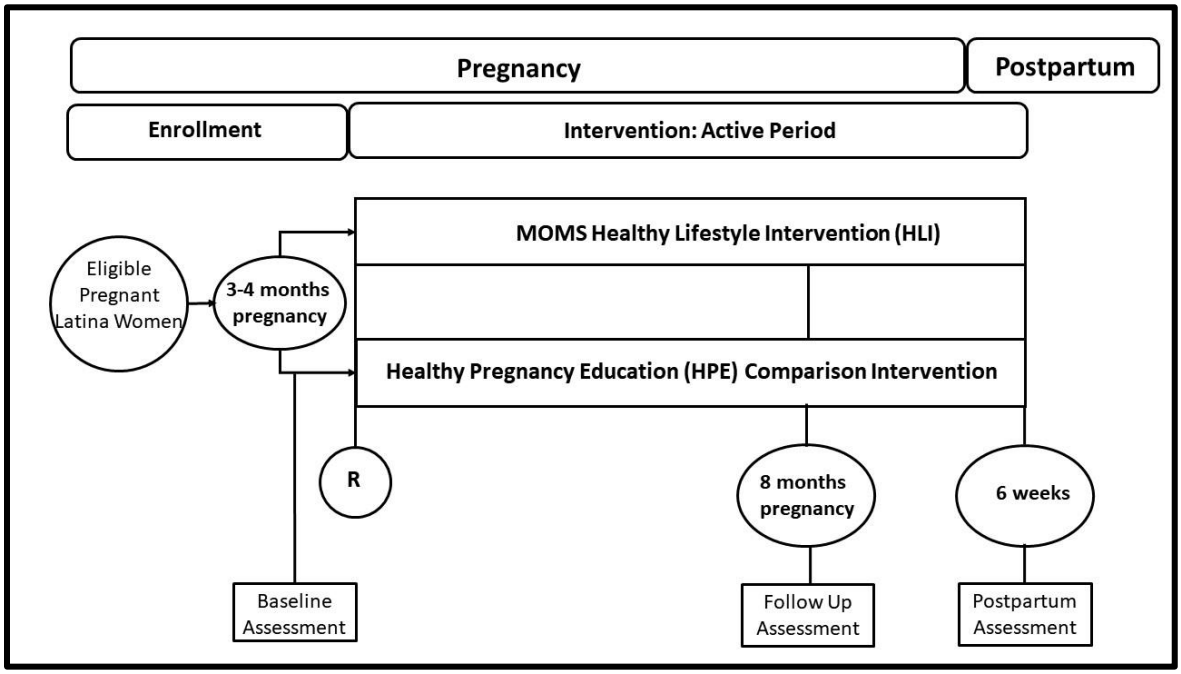
distributed through Latino media, public locations and at several community partner organizations. Eligibility criteria included: (a) 18 years or older, (b) southwest Detroit residents, and (c) less than 20 weeks gestation at eligibility screening. Prior to recruitment, approval from the institutional review board at the University of Michigan was obtained (Kieffer et al., 2013a; Kieffer et al., 2014).

During a CHW-led orientation session, Latina bilingual CHWs explained the study purpose, meaning of randomization, program content, study expectations, and data collection procedures. Informed primary and medical record consents were obtained, baseline data collection visits were scheduled, and information about childcare, transportation and incentive procedures was provided. A total of 278 participants were enrolled into the Healthy MOMs study (Kieffer et al., 2013a; Kieffer et al., 2014). From the total sample, only data from women who identified themselves as Mexican immigrants or Mexican Americans was examined in this dissertation chapter (n=251).

4.2. Randomization

Eligible participants were randomized into one of the two study arms, in a 1:1 ratio: (1) the MOMs Healthy Lifestyle Intervention (Healthy MOMs HLI) consisting of 14 curriculum sessions on healthy diet practices, physical activity, stress reduction, informational social support, and 4 sessions of healthy pregnancy education; or (2) the Pregnancy Health Education (HPE) comparison intervention, which provided the 4 sessions of healthy pregnancy education and standard pregnancy education materials. A University of Michigan statistician generated the random allocation sequence in blocks of 40 for each cohort. The randomization sequence was computer-generated by a data manager who did not meet potential participants during recruitment (Kieffer et al., 2013a; Kieffer et al., 2014). Figure 4.2 shows the Healthy MOMs Study Design.

Figure 4.2 Healthy MOMs Study Design, 2004 - 2006.



4.3. Retention

To encourage participants to attend sessions, the study used the following strategies. Culturally tailored monthly newsletters with health tips, reminder cards, and phone call reminders for meetings and data collection visits were provided in English or Spanish according to the participant's preference. Following each intervention meeting, participants in both Healthy MOMs HLI and HPE groups received the same small gift incentives related to mother and baby care. In addition, all participants received $50 grocery store gift certificates after baseline, follow-up and postpartum data collection. Celebratory graduation ceremonies were held for all participants following completion of study activities. Transportation and childcare were provided for all study activities (Kieffer et al., 2013a; Kieffer et al., 2014).

4.4. MOMs Healthy Lifestyle Intervention Curriculum

The Healthy MOMs HLI considered the importance of family and other social and physical environmental influences on physical activity and diet, along with the expected pregnancy-related changes in diet and PA (Kieffer et al., 2013a; Kieffer et al., 2014). Its methods were structured to help women with goal setting, problem solving and decision making, enabling them to become active participants in their own care. The Healthy MOMs HLI was led by Spanish-speaking Latina CHWs, who were community residents who received extensive training as CHWs and on the Healthy MOMs HLI curriculum and methods, prior to participant recruitment. With the exception of home visits, all sessions were conducted in groups of women from the same recruitment cohort of approximately 15-20 women. All activities were conducted in community-based locations (e.g., non-profit organization partner or church meeting rooms.

Along with information about pregnancy, exercise and healthy eating, curriculum content, discussion and practice focused on the benefits and barriers to these healthy behaviors, how to make healthy behavioral changes, and solve problems that may result from these changes; how to set goals; how to assess their emotional reaction to pregnancy and manage its impact on their behavior; how to optimize their role as a decision-maker and participant in their self-care; how to acquire emotional and instrumental support, including the support of resources within their community; and how to interact productively with health professionals and other members of the healthcare environment (Kieffer et al., 2013a; Kieffer et al., 2014).

Specifically, the Healthy MOMs HLI curriculum consisted of 11 weekly 90-minute curricular meetings scheduled during pregnancy and 3 curricular meetings during early postpartum, primarily dedicated to promoting healthy eating, physical activity, and preparing for birth and infant care. **Table 4.2** shows the Healthy MOMs HLI's curricular meetings. Of these 14 curricular meetings, 4 meetings focused on healthy eating; 2 meetings focused on physical activity; 3 meetings focused approximately half of the session each on healthy eating and physical activity, staying motivated/physical activity, and postpartum health/physical activity; 4 meetings were dedicated to preparing for healthy pregnancies, getting ready for labor and birth, infant care, and postpartum health care for the mother and infant; and 1 meeting dedicated to celebrating the Healthy MOMs HLI conclusion after childbirth. The pregnancy core curriculum was structured to be completed prior to follow up data collection at approximately 8 months of

pregnancy, prior to the pregnancy follow up data collection. Sessions 2 and 3 were one-on-one home visits. Two one-on-one postpartum home visits were designed to be completed at approximately 2 and 4 weeks postpartum, prior to the 6-week postpartum data collection.

During the Healthy MOMs HLI home visits, CHW's also encouraged participants to develop and review their behavioral goals, while providing them with individualized emotional support by recognizing their efforts and challenges. All curricular group meetings ended with a review of the content and the establishment of goals. (Kieffer et al., 2013a; Kieffer et al., 2014).

4.4.1. The Healthy MOMs HLI - physical activity component

The physical activity component of The Healthy MOMs HLI included two 90-minute curricular meetings ('Plan to be active' and 'Move more, sit less'), fully dedicated to physical activity, and three meetings partially dedicated to physical activity-related topics ('Stay motivated,' 'Healthy activities together,' and 'Healthy for life'.) These curricular meetings included information, discussion and activities designed to empower women to develop the knowledge and skills they need to reduce social and environmental barriers to regular exercise. For example, meeting #4 (Move more, sit less) taught participants the benefits of physical activity, explained how to exercise safely during pregnancy, explored their perceptions of the challenges they faced in maintaining a healthy physical activity level, and solicited their ideas on how they could incorporate more physical activity into their daily lives. Moreover, CHWs led group discussions about the barriers to physical activity that participants were experiencing and encouraged them to share strategies and problem solve together. This peer support was reinforced through informal conversations about participants' lives and shared experiences.

4.4.2. Complementary Activity Days

In addition to the 90-minute curricular meetings that were held on Tuesdays, optional and complementary 'activity days' were conducted by the CHWs on Thursdays of the same week for Healthy MOMs HLI participants. Women were encouraged to attend these small group activities that provided guidance, practice and social support. Specifically, four 'activity day'

sessions consisted of exercise activities (e.g., walking groups or aerobic dancing, which corresponded to the topic of that week's curricular meeting). These 'activity days' were conducted at the community-based intervention location (in or outside depending on the activity and weather). Participants were also encouraged to invite family members, friends, or other people who were important to them, to participate in these sessions. All sessions were designed to include some walking.

4.4.3. Adherence to Physical Activity Guidelines

Physical activity interventions followed American College of Obstetricians and Gynecologists (ACOG) guidelines for physical activity during pregnancy (ACOG, 2002). The Healthy MOMS HLI was limited to generally healthy pregnant women, in accordance with ACOG recommendations for moderate exercise for healthy pregnant women. The main PA intervention activity was walking, and the intensity, duration and necessary precautions for this activity were included in the intervention curriculum. The CHWs were trained by an academic research team member who specializes in exercise during pregnancy and the CHWs provided participants with supervision during the PA sessions. During the first 6 weeks postpartum, participants were counseled to gradually commence light to moderate PA, following the recommendations of their obstetric care provider. The CHWs were trained in, and maintained, valid CPR certification.

4.4.4. Healthy MOMs HLI Materials

The HLI's core curriculum included written materials that were specifically developed for the intervention. These materials were distributed and reviewed at each relevant intervention meeting, along with oral information and discussion conducted with individuals and small groups, goal setting and review, and social support activities that were usually covered on "activity days." All written materials were available in English and Spanish (Kieffer et al., 2013a; Kieffer et al., 2014).

The curricula of both the Healthy MOMs HLI and the HPE comparison intervention included identical educational content focused on maternal and infant development. Both the

Healthy MOMs HLI and the HPE comparison intervention groups received the 'Little Pregnancy Book' (Kieffer et al., 2013a; Kieffer et al., 2014), which provided participants with information about maternal and fetal development and care during pregnancy, childbirth and the postpartum period, including breastfeeding (Kieffer et al., 2013a; Kieffer et al., 2014).

Table 4.2 summarizes the content and structure of both the Healthy MOMs HLI and the HPE comparison intervention meetings.

Table 4.2 Comparison of the Healthy MOMs Lifestyle Intervention and the Healthy Pregnancy Education (HPE) Comparison Intervention Curricula. Healthy MOMs Study, 2004 – 2006

Number	Meeting Topic	MOMs HLI[a]	HPE
Pregnancy			
1	Healthy mom, healthy baby!	X[b]	X
2	**Plan to be active! [c]**	**X[b]**	
3	Plan to eat healthy!	X[b]	
4	**Move more, sit less![c]**	**X**	
5	Eat more fiber!	X	
6	Eat more fruits and vegetables!	X	
7	Eat less fat and sugar!	X	
8	Getting ready: labor and birth!	X	X
9	**Stay motivated![d]**	**X**	
10	**Healthy activities together![d]**	**X**	
11	Infant Care!	X	X
Postpartum			
12	Mom and Baby!	X[b]	X
13	**Healthy for Life![d]**	**X[b]**	
14	Celebrate success!	X	

Physical activity meetings in bold. [a] Each Healthy MOMs HLI meeting during pregnancy had a corresponding activity day; [b]Indicates a home visit; [c]Healthy MOMs HLI meetings fully dedicated to physical activity; [d]Healthy MOMs HLI meetings partially dedicated to physical activity. Adapted from Kieffer et al., 2013.

4.5. The Healthy Pregnancy Education Comparison Intervention (HPE)

Participants randomized into the HPE comparison intervention were given this intervention during four group meetings; three during participants' pregnancy and one at approximately 6 weeks postpartum. The content of the HPE meetings corresponded with

Healthy MOMs HLI meetings 1, 8, 11 and 12. During meetings 1 and 12, Healthy MOMs HLI and HPE participants received identical information based on the "Little Pregnancy Book" regarding pregnancy, childbirth and postpartum care, as well as stress management and signs/symptoms of depression during pregnancy and postpartum. In addition, participants in the HPE received standard pregnancy education materials about healthy eating and exercise from the March of Dimes and the American College of Obstetricians and Gynecologists. The HPE comparison intervention was delivered in Spanish by trained infant development and parenting staff from a community mental health agency that participated as a Healthy MOMs partner. All HPE meetings were held in groups of 15-20 participants (Kieffer et al., 2013a; Kieffer et al., 2014).

4.6. Fidelity of Intervention

In their regular meetings, research staff observers, CHWs and participants used checklists to assess their fidelity to the curriculum protocol. For the purposes of process evaluation, their fidelity to each curriculum topic and activity was assessed on a four-point scale (1= not covered, 4= completely covered). Healthy MOMs HLI and HPE group meetings were conducted at two different community organizations that were separate from the community health center where the CHWs were housed and data collection took place (Kieffer et al., 2013a; Kieffer et al., 2014).

4.7. Data Collection

Data were collected at three time points: (1) At baseline, data was collected before randomization and any curricular meetings (3-4 months of pregnancy), (2) At follow up, immediately after the intervention during pregnancy (approximately 8 months of pregnancy), and (3) After delivery (approximately 6 weeks postpartum). Each time point consisted of three data collection visits separated by approximately 1 week to reduce participant burden. Data collection was conducted at CHASS and at participants' homes by employees from the University of Michigan who were blinded to randomization assignment. They were not involved with study administration or delivery of the MOMs HLI or HPE curricula (Kieffer et al., 2013a; Kieffer et al., 2014).

Physical activity data were collected from pedometers and the 7-Day PAR survey (Sallis et al., 1985; see below) conducted at baseline, follow up and postpartum. At the second data collection meeting with each data collection time point, a pedometer was distributed among participants. The participant wore the pedometer for seven continuous days while awake (Day 1=Monday, Day 7=Sunday). At the third data collection meeting (Day=8), the interviewer obtained the total number of steps from the pedometer and recorded this information in the pedometer data form. The pedometer was collected at this point. The 7 Day PAR questionnaire was administered in the same week when participants were wearing the pedometer.

4.8. Outcome Variables

Total number of pedometer STEPS per week (STEPS). This continuous variable was obtained from the raw data (total number of steps in a seven-day period) provided from the pedometer and assessed for normality of distribution and outliers. Then, the raw number of steps for each participant was divided by 1,000 (e.g., number of steps in thousands) to facilitate interpretation of results. One measure of <100 steps per week at baseline was excluded from analysis. STEPS measures were obtained at baseline, follow up and postpartum data collection points.

Total number of METS per week (METS). The 7-Day Physical Activity Recall questionnaire (Sallis et al., 1985) was used to collect self-reported information about the number of minutes per day participants spent on moderate, hard, and very hard intensity PA, such as aerobic exercise, work-related activities, gardening, walking, and recreation. It is important to note that only items related to PA from the PAR questionnaire were used to calculate the PA score. Following specific instructions available for adequate use of the 7-Day PAR (Sallis et al., 1985), a participant's total number of minutes spent per day at each PA category were summed to estimate the total number of minutes per week spent in moderate, hard, and very hard intensity PA. Then, the total number of minutes per week for each PA intensity category was converted to hours (minutes/60). Further, the amount of hours spent on each PA intensity category per week was multiplied by an estimate of Metabolic Equivalent of Task (MET) energy expenditure units assigned to each category of activity. According to the PA intensity category (moderate, hard, very hard), an estimated amount of energy (one MET unit is estimated as 1MET= 1 kcal

kg/hour) spent on engaging in PA, was utilized as follows: one hour of moderate intensity PA = 4 METs, one hour of hard intensity PA= 6 METs, and one hour of very hard intensity PA = 10 METs (Sallis et al., 1985). Finally, METS obtained from each PA category were summed to obtain the **total number of METs per week** per participant. This continuous variable was then assessed for normality of distribution and outliers. METS measures were obtained at baseline, follow up and postpartum data collection points.

4.9. Covariates

Participant's age (AGE). This continuous variable represents the participant's age at baseline in years.

Educational Attainment (EDUCATION). Answers to 'What was the last highest grade of school you completed?' were used to construct this continuous variable to estimate educational attainment measured in years of education completed at baseline.

Country where last educated (COUNTRY-EDU). A baseline dichotomous variable to indicate where a participant received her highest level of education at baseline, Mexico=1, Otherwise=0 (reference).

Years in the US after arrival (AGE-US). A baseline continuous variable that measured the number of years that MOMs participants had been in the US after arriving to the US if born in Mexico or another country.

Marital Status (MARITAL). A baseline dichotomous variable, 1=Married or living with partner, 0=Otherwise (reference).

Employment status (EMPLOYMENT). A baseline dichotomous variable was created to record respondents' employment status since becoming pregnant with current pregnancy. 1=Employed=1, Otherwise=0 (reference).

Household income (INCOME). A baseline categorical variable referring participant's pre-tax household income from all sources, where 1= Under $20,000, 2=Between $20,000 and $30,000, and 3= Over $30,000 (reference).

Number of people living in household (PEOPLE). This categorical variable included the total number of children of any age and adults living in the same home at baseline. It was constructed as follows: 1=1-2 (reference), 2=3-4, 3= ≥5 people.

Self-Rated Health (HEALTH). This baseline continuous variable used data from participants reporting their overall health using a 5-point Likert scale (1=Poor, 5=Excellent).

Gestational age (GESTATION). This continuous variable corresponds to the estimated age of the current pregnancy in weeks at baseline, using all available self-reported and clinical data reviewed by the Healthy MOMs perinatologist using a standard procedure to provide the most accurate estimate.

Body Mass Index (BMI). This continuous variable includes data about body weight (kg) and height (m) used to calculate BMI= kg/m^2 at baseline (BMI, 2015; Keys et al., 1972).

Parity (PARITY). This continuous variable was based on the total number of previous live births that a participant reported at baseline.

English-speaking ability (ENGLISH). A baseline dichotomous variable was based on answers to the question Do you speak any English? Where 1=yes, 0=otherwise.

4.10. Preparing data for analysis

Missing data was assessed by time point for each of the outcome measures. Percentages of missing data were 17.5% at T_0 (baseline), 30.3% at T_1 (follow up), and 29.5% at T_2 (postpartum) for STEPS. Lower percentages of missing data were observed for METS. Those were 4.38% at T_0 (baseline), 20.72% for T_1 (follow up), and 26.4% at T_2 (postpartum) for METS. Because of high levels of missing data at T_1 and T_2 for both outcome measures (STEPS and METS), I imputed the data (outcome, predictor, and control variables of relevance) by utilizing the MICE (multiple imputation by chain equations) procedure (Royston & White, 2011).

A series of diagnostic analyses (correlation matrices and estimation of Variable Inflation Factors (O'brien, 2007) were conducted to identify potential issues of multicollinearity among covariates prior to proceeding with linear mixed regression model fitting for all outcome measures (results not shown) (Alin, 2010). Multicollinearity was identified among baseline covariates (country where last educated, years living in the US, number of people in the household, marital status, employment status). Multicollinearity was addressed by excluding these covariates from the analyses.

To examine the efficacy of the randomization process and attrition patterns that could influence the efficacy of the Healthy MOMs HLI, I used Pearson's or Fisher's Chi square tests

and Student *t* tests to compare participant sociodemographic characteristics at baseline according to protocol specifications (Healthy MOMs HLI vs HPE comparison intervention). A *p*-value < .05 was considered statistically significant.

4.11. Statistical Analysis

To test Hypothesis 1 that stated that participants will have reduced declines of physical activity after participating in the Healthy MOMs HLI during pregnancy and the early postpartum period compared to their counterparts assigned to HPE comparison intervention, I examined change in physical activity over time for participants in the Healthy MOMs HLI (T_0= baseline, T_1= follow up, and T_2 = postpartum). Linear mixed models (LMM) were fitted primarily to estimate intervention effects on physical activity outcomes (pedometer STEPS per week and METS energy expenditure) and make comparisons between and within the Healthy MOMs HLI and HPE comparison intervention groups at the baseline, follow-up and postpartum time points (West, Welch, & Gatecki, 2015). Moreover, LMM included a period effect, and an intervention by time period interaction. The LMM analysis enabled inclusion of covariates considered theoretically important for the analysis such as participants' age (AGE), self-rated health (HEALTH), gestational age (GESTATION), educational attainment (EDUCATION), and English-speaking ability (ENGLISH) as important confounders (Coll et al., 2016; Kieffer et al., 2002; Perez et al., 2016).

MODEL 1

$$\textbf{STEPSij} = \beta 0j + \beta 1j\ \text{Time} + \beta 2j\ \text{HLI} + \beta 3j\ \text{Time*}\ \text{HLI} + \beta 4j\ \text{AGE} + \beta 5j\ \text{HEALTH} + \beta 6j\ \text{GESTATION} + \beta 7j\text{EDUCATION} + \beta 8j\text{ENGLISH} + rij$$

MODEL 2

$$\textbf{METSij} = \beta 0j + \beta 1j\ \text{Time} + \beta 2j\ \text{HLI} + \beta 3j\ \text{Time*}\ \text{HLI} + \beta 4j\ \text{AGE} + \beta 5j\ \text{HEALTH} + \beta 6j\ \text{GESTATION} + \beta 7j\text{EDUCATION} + + \beta 8j\text{ENGLISH} + rij$$

Participant data was analyzed as part of their original random group assignment. An Intent-to-Treat approach was applied to include all participants in the analysis, regardless of the

number of sessions attended or the number of follow-up data collection visits completed (Hollis & Campbell, 1999). STATA 15 software was used for all analyses.

V. Results

5.1. Socioeconomic Characteristics and Attrition of Study Sample (n=251 Women of Mexican Origin)

A total of 278 participants were randomized into the Healthy MOMs study. Only women who identified themselves as Mexican immigrants or Mexican Americans (women of Mexican origin, WMO) were included in this analysis of physical activity (n=251). Among WMO, 129 were randomized into the Healthy MOMs HLI, and 122 were randomized into the HPE comparison intervention. Sociodemographic characteristics of the WMO sample (n=251) at baseline by protocol specification are presented in **Table 4.3.**

Overall, WMO participants in the study were approximately 27 years old years old on average, a majority were born in Mexico (97%), and they have been living in the US for 6.7 years on average. The mean number of years of formal education was 9 years, with only 27% of participants completing high school or higher. Over 50% of participants reported good health.

Pearson' and Fisher's chi square tests, and student t tests showed no statistically significant differences in most sociodemographic, anthropometric or outcome measures at baseline between WMO participants randomized to the Healthy MOMs HLI or the HPE. Only English proficiency (Do you speak any English?) was significantly different between Healthy MOMs HLI and HPE participants, as 26.23% of HPE participants reported that spoke some English, compared to 15.5% of MOMs HLI participants (p-value<.05).

Table 4.3 Sample Characteristics and Outcome Measures[a] (n=251). Healthy MOMs Study, 2004 – 2006

	HLI[b] (n=129)		HPE[c] (n=122)		*p*
	n	**SD**	**n**	**SD**	
Age, years	27.3	5.3	27.2	5.7	.74
Self-rated health	3.1	.85	3.1	.96	.79
Education, years	9.1	3.1	9.7	2.9	.16
Years lived in the US, years	6.6	5.4	6.7	5.9	.94
Gestational age, weeks	17.7	4.3	16.9	4.4	.15
Body Mass Index (kg/m^2)	28.6	5.3	29.1	5.2	.17
Pedometer STEPS (In thousands)[a]	27.6	17.0	27.2	17.1	.73
METS (7-Day PAR questionnaire)[a]	108.0	48.0	117.8	51.8	.13
	n	**%**	**n**	**%**	**X^2, *p***
Self-rated Health					
Poor/fair	26	20.2	24	19.7	.60
Good	73	56.6	61	50.0	
Very good/excellent	29	22.5	33	27.0	
Country of origin (1=Mex, 0=other)	127	98.4	117	95.9	.22
Number of people in the household					
1-2	14	10.9	13	10.1	
3-4	85	65.9	68	55.7	.25
≥5	29	22.5	35	28.7	
Married, living with partner (1=yes, 0=no)	80	62.0	70	57.4	.61
Occupation, homemaker (1=yes, 0=no)	113	87.6	106	86.9	.54
Household annual income					
< $10,000	28	21.7	33	27.0	
$10,001 - $20,000	39	30.2	33	27.0	.11
$20,001 - $30,000	19	14.7	12	9.8	
>$ 30,000	2	1.6	8	6.6	
Parity, number					
0	36	27.9	27	22.1	.21
1-2	72	55.8	81	66.4	
≥3	21	16.3	14	11.5	
English-speaking ability (1=any, 0=none)	20	15.50	32	26.23	.04
WIC participation (1=yes, 0=no)	104	80.6	86	70.5	.18

[a] Baseline data; [b] Healthy MOMs Healthy Lifestyle Intervention; [c] Healthy Pregnancy Education; [d] Outcome measures

Table 4.4 shows sociodemographic characteristics of participants who withdrew from the study. There was a statistically significant difference (p-value=.05) in attrition, with greater attrition among participants randomized into the MOMs HLI (n=13) compared to those randomized into the HPE (n=5).

Table 4.4 WMO Participant Attrition by Participant Characteristics[a]. Healthy MOMs Study 2004 – 2006

	HLI, (n=13)		HPE, (n=5)		*P**
	mean	**SD**	**mean**	**SD**	
Age, years	27.3	4.8	29.4	6.3	.45
Health (1=poor, 5=excellent)	3	.8	4	1.0	**.04**
Education, years	9.5	3.4	7.8	2.7	.31
Years lived in the US, years	7.1	5.8	8.2	7.1	.73
Gestational age, weeks	17.8	4.7	15.8	1.3	.57
Body Mass Index (kg/m^2)	26.3	4.8	27.0	2.4	.78
	n	**%**	**N**	**%**	**X^2, *p****
Self-rated Health					
Poor/fair	3	23.1	0	0	.79
Good	8	61.5	2	40.0	
Very good/excellent	2	15.4	3	60.0	
Country of origin (1=Mex, 0=other)	12	92.3	5	100.0	.52
Number of people in the household					
1-2	1	7.7	0	0	.28
3-4	7	53.8	3	60.0	
≥5	3	23.1	1	20.0	
Married, living with partner (1=yes, 0=no)	9	69.2	3	60.0	.65
Occupation, homemaker (1=yes, 0=no)	12	92.3	5	100.0	.52
Household annual income					
< $10,000	4	30.8	0	0	.19
$10,001 - $20,000	3	23.1	0	0	
$20,001 - $30,000	2	15.4	1	20.0	
≥$ 30,001	0	0	2	40.0	
Parity, number					
0	5	38.5	0	0	.41
1-2	5	38.5	4	80.0	
≥3	3	23.1	1	20.0	
English proficiency (1=any English, 0=no)	3	23.1	2	40.0	.60
WIC participation (1=yes, 0=no)	12	92.3	2	40.0	.36
Attrition	**13**	**100**	**5**	**100**	**.05**

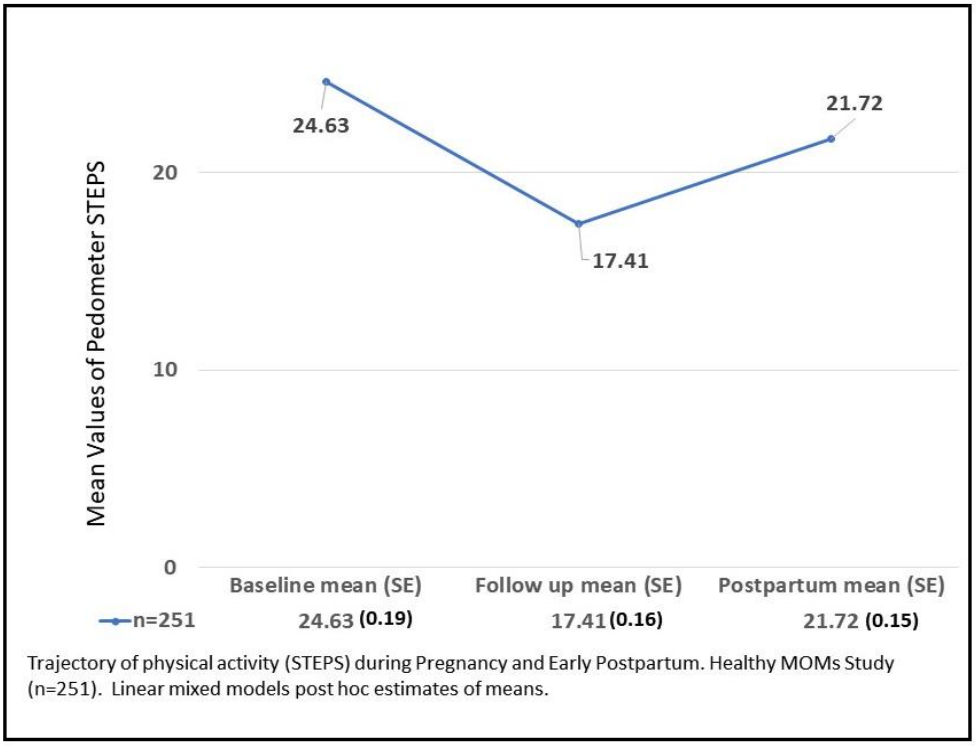
[a] Baseline Sociodemographic data. *Statistically significant (p<.05)

However, there were no significant differences in characteristics between Heathy MOMs HLI participants and HPE participants who withdrew, except for self-reported health, measured by a Likert scale as 1=poor health to 5=excellent. The mean of self-reported health at baseline was 4.0 (SD=1.0) for HPE participants compared to 3.0 (SD=0.8) for Healthy MOMs HLI participants (t student test p-value=.04). Thus, the only statistically significant predictor of attrition was education.

5.2. Physical Activity Decreases as Pregnancy Progresses

Figure 4.3 shows unadjusted changes in mean values for physical activity levels measured by pedometer STEPS in a 7-day period at T_0-baseline (3-4 month of pregnancy), T_1-follow up (8^{th} month of pregnancy on average), and T_2-postpartum (~6 weeks after childbirth) for the whole WMO sample in the Healthy MOMs study (n=251).

Figure 4.3. Unadjusted Changes in Mean Values of Physical Activity (STEPS in thousands) during Pregnancy and Early Postpartum among Women of Mexican Origin (n=251). Healthy MOMs Study, 2004 - 2006

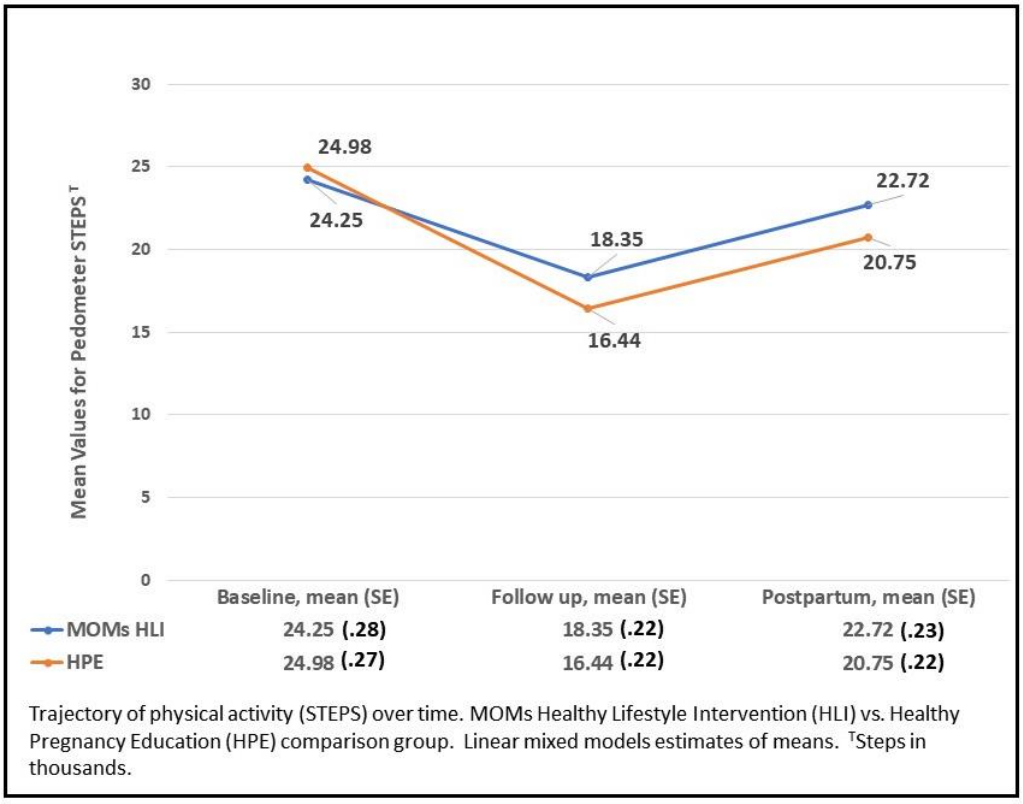


Mean values for PA (STEPS) were 24,625 (SE= 192), 17,413 (SE=157), and 21,715 (SE=160), at T_0-baseline, T_1-follow up, and T_2-postpartum, respectively. A decline of 7,713 steps (SE=248) on average is noted at T_1-follow up (about 8 months pregnancy) compared to T_0-baseline. PA levels increased by 4,303 steps (SE=224) on average at T_2-postpartum compared to T_1-follow up but remain 2,910 steps (SE=250) on average lower than PA levels at T_0-baseline.

5.3. Healthy lifestyle Intervention Effects on Physical Activity (Pedometer STEPS)

Results from liner mixed models fitted to test **Hypothesis 1** that pregnant WMO will have lower declines in physical activity (STEPS) after participating in the MOMs HLI during pregnancy and early postpartum period compared to their HPE counterparts are shown in **Figure 4.4.** It shows unadjusted changes in PA mean values (STEPS) during pregnancy and early postpartum. Pedometer STEPS were measured during a 7-day period at each time point.

Figure 4.4. Unadjusted Changes in Physical Activity (STEPS) During Pregnancy and Early Postpartum between Healthy MOMs HLI and HPE Groups. Healthy MOMs Study, 2004 - 2006



Trajectory of physical activity (STEPS) over time. MOMs Healthy Lifestyle Intervention (HLI) vs. Healthy Pregnancy Education (HPE) comparison group. Linear mixed models estimates of means. TSteps in thousands.

For participants in the Healthy MOMs HLI group, unadjusted STEPS mean values were 24,249 (SE=276); 18,349 (SE=219), and 22,715 (SE=228) steps at T_0-baseline, T_1-follow up, and T_2-postpartum, respectively. Overall, significant changes in PA occurred during pregnancy and postpartum. There was a significant decrease of 1,534 steps (SE=358, *p*=.000) in mean values at T_2-postpartum (~6 weeks after childbirth) compared to T_0-baseline (3-4 months of pregnancy). Similarly, a significant decline of 5,900 steps (SE=352, *p*=.000) was also observed

in mean values of pedometer data collected during a 7-day period at T_0-baseline and T_1-follow up, at 8 months gestation on average. Nonetheless, PA significantly increased by 4,367 steps (SE=316, *p*=.000) at T_2-postpartum, compared to T_1-follow up. Thus, significant physical activity (STEPS) declines were observed at follow up data collection point during the 8th month of pregnancy (on average) and the early postpartum data collection point at approximately 6 weeks postpartum, compared to the pre-intervention baseline (during the second trimester of pregnancy, on average), with the lowest levels of physical activity noted at 8th month of gestation. **Table 4.5** shows these results.

For participants in the HPE group, unadjusted mean values for STEPS were 24,980 (SE=268, *p*=.000) 16,438 (SE=223, *p*=.000), and 20,754 (SE=224, *p*=.000) steps at T_0-baseline, T_1-follow up, and T_2-postpartum, respectively. Significant PA declines occurred at T_1-follow up and T_2-postpartum. The STEPS mean value decreased by 8,543 steps (SE=349, *p*=.000) at T_1-follow up (8th month of pregnancy on average) compared to T_0-baseline. After childbirth, STEPS mean value increased by 4,316 steps (SE=316, *p*=.000) compared to T_1-follow up. Despite this averaged increase in number of steps collected during a 7-day period in the early postpartum, STEPS mean values were still 4,226 (E=349, *p*=.000) steps lower compared to averaged values obtained at T_0-baseline.

The intervention effect was estimated using post hoc contrasts to compare the change from baseline to T_1-follow up and from baseline to T_2-postpartum for the Healthy MOMs HLI vs HPE comparison group (see **Table 4.5**). In the unadjusted analysis, the Healthy MOMs HLI group had a significant lower decline in physical activity (STEPS) from T_0-baseline to T_1-follow up than the HPE comparison group (mean difference in change= -2,643 steps, SE=496, *p*=.000). Overall, from T_0-baseline to T_2-postpartum, the STEPS mean value of the Healthy MOMs HLI significantly decreased by 2,693 steps less than the STEPS mean value of the HPE comparison group (mean difference SE= 500, *p*-value=.000). After adjusting for additional participant characteristics (age, self-reported health, gestational age, education, and English-speaking ability), the overall intervention effects remained statistically significant from T_0-baseline to T_1-follow up (mean difference in change = -2140 steps, SE= 498, *p*-value=.000), and from T_0-baseline to T_2-postpartum (mean difference in change = -2,242 steps, SE= 499, *p*-value=.000).

Table 4.5 Changes in Physical Activity (STEPS[a]) during Pregnancy and early Postpartum in the Healthy MOMs Healthy Lifestyle Intervention vs. the Healthy Pregnancy Education Group. Healthy MOMs Study, 2004 – 2006

	Baseline	Follow-up	Postpartum	Change from:		
	Mean (SE[b])	Mean (SE)	Mean (SE)	Baseline to follow-up	Follow to postpartum	Baseline to postpartum
Unadjusted analysis[c]				Mean (SE)	Mean (SE)	Mean (SE)
MOMs HLI	24.25 (0.28)	18.35 (0.22)	22.72 (0.23)	-5.90 (0.35)***	4.37 (0.32)***	-1.53 (0.36)***
HPE	24.98 (0.27)	16.44 (0.22)	20.75 (0.22)	-8.54 (0.35)***	4.32 (0.32)***	-4.23 (0.35)***
Intervention effect[d]				-2.62 (0.50)***	0.50 (0.45)	-2.27 (0.50)***
Adjusted analysis[e]						
MOMs HLI	24.32 (0.28)	18.24 (0.22)	22.61 (0.23)	-6.09 (0.35)***	4.37 (0.36)***	-1.72 (0.36)***
HPE	2483 (0.68)	16.60 (0.23)	20.86 (0.22)	-8.23 (0.35)***	4.26 (0.32)***	-3.70 (2.33)***
Intervention effect				-2.14 (0.50)***	0.11 (0.45)	-2.24 (0.50)***

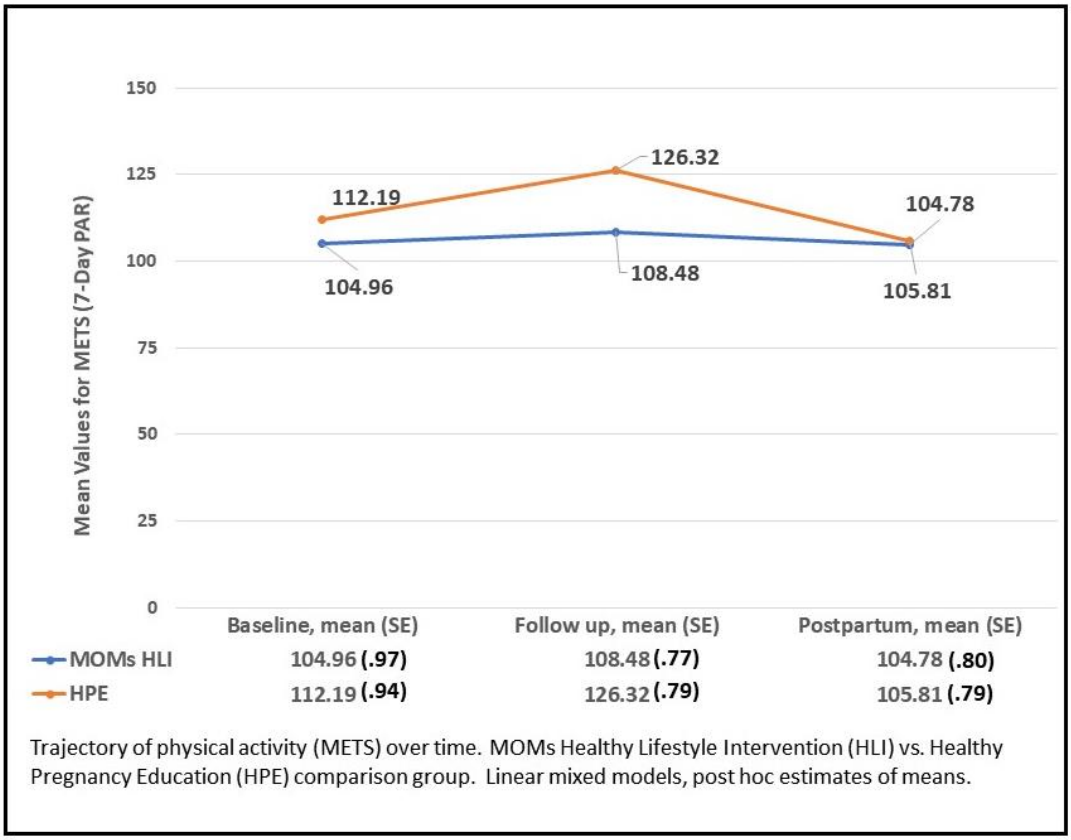
***$p < 0.001$
**$p < 0.01$
*$p < 0.05$
† $p < 0.10$
[a] Pedometer steps, in thousands
[b] Standard error of the mean based on the linear mixed model
[c] The mixed regression analysis is unadjusted and includes all randomized women of Mexican origin (N=251; HLI=129; HPE=122)
[d] Intervention effect is the change in the Healthy MOMs HLI for a specific time period minus the change in the HPE comparison group for the same period
[e] Adjusted for age, self-reported health, educational attainment, gestational age, and English-speaking ability.

4.3. Healthy lifestyle Intervention Effects on Physical Activity (METS, 7-Day PAR)

Figure 4.5 shows changes in PA mean values (METS) during pregnancy and early postpartum. For participants in the Healthy MOMs HLI group, unadjusted METS mean values were 104.96 (SE=0.97); 108.48 (SE=0.77), and 104.78 (SE=0.80) at T_0-baseline, T_1-follow up, and T_2-postpartum, respectively.

Self-reported PA (METS) unadjusted mean values increased significantly from T_0 (baseline) to T_1 (8^{th} month of pregnancy, follow up) by 3.52 (SE=1.24, *p*-value=.005). However, there was a significant decrease of -3.69 METS (SE=1.11, *p*=.001) in mean values at T_2 (postpartum) compared to T_1 (follow up). Self-reported METS declined slightly between T_0 and T_2, but these changes were not statistically significant (mean=-0.18, SE=1.26, *p*-value=.88). Thus, non-significant physical activity (METS) declines were observed in the early postpartum compared to T_0 (baseline). **Table 4.6** shows these results.

Figure 4.5. Unadjusted Changes in Physical Activity (METS) During Pregnancy and Early Postpartum between Healthy MOMs HLI and HPE Groups. Healthy MOMs Study, 2004 - 2006



For participants in the HPE group, unadjusted METS mean values were 112.19 (SE=0.94, 126.32 (SE=0.79), and 105.81(SE=0.79) METS at T_0-baseline, T_1-follow up, and T_2-postpartum, respectively. A significant PA increase of 14.13 METS (SE=1.23, *p*-value=.000) was observed at T_1-follow up, compared to T_0-baseline. At T_2-postpartum, the METS mean value significantly decreased by -20.51 METS (SE=1.11, *p*-value=.000), compared to T_1-follow up. Overall, there was a significant decrease of -6.38 METS (SE=1.23, *p*-value=.000) in the PA (METS) mean values at T_2-postpartum, compared to T_0-baseline. Despite the significant METS mean value increase measured at the 8th month of pregnancy (on average) compared to T_0 (baseline), PA (METS) was lower compared to averaged values obtained at T_0 (baseline).

To assess the intervention effects during pregnancy and early postpartum using the METS measure for physical activity, I compared the change from baseline to T_1-follow up and from baseline to T_2-postpartum for the Healthy MOMs HLI vs HPE comparison group (see

Table 4.6). In the unadjusted analysis, the Healthy MOMs HLI group had a significantly lower increase in physical activity (METS) from T_0-baseline to T_1-follow up than the HPE comparison group (mean difference in change= 10.61 METS, SE=1.75, *p*=.000). However, between T_1-follow up and T_2-postpartum, the METS mean value of the Healthy MOMs HLI significantly decreased by -16.81 METS less than the METS mean value of the HPE comparison group (mean difference SE= 1.58, *p*-value=.000). After adjusting for additional participant characteristics (age, self-reported health, gestational age, education, and English-speaking ability), the intervention effects remained statistically significant between T_1-follow up and T_2-postpartum, (mean difference in change = -13.40 METS, SE= 1.32, *p*-value=.000), and from T_0-baseline to T_2-postpartum (mean difference in change = -5.37 METS, SE= 1.73, *p*-value=.001).

Table 4.6 Changes in Physical Activity (METS[a]) during pregnancy and Early Postpartum in the Healthy MOMs Lifestyle Intervention Group vs. the Healthy Pregnancy Education Group. Healthy MOMs Study, 2004-2006

	Baseline	Follow-up	Postpartum	Change from:		
	Mean (SE[b])	Mean (SE)	Mean (SE)	Baseline to follow-up	Follow to postpartum	Baseline to postpartum
Unadjusted analysis[c]				Mean (SE)	Mean (SE)	Mean (SE)
MOMs HLI	104.96 (0.97)	108.48 (0.77)	104.78 (0.80)	3.52 (1.24)**	-3.69 (1.11)***	-0.18 (1.26)
HPE	112.19 (0.94)	126.32 (0.79)	105.81 (0.79)	14.13 (1.23)***	-20.51 (1.11)***	-6.38 (1.23)***
Intervention effect[d]				10.61 (1.75)***	-16.81 (1.58)***	-6.20 (1.76)***
Adjusted analysis[e]						
MOMs HLI	104.20 (0.96)	109.22 (0.77)	104.37 (0.80)	5.03 (1.23)***	-4.85 (1.10)***	0.17 (1.24)
HPE	112.46 (0.93)	125.17 (0.78)	106.92 (0.78)	12.71 (1.21)***	-18.25 (1.11)***	-5.54 (1.22)***
Intervention effect				7.68 (1.73)***	-13.40 (1.32)***	-5.37 (1.73)***

7-Day Physical Activity Recall
***$p < 0.001$
**$p < 0.01$
*$p < 0.05$
† $p < 0.10$
[a] Metabolic Equivalent Task
[b] Standard error of the mean based on the linear mixed model
[c] The mixed regression analysis is unadjusted and includes all randomized women of Mexican origin (N=251; HLI=129; HPE=122)
[d] Intervention effect is the change in the Healthy MOMs HLI for a specific time period minus the change in the HPE comparison group for the same period
[e] Adjusted for age, self-reported health, educational attainment, gestational age, and English-speaking ability, post hoc contrast analysis.

VI. Discussion

This dissertation chapter was based on the Healthy MOMs study, a prospective randomized control trial aimed at reducing risk factors for type 2 diabetes by promoting healthy behaviors (healthy eating and physical activity) among Latina women during pregnancy and early postpartum in Detroit, MI. Specifically, I examined the physical activity component of the MOMs healthy lifestyle intervention. I focused on a subsample of 251 pregnant women of Mexican origin. My study findings **(1)** are consistent with other studies that have examined physical activity patterns over time and reported that physical activity decreases as pregnancy progresses (Evenson & Wen, 2010); **(2)** expand our limited understanding of the efficacy of behavioral interventions in preventing physical activity from declining during pregnancy and the early postpartum; and (3) provide the first such findings for WMO. The evaluation of the MOMs Healthy Lifestyle Intervention indicates its effectiveness in reducing physical activity declines during pregnancy and early postpartum among women of Mexican origin. Below, each of these findings is addressed in more detail**.**

6.1 Physical activity decreases as pregnancy progresses

This dissertation study findings suggest an overall decline in physical activity levels during pregnancy and early postpartum. I examined physical activity mean values during pregnancy and early postpartum utilizing a pedometer and self-reported data PA measures (METS data from the 7-Day PAR questionnaire (Sallis et al., 1985), and pedometer STEPS). It is important to mention that physical activity patterns during pregnancy assessed in self-reported METS differed from PA patterns assessed by measured pedometer steps reported in this dissertation study and from PA patterns during pregnancy reported in the literature. Mean values of PA measured by self-reported METS were lower (mean= -3.37, SE=0.88) at early postpartum, compared to MET mean values at baseline (on average 3^{rd}-4^{th} month of pregnancy). Mean values increased by 8.54 METS (SE=0.88) on average at the first follow up (approximately 8^{th} month of pregnancy, compared to mean values at baseline, but then declined by -11.91 METS (SE=0.79) at early postpartum. This physical activity pattern is not consistent with findings reported in the literature. Possible explanations for this unexpected increase in physical activity

in the last trimester of pregnancy include: (1) documented error of self-reported PA data collected using the 7-Day Physical Activity Recall questionnaire (Sallis et al., 1985) compared to PA direct data (pedometer); and (2) the reliability and external validity of the Spanish version of the 7-Day PAR instrument. Disagreement between self-report data from PA questionnaires and pedometer-based PA have been widely discussed in the literature (Ainsworth et al., 2012; Cerin et al., 2016; Matthews et al., 2012; Neilson et al., 2008). For example, Ainsworth and colleagues (2012) developed a conceptual framework for reducing errors using physical activity self-report questionnaires after conducting a review of instruments available to measure PA, given the questionable accuracy of recall and reporting bias. Moreover, Ainsworth et al. (2015), reported the relative accuracy of PA self-report questionnaires describing high intensity PA but not when reporting low to moderate intensity PA (Ainsworth et al., 2015). A second possible explanation for differences in PA patterns during pregnancy when measured in METS and pedometer steps reported in this dissertation study may be due to cultural and/or linguistic differences between populations where this instrument has been tested and validated. There are a limited number of reports assessing the reliability and external validity of the Spanish-language version of the 7-Day PAR questionnaire (Sallis et al., 2001). In my review of the literature, I identified only one study (Zuazagoitia et al., 2014) that evaluated the performance of the Spanish version of the 7-Day PAR. In this report, Zuazagoitia et al (2014) reported low to moderate reliability and convergent validity coefficients of the Spanish version of the 7-Day PAR in a Spanish population (Zuazagoitia et al., 2014). Further efforts to improve self-report measures of physical activity are needed, especially when language translations are used.

In this dissertation chapter, direct data of physical activity consisted of pedometer STEPS. STEPS mean values obtained from data collected over a 7-day period at 3rd-4th months of pregnancy (T_0), 8th month of pregnancy on average (T_1), and after childbirth (T_2), provided evidence of overall declines in PA levels during pregnancy and early postpartum. Among the WMO study sample (n=251), mean values for PA (STEPS) declined by 7,213 steps (SE=248) when measured at T_1-follow up and by 2,910 (SE=250) steps at T_2-postpartum on average during a 7-day period, compared to baseline levels (mean= 24,625 steps, SE=192). I also observed an increase of 4,303 (SE=224) steps on average in PA levels at early postpartum, compared to the 8th month of pregnancy, but PA mean values at early postpartum were still lower compared to PA levels at baseline (the 3rd-4th month of pregnancy, on average).

These pedometer-based findings are consistent with those from studies of physical activity patterns during pregnancy and early postpartum. Overall, several studies have documented decreases in physical activity associated with pregnancy. For example, Pereira and colleagues (2007) reported declines of 1.4 hours per week PA levels between pre-pregnancy and 6 months postpartum (Pereira et al., 2007). Similarly, in a review of the literature conducted by Gaston et al. (2011), the authors identified 25 studies of physical activity patterns during pregnancy, but only five studies measured PA levels at different time points during pregnancy (Gaston & Cramp, 2011). One of these studies, conducted by Mudd (2009) compared odds of participating in PA at the second or third trimester of pregnancy (Mudd et al., 2009). In Mudd's study, women in the first trimester of pregnancy were almost twice as likely to participate in any exercise than women in the last trimester (Mudd et al., 2009). In another study, Hawkins and colleagues (2014) reported declines in moderate physical activity measured at mid-pregnancy and postpartum, compared to baseline (Hawkins et al., 2014). Despite differences in PA measures between this dissertation study (pedometer steps) and all the studies mentioned above that utilized self-reported PA measures, findings from this dissertation study provide additional and objectively measured evidence to support the finding of declines in physical activity during pregnancy and postpartum, in this case for WMO.

Several factors may influence low levels of physical activity during pregnancy and the early postpartum period. For instance, women who perceive physical activity during pregnancy as risky to maternal or fetal health would have a higher propensity to reduce or discontinue exercise activity during their pregnancies (Kieffer et al., 2002; Thornton et al., 2006). Also, early pregnancy symptoms, such as nausea and fatigue, might be expected to negatively impact physical activity, although this is not always the case (Troiano, 2018). Moreover, sociodemographic factors such as age, employment status, caregiver responsibilities or level of education have been associated with low levels of PA among pregnant (Kieffer et al., 2002; Thornton et al., 2006), and non-pregnant Latinas (Coll et al., 2017; Larsen et al., 2013).

Environmental factors such as presence and physical condition of sidewalks, streets, and recreational places have also been associated with low PA levels during pregnancy (Laraia et al., 2007). This RCT design did not directly address neighborhood characteristics, although the Healthy MOMs HLI curriculum included discussion and problem solving related to perceived barriers to PA. In examinations of physical activity levels conducted in my previous dissertation

chapter, I found significant associations between neighborhood-level factors and physical activity levels at baseline (the 3rd-4th months of pregnancy), before intervention activities. Specifically, perceptions of neighborhood social cohesion (strong neighborhood social ties), presence/condition of sidewalks, parks, and playgrounds were positively and significantly associated with PA (STEPS). Another salient neighborhood characteristic was neighborhood safety, which moderated the association between neighborhood poverty and walking. For example, pregnant women who perceived their neighborhoods to be safe, walked 860 steps more in average, compared to those who perceived their neighborhoods to be unsafe.

Despite greater understanding of declines in physical activity during pregnancy, it is important to learn what factors are likely to drive those changes, and what factors might reduce the decline. In the following section, I discuss the efficacy of Healthy MOMs HLI on supporting continued physical activity during pregnancy and early postpartum.

6.2. Efficacy of the MOMs Healthy Lifestyle Intervention in Reducing Declines in Physical Activity During Pregnancy and Early Postpartum

Findings from this dissertation study provide mixed evidence to support the hypothesis that pregnant WMO will have lower declines in physical activity after participating in the Healthy MOMs healthy lifestyle intervention (Healthy MOMs HLI) during pregnancy and early postpartum compared to their counterparts assigned to the healthy pregnancy comparison intervention (HPE), depending on the outcome measure that was studied. As discussed below, evidence is stronger for effectiveness of the intervention when using pedometer recorded steps (STEPS) than when using Metabolic Equivalent Task units (METS) derived from self-reported physical activity.

The Healthy Mothers on the Move~*Madres Saludables in Movimiento* (Healthy MOMs), a community-based, randomized control trial was designed to reduce risk factors for type 2 diabetes by promoting healthy behaviors among pregnant and postpartum Latinas, predominantly of Mexican origin (Kieffer et al., 2013; Kieffer et al., 2014). Community health workers (CHWs) led the MOMs healthy lifestyle intervention (MOMs HLI). It had two main goals, (1) improve dietary outcomes (Kieffer et al., 2014), and (2) reduce declines in PA among 278 pregnant and early postpartum Latina women (Kieffer et al., 2013; Kieffer et al., 2014). A

subsample of women of Mexican origin (n=251) was included in this dissertation study of physical activity.

The physical activity-component of the MOMs healthy lifestyle intervention aimed at reducing declines in physical activity during pregnancy and early postpartum. It included information, discussion and activities designed to empower pregnant Latina women to develop the knowledge and skills needed to reduce social and environmental barriers to regular exercise. It consisted of two 90-minute curricular meetings fully dedicated to-, and three curricular meetings partially dedicated to physical activity-related topics, from a total of 14 curricular meetings that made up the MOMs HLI. In addition to these meetings, participants in the HLI were invited to attend optional 'activity days.' The MOMs healthy lifestyle intervention utilized a group social support-oriented curriculum supplemented by 4 one-on-one home visits. Attendance to 'activity days' was presented as optional to prevent potential burden that taking part in the study may represent to participants. On average, attendance for curricular meetings was successful (80%), while attendance for "activity days" was lower (55.23%).

The efficacy of the MOMs HLI was estimated by comparing PA change from baseline to follow up, and from baseline to early postpartum for the MOMs HLI vs HPE comparison group, using two distinct measures of PA. Despite overall declines in PA during pregnancy and early postpartum among this subsample of women of Mexican origin, the MOMs HLI group had a significant lower decline in physical activity (STEPS) from baseline (on average, 3^{rd}-4^{th} month of pregnancy to the T_1 follow up (on average 8^{th} month of pregnancy than the HPE comparison group (unadjusted mean difference in change= -2,643 steps, SE=496, *p*=.000). PA declines from baseline to early postpartum (on average 6 weeks postpartum) were also significantly lower for the Healthy MOMs HLI group compared to the HPE comparison group (unadjusted mean difference in change=-2693 steps, SE= 500, *p*-value=.000). After adjusting mean values for participants' age, self-reported health, gestational age, education, and English-speaking ability, the overall intervention effects remained statistically significant for baseline to T_1 follow up and from baseline to postpartum. These findings provide evidence of the efficacy of the Healthy MOMs HLI in reducing physical activity decline during pregnancy and early postpartum among women of Mexican origin.

It is important to note that physical activity patterns during pregnancy reported in this dissertation study were inconsistent depending on the physical activity measure used to assess

PA levels. Specifically, PA patterns were different from T_0 (baseline) to T_1 (follow up): PA levels decreased when measured in STEPS and increased when PA was measured in METS. When PA levels were assessed with STEPS, an objective PA measure, an overall PA decline was observed between T_0 (baseline) and T_1 (follow up), then a PA increase was measured between T_1(follow up) and T_2 (postpartum). This PA pattern was observed across the Healthy MOMs sample, independently of randomization. However, when PA was measured in METS, obtained from self-reported data collected through the 7-Day PAR questionnaire, PA mean values increased between T_0 (baseline) and T_1 (follow up), then PA levels significantly declined from T_1 to T_2. Further efforts to improve self-report measures of physical activity are needed, including the Spanish language version of the 7-Day PAR questionnaire during pregnancy.

Findings reported here are consistent with studies that have reported the efficacy of behavioral interventions in increasing physical activity among Latina women during pregnancy and postpartum. However, there are substantial differences in study design and interventions between the MOMs healthy lifestyle intervention and other behavioral lifestyle interventions. For example, Hawkins and Chasan-Taber et al. (2014) assessed the efficacy of a lifestyle intervention in increasing physical activity -- based on self-reported data-- during the second and third trimesters of pregnancy among women of predominantly Puerto Rican heritage (Hawkins et al., 2014). Their behavioral lifestyle intervention, delivered by bilingual and bicultural health educators, consisted of 6, monthly in-person sessions, 5 phone-based booster sessions and mailed printed materials tailored to reduce declines in PA during pregnancy and improve dietary outcomes (Hawkins et al., 2014). These researchers reported a smaller decrease in moderate-intensity PA, and an increase in total walking during pregnancy among women in the intervention arm, compared to women in the control arm post-intervention but differences in moderate-intensity PA change were not statistically significant, nor was the increase in total walking (Hawkins et al., 2014). Moreover, the study did not include measures of PA after childbirth. In another behavioral intervention conducted by Gessell et al. (2015), a small sample (n=87) of non-Hispanic women (n=18) and immigrant women of predominantly Mexican origin (n=69) were randomized into the intervention arm and attended 12 weekly 90-minute group sessions. Intervention topics included weight management, coping with stress and anxiety, social support, walking groups, and cooking clubs. Even though fewer participants in the intervention arm exceeded the recommended gestational weight gain compared to women in the

control group, the intervention effect on physical activity levels was not significant and, in fact, was not discussed in detail.

Other studies in non-Latina populations have examined the efficacy of lifestyle interventions on physical activity levels during pregnancy (Choi et al., 2013; Currie et al., 2013). These studies reported increases in supervised prenatal physical activity, but most results were not statistically significant (Currie et al., 2013). Moreover, most of these studies were conducted predominantly with NHW middle-class pregnant women.

There is a solid body of research on efficacy of behavioral interventions aiming at improving health outcomes during pregnancy such as (a) excessive weight gain (Gesell et al., 2015; Leite et al., 2017); (b) gestational diabetes (Russo et al., 2015), (c) metabolic syndrome (Mudd & Evenson, 2015); and (d) depressive symptoms (Kieffer et al., 2013); as well as to improve (e) dietary practices (Kieffer et al., 2014); (f) delivery outcomes (Domenjoz et al., 2014); and (g) offspring outcomes (Ehrlich et al., 2012; Pastorino et al., 2018). Even though these study designs for the most part have aimed at improving consumption of healthy foods and increasing physical activity levels during pregnancy, the effects of physical activity have not been examined independently and/or in terms of their impact on health outcomes (Aune et al., 2014; Mudd & Evenson, 2015; Russo et al., 2015), hence their findings cannot be compared to this dissertation study findings.

This limited body of intervention research focused on physical activity and other health behaviors during pregnancy, with conflicting results, and the scarcity of studies conducted among pregnant Latinas and women of Mexican origin, highlight the importance of findings reported here on the efficacy of the Healthy MOMs lifestyle intervention on reducing declines in physical activity during pregnancy and early postpartum among women of Mexican origin.

VII. Study Strengths

In addition to providing objectively measured evidence to support the study hypothesis that participation in the healthy lifestyle intervention reduced declines in physical activity levels during pregnancy and the early postpartum among pregnant women of Mexican origin in Detroit, MI., the Healthy MOMS study has several strengths. First, this study successfully recruited Latina women of predominantly Mexican origin, who are significantly under-represented in

similar studies to date (Kieffer et al., 2014; Martin et al., 2015; Schüz et al., 2017; Soto et al., 2018). Recruiting Latinos/Latinas into a longitudinal research study is challenging and may be, in part, why they have been underrepresented in intervention research. The Healthy MOMs study recruitment strategy relied on referrals from a trusted source, such as Spanish-speaking healthcare providers, community leaders, and outreach efforts by the study community health workers. Second, participant retention was very high. Over 90% of recruited participants completed their participation in the study. Retention strategies focused on building relationships and trust with study participants, which required maintaining continuity of study CHWs and data collection staff and sending regular Spanish-language newsletters and contact updates. Childcare and transportation supported ongoing participation. Retention strategies also included supportive materials and approaches that helped maintain a sense of fun and support, e.g., recipes, celebratory cards, birth announcements. The study activities were conducted in trusted and respected community organization sites.

Third, the MOMs healthy lifestyle intervention curriculum was delivered by Spanish-speaking Latina community health workers who share a common background and experience with most participants. They received substantial training regarding adult learning, as well as development, implementation and evaluation of randomized control trials. Their contributions to the recruitment success and very high retention rates, and implementation and this randomized control trial were positive attributes of the study. Their knowledge and experience within the Latino community played a substantial role to the overall success of the Healthy MOMs study.

Lastly, the Healthy MOMs study resulted in other significant outcomes. Other MOMs Healthy lifestyle intervention effects include a significant decrease of added sugars, total fat and saturated fat, and significant increase of fruit, vegetables and fiber in participants' diet (Kieffer et al., 2014), and significant reductions of depressive symptoms during pregnancy and between baseline and postpartum for non-English speaking participants (Kieffer et al., 2013a).

VIII. Study Limitations

This study had several limitations. One limitation was missing data on the primary PA measures. Despite good overall retention rates and Healthy MOMs HLI-session attendance rates (67.7%), overall data completion, defined as successful data collection at each time point, was 45% for pedometer STEPS, and 62.5% for METS (See Tables S1 to S4 in the Appendix). Two

binary logistic regression models showed that years in the US and years of educational attainment were marginally associated with the likelihood of not providing PA data at all time points, compared to all pedometer data completion (3 data time points). Similar marginal associations were observed for the likelihood of not completing all METS data point collection and years of education. Participant's age was positively and significantly associated with odds of providing outcome data at all time points. Yet, the utilization of multiple imputation by chain equations provided balanced data to conduct the analyses reported here.

Another limitation of the Healthy MOMs study was that the study funding did not allow for data collection beyond the 6-week postpartum time point, which did not allow assessment of further physical activity change later in the postpartum period and limited my ability to assess the sustainability of intervention effects beyond the early postpartum period.

Pregnancy is often called a "teachable moment" for pregnant women to adopt healthy behaviors when these behaviors are perceived to improve both the women's and their babies' health (Thompson et al., 2017). Yet, during pregnancy and postpartum, adjustment to many changes (e.g., physical, physiological, emotional) during pregnancy and motherhood may include caring for a new baby, or more children in the household makes it hard for pregnant and postpartum women to prioritize their own health behavior and to adopt a new behavior (Kieffer et al., 2002; Langer, 2018; Soto et al., 2018; Thornton et al., 2006). Adding to the struggle, are the need to make ends meet and the lack of social support commonly mentioned in the literature as factors associated with low physical activity levels (Harrison et al., Kieffer et al., 2013a). The Healthy MOMs lifestyle intervention provided knowledge, skills and informal social support needed to empower participants to overcome multiple social and environmental barriers to regular exercise.

IX. Conclusion

The Healthy MOMs lifestyle intervention significantly reduced declines of physical activity measured as pedometer-recorded steps, during pregnancy and the early postpartum among women of Mexican origin in Detroit, MI, compared with women in an intervention control group. Further, the MOMs HLI is feasible to implement in a hard-to-reach, high-risk subpopulation of low-income pregnant women of Mexican origin. Because of solid evidence

supporting associations between physical activity and lower risk of several metabolic conditions (e.g., obesity, gestational diabetes mellitus, pre-eclampsia and eclampsia, type 2 diabetes) during pregnancy, further intervention research is needed to design and test interventions that successfully promote physical activity among low income WMO pregnant and postpartum women.

X. Appendix

Table 4.7 Data Completion, Pedometer STEPS

Time point	Number of Participants	Percent	Valid Percent	Cumulative Percent
.00	10	4.0	4.0	4.0
1.00	37	14.7	14.7	18.7
2.00	90	35.9	35.9	54.6
3.00	114	45.4	45.4	100.0
Total	251	100.0	100.0	

Table 4.8 Analysis of Missing Data (STEPS). Logistic Regression, 1= All Three Data Points Were Completed, 0= Otherwise

	B	SE	p-value	OR
People in household (>7)			.227	
People in household(1-2)	-1.719	1.233	.163	.179
People in household(3-4)	-.690	1.020	.499	.502
People in household(5-6)	-.093	1.076	.931	.911
Years lived in the US	**-.094**	**.053**	**.076**	.910
Married & living with partner (y/n)	-.285	.390	.465	.752
Health (1=poor, 5=excellent)	.146	.200	.466	1.157
Education, years	**-.134**	**.067**	**.056**	.874
Gestational age (Weeks)	-.012	.047	.793	.988
BMI kg/m2	.068	.040	.087	1.071
Age, years	**.117**	**.047**	**.014**	1.124
Income (>30K)			.472	
Income (<10K)	.247	.949	.795	1.280
Income (10-20K)	.879	.931	.345	2.407
Income (20-30K)	.728	.996	.465	2.071
Parity group (3+)			.569	
Parity group (0)	.930	.878	.289	2.536
Parity group (1-2)	.485	.612	.428	1.624
Homemaker (y/n)	.408	.656	.535	1.503
Intercept	-5.229	2.503	.037	.005

Table 4.9 Data Completion , METS from 7 Day-PAR[a]

Time point	Number of Participants	Percent	Valid Percent	Cumulative Percent
.00	2	.8	.8	.8
1.00	28	11.2	11.2	12.0
2.00	67	26.7	26.7	38.6
3.00	154	61.4	61.4	100.0
Total	251	100.0	100.0	

[a] Sallis et al., 1985

Table 4.10 Analysis of Missing Data (METS) from 7 Day-PAR[a]. Logistic Regression, 1= All Three Data Points Were Completed, 0= Otherwise

	B	S.E.	p-value	OR
People in household (>7)			.408	
People in household(1-2)	1.492	1.179	.206	4.447
People in household(3-4)	.946	.990	.339	2.576
People in household(5-6)	1.524	1.060	.151	4.589
WIC services (y/n)	.059	.454	.897	1.060
Years lived in the US	.034	.055	.535	1.035
Married & living with partner (y/n)	-.216	.404	.594	.806
Health (1=poor, 5=excellent)	-.022	.202	.915	.979
Education, years	**-.131**	**.069**	**.056**	.877
Gestational age (Weeks)	.014	.047	.760	1.015
BMI kg/m2	.033	.041	.421	1.033
Age, years	-.046	.044	.294	.955
Income (>30K)			.141	
Income (<10K)	1.233	.851	.147	3.433
Income (10-20K)	1.883	.860	.029	6.574
Income (20-30K)	1.558	.922	.091	4.751
Parity group (3+)			.497	
Parity group (0)	.297	.862	.730	1.346
Parity group (1-2)	.660	.626	.292	1.935
Homemaker (y/n)	.670	.600	.264	1.955
Constant	-1.632	2.391	.495	.195

[a] Sallis et al., 1985

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Chapter 5

Findings from Examining Physical Activity Levels of Pregnant Women of Mexican Origin in Detroit, MI: A Socio-Ecological Approach

I. Study rationale

The purpose of this dissertation was to examine individual-level, interpersonal-level and neighborhood-level factors associated with low physical activity (PA) levels during pregnancy, as well as the efficacy of a randomized control trial of a behavioral lifestyle intervention on reducing PA declines during pregnancy and early postpartum among Mexican immigrant and Mexican American women (hereafter women of Mexican origin) in Detroit, MI. Employing a socioecological approach, this dissertation built on literature describing associations between physical activity-related beliefs, attitudes, subjective norms and perceived behavioral control (individual level), social support (interpersonal level), and neighborhood poverty, social cohesion, safety, walkability, presence/condition of parks and playgrounds, and car/truck traffic (neighborhood level) and PA among pregnant and non-pregnant women of Mexican origin and other Latina subpopulations. The conceptual model for this dissertation is an adaptation of models for the Healthy Mothers on the Move (Healthy MOMs) study (Kieffer et al., 2014; Kieffer, 2013; Kieffer et al., 2001) and The Racial and Spatial Relations as Fundamental Determinants of Health in Detroit Conceptual Models (Schulz, Williams, Israel, & Lempert, 2002) (Figure 1.1) that focused specifically on organizing associations between individual and interpersonal factors, and neighborhood environmental characteristics, as significant contributors to low PA levels of women of Mexican origin during pregnancy.

This dissertation research utilized data from the Healthy MOMs Study, a two-arm longitudinal randomized control trial aimed at reducing risk factors for type 2 diabetes by promoting healthy behaviors (healthy eating and physical activity) among Latina women during pregnancy and early postpartum. This study was conducted between 2004 and 2006 in southwest Detroit, a predominantly low-income, Mexican-origin community (Kieffer et al.,

2013a; Kieffer et al., 2014). Guided by community-based participatory research (CBPR) principles, the Healthy MOMs study was developed and implemented in collaboration with the Detroit Community Academic Urban Research Center and the REACH Detroit Partnership a community-academic partnership (Israel et al., 2001; Kieffer et al., 2013b; Kieffer et al., 2002; Thornton et al., 2006). The Healthy MOMs Health lifestyle intervention (Healthy MOMs HLI) was based on formative research that included semi-structured interviews and focus groups with Spanish-speaking pregnant and postpartum Latinas and people who they indicated influenced their eating, exercise, and weight beliefs and behaviors (Kieffer et al., 2013a; Kieffer et al., 2002). The Healthy MOMs HLI curriculum was conducted in Spanish with groups of 15 to 20 pregnant women by trained Latina community health workers (CHWs). Content integrated general pregnancy education and information, discussion, and activities aimed at changing women's beliefs, attitudes and perceived social norms that may influence adoption and/or maintenance of healthy behaviors during pregnancy and postpartum, while developing knowledge and skills needed to empower women to reduce social and environmental barriers to healthy eating, regular exercise, and management of daily life stressors (Kieffer et al., 2013a; Kieffer et al., 2014). A key component of the MOMs intervention was informational and emotional social support from the CHWs and peers. CHWs encouraged women to problem solve, share strategies, and recognize each other's efforts. Latina participants of predominantly Mexican origin were randomized (N= **278) to the two arms of the study**. Among these participants, the analyses in this dissertation were limited to the subsample of **251** pregnant women who identified themselves as Mexican immigrants and Mexican American women (women of Mexican origin, WMO).

Chapters Two and Three utilized baseline data collected at T_0 (baseline, before randomization and any intervention sessions were held, between the 3rd-4th month of pregnancy. Chapter Four utilized data collected at T_0 (baseline), T_1 (follow up immediately after the pregnancy phase of the intervention), on average at the 8th month of pregnancy, and T_2 (at an average of 6 weeks post-postpartum. Consistently, two measures of physical activity (pedometer STEPS and METS from the 7-Day PAR questionnaire) were utilized as outcome variables in each of the analytical chapters (Two to Four).

II. Analytical Chapter Summaries

In **Chapter Two**, the Theory of Planned Behavior constructs (Ajzen, 1985) and the Theory of Social Support (Cohen & McKay, 1984) provided guidance to examine joint associations of physical activity-related attitudes, subjective norms, perceived behavioral control (individual level factors) and **(1)** PA intention and **(2)** PA behavior. In addition, I examined a hypothesized moderating role of social support from three different sources (husband/partner, mother/woman who raised her or friends) on associations between perceived behavioral control and PA intention, and PA behavior. I utilized Healthy MOMs baseline data to conduct these analyses. Findings from this chapter are consistent with the hypothesis that a pregnant woman's positive attitude and perceived behavioral control (PBC) are associated with PA intention (plan to exercise for 30 minutes for at least five days a week during pregnancy). No significant associations were found between the TPB constructs (attitudes and perceived behavioral control) and PA behavior (STEPS nor METS).

I did not find evidence to reject the null hypothesis of no moderation of PA-related social support from any source on the associations between PBC and PA intention. Regression coefficients for the moderating effects of social support from husband/partner or friends indicated negative moderating effects on such association, but these effects were not statistically significant. In analyses assessing the moderating effect of social support from 'mother/woman who raised you,' the regression coefficient showed a positive moderating effect on the association PBC-PA intention but this moderating effect was also not statistically significant. Further, social support from any source did not moderate the association between PBC and PA behavior (STEPS nor METS). However, I did find a significant independent positive association between social support from 'mother/woman who raised you' and PA behavior (METS). Social support from the other two sources (husband/partner or friends) were not associated with PA behavior (STEPS nor METS).

In **Chapter Three,** I examined the independent and joint associations between six neighborhood characteristics and physical activity. Specifically, I assessed independent and joint associations between three measures of the social environment: **(1)** neighborhood poverty (2000 US Census tracts), **(2)** perceived social cohesion and **(3)** perceived safety (neighborhood social environment); and three measures of the physical environment: **(4)** perceived neighborhood

walkability (presence/condition of sidewalks, streets, housing, and vacant lots), **(5)** self-reported presence/condition of parks and playgrounds, and **(6)** self-reported heavy car/truck traffic, and walking, the most common type of moderate physical activity recommended during pregnancy (ACOG, 2015). Lastly, I evaluated the moderating effect that perceptions of the neighborhood social and physical environments may have on the association between neighborhood poverty and physical activity.

I did not find evidence to reject the null hypotheses of no association between physical activity and **(1)** neighborhood poverty, **(2)** neighborhood social cohesion and **(3)** heavy car/truck traffic. In contrast, findings from this dissertation chapter suggest several meaningful independent associations between maternal perceptions of **(4)** neighborhood safety; **(5)** walkability (presence and physical condition of sidewalks, streets, housing and vacant lots; and **(6)** presence and physical condition of parks and playgrounds, and physical activity (either STEPS or METS). I also found that perceptions of neighborhood safety moderated the effect of neighborhood poverty on physical activity (STEPS). Further, this chapter reports significant joint associations of neighborhood social cohesion, neighborhood safety, neighborhood walkability, and presence/condition of parks and playgrounds on physical activity (STEPS).

In **Chapter Four**, I assessed the efficacy of the Healthy MOMs lifestyle intervention (Healthy MOMs HLI) in reducing PA declines during pregnancy and early postpartum. The Healthy MOMs HLI curriculum consisted of 14 curricular meetings (10 in a group and 4 individually) focused on healthy eating, exercise, identifying and managing stress and depressive symptoms, as well as maternal and infant care during pregnancy and postpartum. The Healthy MOMs HLI's physical activity component consisted of five 90-minute curricular meetings of which two were fully dedicated to-, and three partially dedicated to physical activity. Three of these meetings were held during pregnancy and the other two after childbirth. The first and last PA-curricular meetings were one-on-one home visits with a community health worker (CHW). Both group meetings and home visits included information, discussion and activities aimed at developing knowledge and skills to reduce barriers to regular exercise. In addition to the curricular meetings, Healthy MOMs HLI participants were invited to attend optional 'healthy eating and exercise activity days' that included walking groups or aerobic dancing. The healthy pregnancy education (HPE) comparison intervention consisted of four group meetings of which three were held during pregnancy and one at approximately 6 weeks after childbirth (Kieffer et

al., 2013a; Kieffer et al., 2014). Both the HPE and Healthy MOMs HLI included identical information about maternal and infant care and identifying and managing stress and depressive symptoms during and after pregnancy (Kieffer et al., 2013a; Kieffer et al., 2014). The HPE curriculum content also consisted of standard pregnancy education materials about eating and PA from the March of Dimes and the American College of Obstetricians and Gynecologists.

The study found that physical activity levels (STEPS) declined during pregnancy and early postpartum. Overall, PA levels of the whole sample of women of Mexican origin (n=251) had declined at follow up (8th month of pregnancy on average), and early postpartum compared to PA levels at baseline (3rd-4th month gestation, on average). In contrast, PA levels increased from follow-up to early postpartum, but 6-week postpartum PA levels were still lower than PA at baseline.

To test the efficacy of the Healthy MOMs HLI, changes in PA from baseline to follow up and from follow up to early postpartum for the Healthy MOMs HLI vs the HPE comparison intervention group were compared, using the objective measure of STEPS and self-reported METS. The Healthy MOMs HLI group had an adjusted significant lower decline in physical activity (STEPS) from the 3rd-4th months to the 8th month (on average) of pregnancy than the HPE comparison group. Moreover, adjusted PA declines from the 3rd-4th months of pregnancy to early postpartum were also significantly lower for the Healthy MOMs HLI group compared to the HPE comparison group. Contrastingly, the Healthy MOMs HLI group had an adjusted significant lower increase in physical activity measured in METS from baseline to follow up than the HPE comparison group. However, from follow up to early postpartum, the METS mean value of the MOMs HLI significantly decreased less than the METS mean value of the HPE comparison group. These findings provide evidence of the efficacy of the MOMs Healthy Lifestyle Intervention in reducing physical activity decline during pregnancy and early postpartum among women of Mexican origin.

III. Contributions to the Literature

These dissertation findings contribute to the literature by addressing several key gaps: **(1)** Examining associations between attitude, subjective norm, and perceived behavioral control and physical activity during pregnancy; **(2)** Assessing associations of social support and physical

activity independently and in conjunction with constructs from the TPB; **(3)** Examining independent and joint associations between neighborhood poverty and perceived characteristics of the neighborhood social environment (neighborhood social cohesion and safety) and the physical environment (neighborhood walkability, parks, playgrounds, and car/truck traffic), and physical activity; **(4)** Examining whether perceived characteristics of the neighborhood social and physical environments modified associations between neighborhood poverty and physical activity; **(5)** Assessing changes of physical activity patterns during pregnancy and early postpartum; **(6)** Evaluating a healthy lifestyle intervention focusing on changing attitudes and social norms, and enhancing perceived behavioral control and social support to reduce declines of physical activity during pregnancy and the early postpartum period; and **(7)** Linking all these new pieces of evidence together, this dissertation contributes to expanding our understanding of physical activity behaviors of pregnant and postpartum women of Mexican origin. Women of Mexican origin have the highest birth rates in the US (APA, 2012; Gonzalez-Barrera & Lopez, 2013). They also are among the highest risk for gestational diabetes and type 2 diabetes, both of which are associated with sedentary behaviors (Hedderson et al., 2010; Kim et al., 2013). Each gap and contribution to the literature is described below.

3.1. Examining Attitude, Subjective Norm, Perceived Behavioral Control Constructs and Physical Activity During Pregnancy

This dissertation contributes to a small body of theory-informed research of physical activity during pregnancy, as evidence has shown that using theory to design interventions can lead to improved effects compared to those without theory (Glanz et al. 2008). It also adds quantitative evidence to a body of qualitative research of individual and interpersonal-level factors associated with physical activity among women of Mexican origin during pregnancy.

Findings from this dissertation research showed that attitude and perceived behavioral control (PBC) were significantly associated with PA intention to plan to exercise for 30 minutes a day at least five days a week. These findings are consistent with three studies reporting significant associations between attitude and PBC, and PA intention among predominantly non-Hispanic White women (Downs & Hausenblas, 2003; Hausenblas et al., 2008; Hausenblas &

Downs, 2004), and one small study conducted with predominantly Mexican origin Latina women during pregnancy (Black et al., 2007). The remaining TPB construct, subjective norm, was not significantly associated with PA intention. This finding is also consistent with those of Downs et al. (2003), Hausenblas et al. (2004 and 2008), and Black et al. (2007). In contrast, in another quantitative study of TPB constructs and PA intention/behavior among Taiwanese pregnant women, Lee and colleagues (2016) reported that subjective norm was strongly associated to PA intention (Lee et al., 2016). Further, Lee et al (2016) argued that cultural and normative beliefs embedded in the subjective norm measure they used were highly likely to reflect sociocultural norms specific to traditional Taiwanese ethnicity.

Dissertation findings and another quantitative study regarding the non-significant association between subjective norm and PA intention among predominantly immigrant pregnant women of Mexican origin may be of particular interest given that a robust body of qualitative research has consistently identified traditional sociocultural and normative beliefs to strongly influence PA intentions and PA behaviors among pregnant Latina women (Kieffer et al., 2002; Larsen et al., 2013; Lynch et al., 2012; Thornton et al., 2006). For example, familism, a traditionally important sociocultural set of beliefs and norms used to characterize minority women from Latin-American countries (Austin et al., 2013), has often been identified as one important barrier associated with low PA levels among non-pregnant and pregnant WMO and other Latina women (Austin et al., 2013; Downs et al., 2012; Kieffer et al., 2002; Thornton et al., 2006; Tovar et al., 2010). Manifestations of familism, such as WMO putting the needs of their family members before theirs, having limited time because of their gendered-based responsibilities taking care of children and homes, and/or the need for approval from family members, have been commonly identified as barriers to engage in PA during pregnancy (Evenson et al., 2009; Kieffer et al., 2002; Thornton et al., 2006). These sociocultural and normative beliefs derived from formative research conducted in the same community have also informed the subjective norm construct in this dissertation research (Kieffer et al., 2002; Thornton et al., 2006). Yet, subjective norm was not associated with PA, which in this sample of pregnant, predominantly immigrant WMO, one could expect to be culturally as well as socially embedded in their PA behaviors. Additional research is needed to corroborate this finding of whether there may be less influence of subjective norm on PA behavior among WMO during

pregnancy. Further research is also needed to determine if this TPB construct is adequate for measuring this influence.

In this dissertation study, PA intention was not associated with PA behavior. This finding is consistent with those of only one study of physical activity during pregnancy (Hausenblas & Downs, 2004; Rhodes & Dickau, 2013). Hausenblas and colleagues (2004) reported that only perceived behavioral control was significantly associated with PA behavior but along with PA intention, these TPB constructs explained over 25% of the variance for behavior. In contrast, most studies of physical activity during pregnancy have reported significant associations between PA-intention and PA behavior (Downs & Hausenblas, 2003, 2007; Hausenblas et al., 2008), although most of these studies were conducted among pregnant non-Hispanic White women. Even though these findings provide evidence suggesting that PA intention is associated to PA behavior during pregnancy, there is a growing agreement among researchers that a disconnect between women's intention to engage in physical activity and actual execution of the behavior exists (Rhodes & Yao, 2015). This growing agreement about the weak association between PA intention and PA behavior is strengthened when factors additional to PA intention may influence PA behavior, such as socioeconomic status, education, and social support (Rhodes & Dickau, 2013; Rhodes & Yao, 2015).

3.2. Assessing Associations of Social Support and PA levels Independently or in Conjunction with Constructs from the Theory of Planned Behavior

This study did not provide statistically significant evidence that social support from any source (Husband/partner, Mother/woman who raised you, or friends) positively moderated the relationships between PBC and PA intention, nor the association between PBC and PA behavior, among pregnant women of Mexican origin. Because of the lack of quantitative studies examining social support as a moderator of the associations between perceived behavioral control and PA intention, or PA behavior during pregnancy, it is not possible to compare this finding with others. This dissertation finding contributes quantitative evidence to fill the gap in research examining the application of theoretical frameworks in explaining the moderating effect of social support on physical activity behaviors during pregnancy, and uniquely contributes to

understanding physical activity among pregnant women of Mexican origin. Further research is needed to corroborate these findings.

I also examined independent associations between social support from husband/partner, mother/woman who raised her and friend(s) and **(1)** PA intention and **(2)** PA behavior. Only the association between social support from 'mother/woman who raised her' and PA behavior (measured as METS) was significant. This finding contributes to the literature by adding quantitative evidence to the results of qualitative studies of social support and PA conducted among pregnant and non-pregnant Latinas (Chasan-Taber et al., 2007; Kieffer et al., 2002; Larsen et al., 2013; Thornton et al., 2006). Further, it extends our understanding about what sources of social support are more likely to enable physical activity among pregnant women of Mexican origin. For example, Larsen et al (2013) systematically reviewed over 25 studies on PA among nonpregnant Latinas and Latinos and found that social support was often mentioned as a motivator associated with PA among Latina women than it was for men (Larsen et al., 2013). In addition, in a qualitative study of social support among pregnant and postpartum women of Mexican origin in Detroit, MI, Thornton et al., (2006) reported that participants identified social support from their husband/partner as a salient factor enabling physical activity (Thornton et al., 2006). This dissertation study extends the literature by examining three different sources of social support (husband/partner, mother/woman who raised you, and friends). Results did not show significant main associations between social support from husband/partner nor friends and 1) PA intention nor 2) PA behavior. Another finding that social support from mother/woman who raised you was significantly associated with PA behavior but not with PA intention, is inconsistent with what Thornton and colleagues (2006) reported in their qualitative study that did not identify the social support from mothers as important for PA behavior.

This research finding helped clarify what sources of social support are more likely to enable PA behavior among this sample of pregnant WMO but cannot identify which types of social support were involved specifically. It is possible that 'mother/woman who raised you' provided instrumental social support that may be more important than other types of social support (informational, emotional), and which also may be readily available from mothers or other female relatives frequently living in the same house or nearby. Thus, when pregnant WMO are motivated to engage in PA, they may draw more heavily on the amount of instrumental social support (e.g., help with childcare or house chores, companionship), they

anticipate from their close female relatives than on the support they may receive from their husbands/partners. Further empirical research should be conducted to test this conjecture.

Overall, some TPB constructs and social support were associated with PA behavior, but only accounted for 6.8% of the variance in regression models (Attitudes, PBC, and SS-MOTHER, regressed on STEPS, adjusted for confounders) fitted to assess these relationships. This suggests that other factors such as the neighborhood environmental characteristics where PA is likely to occur may also be important factors influencing a person's PA behavior, above and beyond her PA attitudes and intentions (Larsen et al., 2015).

3.3. Examining Associations of Neighborhood Poverty and Perceived Characteristics of the Social and Physical Environments and Physical Activity during Pregnancy

Based on the premise that neighborhood characteristics might help to explain low physical activity levels during pregnancy in low income neighborhoods, I sought to examine associations between neighborhood economic condition, perceived characteristics of the neighborhood social and physical environments, and physical activity among pregnant women of Mexican origin living in Southwest Detroit. The average neighborhood poverty level was 31%, almost three times the poverty rate in the state of Michigan (31% vs. 10.5%), and over two times the federal poverty levels (31% vs. 12.4% (2000 US Census). Despite these high poverty levels, the association between neighborhood poverty levels and physical activity was not significant. One potential explanation for this lack of a significant association may be that over 65% of participants were in 2000 Census tracts with over 30% poverty rates, while only 1.6% of them were in tracts with less than 16% poverty rate (e.g., Michigan's poverty rate). Hence, there may have been insufficient variation among study tracts to in the percentage of participants living in neighborhoods with lower poverty to detect potential effects of lower poverty levels on physical activity. Future studies examining the influence of neighborhood economic conditions on physical activity should be conducted with a sample that reflects greater variation in census tract poverty rates.

Other findings from my research suggest that other neighborhood characteristics are associated with physical activity levels of pregnant women of Mexican origin living in poor neighborhoods. Specifically, social cohesion, walkability, and presence/condition of parks and

playgrounds were positively and concurrently associated with increased physical activity levels. These associations remained robust after accounting for individual covariates such as participants' age, self-reported health, gestational age, and educational attainment. These neighborhood characteristics accounted for 15% of the variance in the regression model of joint associations. These dissertation findings are consistent with those reported in the small body of qualitative and quantitative research available. For example, in my review of the literature, I located several qualitative studies indicating that neighborhood poverty, the built infrastructure (sidewalks, streets, parks, etc.) and social environment (neighborhood safety and crime) may inhibit or promote physical activity among pregnant Latinas (Chasan-Taber et al., 2008; Kieffer et al., 2002; Thornton et al., 2006). Findings from my study confirm and extend those qualitative findings with an objectively measured PA outcome. I was able to identify only one quantitative study that examined neighborhood characteristics and PA during pregnancy (Laraia et al., 2007). Laraia and colleagues (2007) studied PA levels of mostly non-Hispanic Black pregnant women in low income neighborhoods in Raleigh, SC. Their finding that low income pregnant NHB women in poor neighborhoods were more likely to engage in PA than women with higher incomes is consistent with the finding reported in this study with WMO living in low income neighborhoods in Detroit, MI. Further, this dissertation's findings that neighborhood social cohesion, neighborhood walkability (presence/condition of sidewalks, streets, housing) and neighborhood parks (presence/condition of parks and playgrounds) were positively and concurrently associated with physical activity during pregnancy are also consistent with those of Laraia et al. (2007). My study suggests that pregnant residents whose perceptions that neighborhood social cohesion, walkability and parks/playgrounds were good or excellent had higher levels of physical activity, compared to residents whose perceptions of those neighborhood environmental characteristics were negative.

Lastly, another relevant contribution to the literature is that perceptions of neighborhood safety significantly moderated the association between neighborhood poverty and physical activity. I found that pregnant women of Mexican origin who lived in poor neighborhoods and perceived their neighborhoods as unsafe were likely to be more physically active, while those living in poor neighborhoods who perceived their neighborhoods as safe were more physically active. To my knowledge, I am the first to examine the moderating effect of neighborhood

safety on the association between neighborhood poverty and physical activity during pregnancy and, additionally provide the first for women of Mexican origin.

This dissertation research of associations of neighborhood environmental characteristics with physical activity during pregnancy provides quantitative evidence to a growing body of qualitative research and extend our understanding of the influence that neighborhood poverty, social and physical environments may have on physical activity levels of pregnant women of Mexican origin in poor neighborhoods. All neighborhood environmental characteristics, including neighborhood poverty, accounted for 22% of the variance in the regression model fitted to assess joint effects on physical activity (STEPS), after adjusting for confounders. This percentage represents three times more the percentage of variance explained by individual and interpersonal factors and physical activity (STEPS) fitted in Chapter 2 of this dissertation. Thus, these findings provide evidence for the important effects that neighborhood characteristics may have on physical activity. Further, it identifies which neighborhood environmental characteristics may influence maternal physical activity that may be on the causal pathway between neighborhood environments, disease risk and pregnancy outcomes.

3.4. Assessing Changes in Physical Activity Patterns during Pregnancy and Early Postpartum

Overall, my study findings showed that a steep decline of physical activity as measured by STEPS between baseline at a group average of 3-4 months and follow up during pregnancy at a group average of 8th month of pregnancy (on average). It also documented an increase in PA between follow up during pregnancy and follow up measured at early postpartum (~6 weeks postpartum). Yet, PA levels at early postpartum were lower compared to those at the end of the first trimester of pregnancy (3rd-4th months of pregnancy). In adjusted mixed regression models, a significant decline of -7,213 (SE= 248, *p*-value=.000) pedometer steps was observed at follow up, compared to baseline. A significant decline of -2910 (SE=250, *p*-value=.000) steps was also observed at postpartum compared to baseline. PA levels significantly increased by 4303 steps (SE=224, *p*-value=.000) from follow up to early postpartum. These changes of PA patterns during pregnancy and early postpartum were measured using data from the whole WMO study

sample without contrasting differences in change between participants in the study intervention vs the comparison group; in other words, these analyses did not account for intervention effects.

These findings are consistent with the literature (Evenson & Wen, 2010; Gaston & Cramp, 2011; Piercy & Troiano, 2018). Several factors may influence the level of physical activity during pregnancy. For instance, early pregnancy symptoms, such as nausea and fatigue, might be expected to negatively impact physical activity, although this is not always the case (Troiano, 2018). In addition, beliefs and attitudes that physical activity during pregnancy may be risky to maternal or fetal health could also influence a higher propensity to discontinue or decrease exercise activity (Kieffer et al., 2002; Thornton et al., 2006). Moreover, other factors such as perceptions of neighborhood characteristics such as neighborhood walkability, and presence/condition of parks and playgrounds, and occupational and marital status (Larsen et al., 2013) have also been associated with low levels of physical activity among pregnant and non-pregnant women. This dissertation research (analytical chapters two and three) also provides quantitative evidence that beliefs, attitudes, social support, and neighborhood characteristics significantly influence changes in physical activity levels during pregnancy.

3.5. Evaluating Efficacy of a Behavioral Intervention in Reducing Declines in Physical Activity Levels during Pregnancy and Early Postpartum

Despite overall declines in PA during pregnancy and early postpartum within the whole subsample of women of Mexican origin, the Healthy MOMs healthy lifestyle intervention group had significant lower declines in physical activity (STEPS) from the end of the first trimester (3^{rd}-4^{th} months) to the 8^{th} month (on average) of pregnancy, and from the end of the first trimester to early postpartum (6 weeks after childbirth), compared to the HPE comparison group. In the unadjusted analysis, the Healthy MOMs HLI group had a significant lower decline in physical activity (STEPS) from baseline to follow up than the HPE comparison group (mean difference in change= -2,643 steps, SE=496, *p*=.000). Moreover, from baseline to postpartum, the STEPS mean value of the MOMs HLI significantly decreased by 2,693 steps less than the STEPS mean value of the HPE comparison group (mean difference SE= 500, *p*-value=.000). After adjusting for additional participant characteristics (age, self-reported health, gestational age, education, and English-speaking ability), the overall intervention effects remained

statistically significant from baseline to follow up (mean difference in change = -2140 steps, SE= 498, *p*-value=.000), and from baseline to postpartum (mean difference in change = -2,242 steps, SE= 499, *p*-value=.000).

When measuring physical activity in METS, the Healthy MOMs HLI group had a significant lower increase in physical activity from baseline to follow up than the HPE comparison group (mean difference in change= 10.61 METS, SE=1.75, *p*=.000). However, from follow up to postpartum, the METS mean value of the Healthy MOMs HLI group significantly decreased by -6.81 METS less than the METS mean value of the HPE comparison group (mean difference SE= 1.58, *p*-value=.000). After adjusting for participant characteristics (age, self-reported health, gestational age, education, and English-speaking ability), the intervention effects remained statistically significant from follow up to postpartum, (mean difference in change = -13.40 METS, SE= 1.32, *p*-value=.000), and from baseline to postpartum (mean difference in change = -5.37 METS, SE= 1.73, *p*-value=.001). These findings provide evidence of the efficacy of the Healthy MOMs HLI in reducing physical activity decline during pregnancy and early postpartum among women of Mexican origin.

The Healthy MOMs HLI intervention effects are consistent with a limited body of studies that have reported the efficacy of behavioral interventions in reducing PA declines during pregnancy and postpartum. However, there are substantial differences in study design between the MOMs healthy lifestyle intervention and other behavioral lifestyle interventions. For example, Hawkins and Chasan-Taber et al. (2014) assessed the efficacy of a lifestyle intervention on physical activity during the second and third trimesters of pregnancy among women of predominantly Puerto Rican heritage (Hawkins et al., 2014). These researchers reported a smaller decrease in self-reported moderate-intensity PA during pregnancy among women in the intervention arm, compared to women in the control arm but differences were not statistically significant (Hawkins et al., 2014). The main differences between this dissertation and Hawkins and colleagues' study (2004) were that the dissertation results were based on objective data (pedometer steps), while results from Hawkins' were based on from self-reported questionnaire data. In addition, my study included PA measures after childbirth, but Hawkins' did not. In another behavioral intervention study conducted by Gessell et al. (2015) focused on weight management, healthy eating and physical activity during pregnancy among a small sample of non-Hispanic women and immigrant women of predominantly Mexican origin. In this

feasibility study, fewer participants in the intervention arm exceeded the recommended gestational weight gain compared to women in the control group, but this intervention effect was not significant. Additionally, intervention effects on physical activity levels were fully discussed.

The scarcity of studies conducted among pregnant women of Mexican origin and other Latinas, with results that have been obtained from self-reported data and/or have not reached statistical significance, highlights the importance of findings reported here on the efficacy of the Healthy MOMs lifestyle intervention on reducing declines in physical activity during pregnancy and early postpartum among women of Mexican origin.

IV. Limitations

This dissertation study has several limitations. **(1)** Measures of several key predictor variables were based on one item. For example, in Chapter 2, subjective norms and PA intention were measured with one item. In Chapter 3, neighborhood safety and heavy car/truck traffic were also measured using only one item. This approach may have reduced the reliability and validity of the measures. **(2)** High rates of missing data on important indicators such as baseline household income, and pedometer data and the 7-Day PAR at the follow up and early postpartum data collection points, were observed. This limitation was addressed by utilizing the multiple imputed chain equations (MICE) procedure to impute outcome, predictor and control variables of relevance. **(3)** High proportions of study participants lived in neighborhood areas with high poverty rates, limiting the amount of variance on an important neighborhood indicator. This circumstance may have affected my ability to detect significant associations between physical activity levels and neighborhood poverty. **(4)** I was not able to fit a multilevel regression model to analyze the influence of neighborhood poverty due to the structure of the data (less than 25 groups, and groups with less than 5 members in each group) and low intraclass correlation coefficients (Maas & Hox, 2005), which would lead to unreliable regression coefficients and standard errors (Maas & Hox, 2004).

V. Strengths

There are several strengths of this study. The strengths of this study include: **(1)** Grounding in two theoretical models of behavioral change (Theory of Planned Behavior and Theory of Social Support) and formative research conducted with pregnant and postpartum WMO from the same community prior to the Healthy MOMs study; **(2)** Focus on a sample of women of Mexican origin (WMO), who are significantly under-represented in the literature in all three of the study areas, as most research of physical activity and most physical activity interventions during pregnancy or the early postpartum period have been conducted with non-Hispanic white women; **(3)** Use of two measures for physical activity. Data for these measures was collected with a pedometer (objective measure) and the 7-Day PAR questionnaire (self-reported data) in the same timeframe; **(4)** Analysis of individual-level, interpersonal-level, and neighborhood-level factors associated with physical activity behavior; **(5)** Recruitment, randomization and retention strategies for the intervention trial were successful. Recruiting and retaining minority non-pregnant participants into a longitudinal RCT is challenging, even more challenging is to recruit low income Spanish-speaking women of Mexican origin during pregnancy. The Healthy MOMs study successfully recruited Latina women, who are significantly under-represented in similar studies to date. (Kieffer et al., 2014; Martin et al., 2015; Schüz et al., 2017; Soto et al., 2018). Recruiting Latinos/as into a longitudinal research study is challenging and in part, why they have been underrepresented in research; **(6)** Identification of research gaps and propositions of potential ways to address those gaps.

Lastly, **(7)** this is the first study that examined the modifying effects of (i) social support on the association between perceive behavioral control and physical activity, and (ii) perceptions of neighborhood safety on the association between neighborhood poverty and physical activity, and objectively measured associations of neighborhood environmental characteristics and physical activity overall, and among women of Mexican origin; and the first study of physical activity outcomes from a full-scale healthy lifestyle RCT among pregnant and early postpartum women of Mexican origin in predominantly low income urban neighborhoods.

VI. Implications for Public Health Research

This dissertation has several findings that can inform public health interventions that focus on physical activity during pregnancy among urban populations of low-to-moderate income, especially women of Mexican origin. My findings suggest the importance of considering social and physical contexts at the neighborhood level when designing and evaluating interventions to address physical activity among minority women of childbearing age. These interventions can use multilevel models (e.g., social ecological model) to design complex interventions to address neighborhood (e.g., neighborhood poverty, social and physical environments), interpersonal (e.g., social support), and individual (e.g., attitudes, norms and perceived behavioral control) factors influencing physical activity during pregnancy.

In addition, findings from this dissertation research may also inform prenatal care and postpartum care providers, city planners and community leaders, who should become aware of the importance of the influence of neighborhood environmental characteristics may have on physical activity levels directly, and on health outcomes indirectly, of minority and low-income pregnant women. Explicating the ways through which neighborhoods influence health behaviors and outcomes is important for identifying the policy-relevant, modifiable neighborhood characteristics to which scarce public health resources can be applied.

Most research available on physical activity during pregnancy has focused on NHW women. There is a great need for further research on PA and effective interventions during pregnancy and the early postpartum that may ameliorate the increasing rates of metabolic diseases associated with inadequate PA levels during and after pregnancy that greatly affect women of Mexican origin, other minority low income women and their children and communities.

VII. Conclusions

This study provides evidence for the strengths and some limitations of theoretical constructs as useful tools for examining physical activity among pregnant women of Mexican origin. Further, it identifies which neighborhood environmental characteristics may influence physical activity and provides important quantitative evidence complementing and supporting

the solid body of qualitative research on associations of individual, interpersonal and neighborhood level factors promoting or deterring physical activity during pregnancy. Further, this dissertation study showed a significant intervention effect of the Healthy MOMs CHW-led healthy lifestyle intervention on physical activity, which adds to previously published significant intervention effects on diet and depressive symptoms in women of Mexican origin participating in the same RCT. The results from this study may provide a useful model for future interventions in similar populations and communities.

Given the burden of preventable diseases (e.g., preeclampsia, gestational diabetes, type 2 diabetes) disproportionally affecting minority pregnant women and especially pregnant women of Mexican origin and their children, further research focused on understanding of what, how and when individual, interpersonal, and neighborhood level factors may influence PA behavior during pregnancy and early postpartum, and how to best deliver effective interventions, is warranted.

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