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Exercise Adherence among Pregnant Women: The Roles of Socioeconomic Status, Attitudes towards Prenatal Exercise, and Social Support

Lee Anne Flagg
University of Alabama at Birmingham

EXERCISE ADHERENCE AMONG PREGNANT WOMEN: THE ROLES OF SOCIOECONOMIC STATUS, ATTITUDES TOWARDS PRENATAL EXERCISE, AND SOCIAL SUPPORT

by

LEE ANNE FLAGG

ELIZABETH BAKER, COMMITTEE CO-CHAIR
JULIE L. LOCHER, COMMITTEE CO-CHAIR
PAULA C. CHANDLER-LANEY
BISAKHA SEN
JOSEPH D. WOLFE

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LEE ANNE FLAGG

MEDICAL SOCIOLOGY

ABSTRACT

Drawing on the sociological theories of fundamental causes and social support, it was hypothesized that exercise during pregnancy would be positively associated with both socioeconomic status (SES) and social support for exercise and that the association between SES and exercise levels would be at least partially explained by attitudes towards exercise. It was also hypothesized that there would be a positive interaction between SES and social support for exercise in relation to exercise levels during pregnancy. Cross-sectional observational data was obtained from a survey of pregnant women, predominantly from those accessing prenatal care at Birmingham, AL area obstetric clinics. The primary dependent variable was an assessment of exercise activity levels by the Pregnancy Physical Activity Questionnaire (PPAQ). The primary independent variables of interest were years of school, household income, attitudes towards exercise, and social support for exercise. Years of school, household income, and attitudes towards exercise are all positively related to PPAQ-exercise activity, but attitudes towards exercise do not explain the relationships between years of school or household income and PPAQ-exercise activity. Social support for exercise, whether from family or friends, is positively associated with PPAQ-exercise activity, but only family social support for exercise positively interacts with SES in its relationship to PPAQ-exercise activity. This study has implications for clinical trials and public health

interventions aimed at augmenting exercise adherence during pregnancy to improve exercise recommendations to pregnant women and enhance maternal and child health.

Keywords: socioeconomic status, attitudes, social support, exercise, pregnancy

DEDICATION

To my father, for his unconditional love and support.

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CHAPTER 1

INTRODUCTION

While pregnancy is a unique physiological condition, the beliefs and expectations surrounding it are not necessarily derived from the nature of the condition itself. There are shared cultural meanings attached to pregnancy and these beliefs and expectations can be socially constructed. Such expectations include, for example, the recommendations for prescribing exercise during pregnancy and how the recommendations have changed to become increasingly permissive or liberal over time. While these changes have rightly shifted due to the growing scientific knowledge of the physiology of exercise during pregnancy, these shifts are also in part due to the nature of the research questions asked by medical professionals and scientists. Until the 1970s, much of this research focused on the potential negative effects of exercise on maternal-fetal health, and it was not until the late 1970s and early 1980s that researchers began to ask questions pertaining to the positive health consequences of prenatal exercise (Dempsey, Butler, and Williams 2005). Even though many unanswered questions still remain concerning the effects of exercise during pregnancy on perinatal outcomes, some evidence exists that prenatal exercise produces beneficial effects on gestational weight gain (GWG), placental volume and growth rate, and the reduced risk of C-section, with low risk to the fetus (Choi, Fukuoka, and Lee 2013; Kramer and McDonald 2006; Oteg-Ntim et al. 2012; Price, Amini, and Keppeler 2012; Renault et al. 2013; Sui, Grivell, and Dodd 2012).

Despite current recommendations that encourage exercise during pregnancy and its acknowledged health benefits, the prevalence of pregnant women meeting these recommendations in the U.S. is low (Borodulin et al. 2008; Evenson, Savitz, and Huston 2004; Gaston and Vamos 2013; Smith and Campbell 2013). In addition, some clinical trials report very low levels of adherence to their exercise interventions (Haakstad and Bo 2011a; Oostdam et al. 2012; Vinter et al. 2011), which makes interpretation of these studies problematic, and it becomes difficult to attribute any change in outcomes to the exercise interventions themselves. Prior to conducting clinical trials of exercise, investigators should examine the feasibility of a given intervention and whether participants are willing and able to adhere to exercise programs. Therefore, the overall purpose of this project has been to identify potential means to increase exercise adherence among pregnant women, with implications for randomized controlled trials of exercise as well as public health interventions at a population level. Following previous research on both pregnant and nonpregnant individuals, and drawing on sociological theories of fundamental causes and social support, this study focuses on known covariates of exercise: socioeconomic status (SES) and social support. Previous epidemiological research has found that individuals with a lower SES are less likely to be active during pregnancy and are more likely to believe that it is unsafe (Mudd et al. 2009). Some evidence, albeit limited, suggests that due to a lack of social support, pregnant women may perceive more barriers to exercise and have lower physical activity levels (Da Costa and Ireland 2013; Dumith et al. 2012). The objective of the current study is to examine how these two constructs interact and how they relate to attitudes towards prenatal exercise as well as reported exercise levels among pregnant women.

The findings of this study suggest there are some potential means to improve exercise adherence among pregnant women participating in clinical trials, which would allow researchers to draw causal conclusions about the health benefits of prenatal exercise. This study thus has the potential to improve exercise prescriptions to pregnant women in terms of frequency, intensity, and duration by informing these further studies. The results of this study may also be used to increase exercise levels in the general population of pregnant women with the goal of improving maternal and child health in the US.

CHAPTER 2

THEORETICAL FRAMEWORK

The Social Construction of the Pregnancy Experience

Many cultural meanings are associated with pregnancy, and these thoughts and ideas are not necessarily inherent to the condition. These meanings shape how women experience pregnancy, as well as how society responds to pregnancy and interacts with pregnant women. Under the social constructionist view, these cultural meanings and societal responses shape how people understand their conditions and live with them (Conrad and Barker 2010).

In other words, reproduction takes place within an ideological context and not just within an economic and social structural context, although these factors are related. Certain beliefs can affect reproduction, as the social reality of these beliefs provides a cognitive framework that guides an individual's actions. Beliefs about reproduction provide guidelines and justifications for such actions at the level of the individual, legitimizing certain childrearing practices. These ideologies provide a set of expectations, and the corresponding rationale, for an individual's reproductive behavior (Busfield 1974).

Freed (1999) argues that the experience of pregnancy and the expectations for behavior during pregnancy are constructed by individuals and communities that surround pregnant women. Doctors, health professionals, family members, and all the others who surround pregnant women tend to hold distinct opinions about pregnancy and routinely construct for women their condition and what should constitute the experience. Pregnant women frequently report that others—whether they are obstetricians, midwives, neighbors, mothers, and so forth—offer advice, often unsolicited, interposing their own beliefs or opinions on how pregnant women should feel or behave. Oftentimes these communities' conceptions are at odds with those of the woman herself and with one another. And even the dominant cultural rhetoric concerning pregnancy can change over time (Freed 1999).

Medical advice about any condition, including pregnancy or fetal development, is not entirely driven by its true nature but is constructed by social groups, such as medical professionals and scientists. For example, well into the 20th century, women were advised against dancing during pregnancy as it was believed to threaten the well-being of the fetus (Conrad and Barker 2010). In the publication "Prenatal Care," a public health campaign by the U.S. Children's Bureau from the early 1900s to the mid-1930s, it was advised that pregnant women partake in "pleasant exercise," such as "easy gardening work" on a daily basis, but not to the point of fatigue (Barker 1998). In an analysis of articles from the 1980s and 1990s by Gardner (1994), one principal "cause" of harm to the fetus was too much exercise.

Medical knowledge depends upon the social context in which it develops, or in other words, medical knowledge is negotiated, interpreted, and understood within a social context (Conrad and Barker 2010). Recommendations for exercise during pregnancy stand as an example of the social construction of the pregnancy experience, and they have changed as scientific knowledge surrounding the topic has been constructed over time. Until the 1970s, medical research focused on the theoretical and potential ill-effects of exercise during pregnancy. Early animal studies used stressors other than actual exercise stimuli, such as thermal stress or nutritional deficits, to make claims about the effects of exercise during pregnancy. These do not necessarily provide physiologically relevant levels of stress that would be experienced by healthy exercising pregnant women with an adequate nutritional intake. Not until the late 1970s and early 1980s did researchers begin to ask questions of how prenatal exercise may hold beneficial effects for the maternal-fetal unit (Dempsey et al. 2005). As the body of literature exploring the potential benefits of prenatal exercise has grown tremendously over the past decade, exercise during this stage of the life course is now recommended (ACOG 2002). The changing medical advice and scientific knowledge concerning exercise during pregnancy is just one example of the social construction of the pregnancy experience, giving credence to the notion that a sociological framework, such as fundamental causes and social support theories, is relevant to the study of behavior patterns during reproduction.

Fundamental Cause Theory

The theory of fundamental causes provides a primary framework for understanding health behaviors during pregnancy. Proposed by Link and Phelan in 1995, this approach concentrates on basic social conditions as the underlying causes of health and disease. Link and Phelan broadly defined social conditions as:

> factors that involve a person's relationships to other people. These include everything from relationships with intimates to positions occupied within the social and economic structures of society. Thus, in addition to factors like race, SES, and gender, we include stressful life events of a social nature (e.g., the death of a loved one, loss of a job, or crime victimization), as well as stress-process variables such as social support (1995, p. 81).

Fundamental cause theory attempts to contextualize risk factors or identify factors for risk factors. In other words, it is a way of understanding how people become vulnerable to individually-based risk factors and potentially how to design interventions more effectively. Examples of these "fundamental causes" are SES and social support. These social factors are possible underlying causes of disease because they affect access to resources, involve multiple risk factors and multiple outcomes, and maintain an association with health outcomes despite changing intervening mechanisms. The following sections will address these aspects of social conditions as fundamental causes of disease in further detail.

Access to Resources

Access to resources is an essential feature of fundamental causes as resources can help individuals avoid the disease itself or the negative consequences of the disease (Link and Phelan 1995). Resources are broadly defined as "money, knowledge, power, prestige, and the kinds of interpersonal resources embodied in the concepts of social support and social network" (Link and Phelan 1995, p. 87). Variables such as SES directly assess individuals' resources, but other variables, such as race/ethnicity and gender, are also closely related to one's resources, so they can also be considered fundamental causes (Link and Phelan 1995). Furthermore, those with a higher SES tend to have access to additional resources, such as social relationships or information, which can also help individuals avoid disease and optimize their health (Cockerham 2010; Link and Phelan 1995). Because fundamental causes involve access to resources, they have persistent associations with health outcomes (Link and Phelan 1995).

Multiple Risk Factors and Multiple Outcomes

Another aspect of fundamental causes is change over time in the diseases afflicting individuals and the risk factors for those diseases, including the knowledge of those risks and treatments for the disease. Regardless of which diseases pose current threats and what the risk factors for those diseases might be, people who are better positioned with the most resources will be less likely to be afflicted by the disease or its negative consequences. Scientific knowledge of the importance of lifestyle factors in health, such as diet and exercise, did not always exist. When their importance became known, they became linked to SES, as those with higher SES would be most likely to have access to this new knowledge and be more able to implement appropriate changes in their lifestyle. Again, since fundamental causes involve access to resources, they tend to influence multiple risk factors and multiple health outcomes (Link and Phelan 1995).

Replacement of Intervening Mechanisms

These social conditions are considered "fundamental" causes because addressing the intervening mechanisms does not necessarily eliminate their health effects. SES is seen as a fundamental cause because of its persistent associations with various diseases (House et al. 1990, 1994 as cited in Link and Phelan 1995), despite changing intervening mechanisms. Individuals with a higher SES may be better informed about health behaviors, such as diet and exercise, and better able to implement changes in these behaviors. Yet even if the risk factors mediating these associations change, high SES individuals are more favorably positioned to know about these risks and have access to the resources that may protect them from these new risks. Overall, this approach attempts to contextualize risk factors and focus on fundamental causes of disease, which involve access to resources and thus multiple risk factors and outcomes, persisting despite changes in intervening mechanisms (Link and Phelan 1995).

Social Support Theory

Later, in 2000, Cohen, Underwood, and Gottlieb introduced a main effect model for explaining the potential direct effects of social relationships on health and the corresponding mechanisms. This model posits that everyone is subject to the influences of his or her social networks on normative health behaviors, including diet and exercise. These network ties can provide information or provide tangible resources, such as food, transportation, etc., which could influence health behavior or exposure to risk factors and ultimately impact physical and mental health.

In this model, social relationships exert social influence, provide services, or distribute information that may affect physical health through health behaviors. These social relationships may also have more direct influences on physical health through endocrine, immune, or cardiovascular effects. Social ties may also influence psychological states either through similar mechanisms (i.e. information) or directly, which can then affect health behaviors or neuroendocrine responses, leading to physical and mental health outcomes.

There are various supportive functions of these social relationships: emotional support, instrumental support, informational support, companionship support, and validation. Emotional support may include discussing feelings or stressors and indicate sympathy, caring, or acceptance, which can then potentially alter the appraisal of threatening life events, reduce anxiety or depression, increase self-esteem, and enhance coping. Instrumental support is the provision of tangible resources, such as money, transportation, child care, housework, etc., that assists in the solving of practical problems and frees time for other efforts or coping. Informational support provides information about potential resources and courses of action, which assists in the acquisition of resources and effective coping—though it should be noted that informational support could potentially be negative if provided information contains errors or leads individuals to adopt negative health behaviors. Companionship support means having a partner for various activities, such as exercise, entertainment, dining, trips, etc., which may produce positive affect through coping or distraction from problems. Lastly, validation, also known as feedback or social comparison, provides information on the consensus about the prevalence of problems or normativeness of an individual's status, behavior, or feelings, which may increase feelings of normalcy, acceptance, and favorable comparison (Cohen et al. 2000). Thus there are several forms of social support that may affect health or health behaviors, or both, through various mechanisms.

Fundamental causes such as SES and social support are related to numerous health behaviors and outcomes, including health behaviors during pregnancy such as exercise. SES and social support are also related to access to resources, such as money, transportation, and information (Link and Phelan 1995), which could potentially affect one's level of exercise during pregnancy. Those with more information, companionship, or instrumental support may be more likely to adopt and maintain exercise behaviors during pregnancy. In addition, given that the knowledge of the health benefits of prenatal exercise is relatively new and is still being developed and accumulated following research beginning in the 1980s (Dempsey et al. 2005), those of higher SES, particularly with higher levels of education, and those with more informational support, would be more likely to be aware of these health benefits and thus adopt recommended behaviors earlier than other social groups (Cockerham 2010; Link and Phelan 1995). Again, the knowledge of the health benefits of exercise during pregnancy and thus the recommendations for prenatal exercise have changed over time, providing an appropriate behavior to examine this trend. The following section will review the literature and provide an overview of how these recommendations have changed over time.

CHAPTER 3

LITERATURE REVIEW

Recommendations for Exercise during Pregnancy

In the U.S. there are two main governing bodies that provide guidelines for exercise during pregnancy: the American College of Sports Medicine (ACSM) and the American Congress of Obstetricians and Gynecologists (formerly known as the American College of Obstetricians and Gynecologists) (ACOG). The ACSM published the first edition of *Guidelines for Graded Exercise Testing and Exercise Prescription* in 1975 and most recently published *ACSM's Guidelines for Exercise Testing and Prescription* in 2014. The ACOG published its first guidelines for exercise during pregnancy in a technical bulletin in 1985. They updated their guidelines in 1994 and 2002, and then reaffirmed them in 2009. In addition, the Department of Health and Human Services (DHHS) issued the first physical activity guidelines for Americans in 2008, which included exercise guidelines for pregnant women. Recommendations for exercise during pregnancy have changed over time, reflecting the changing attitudes towards prenatal exercise among clinicians and scientists and the increasing scientific knowledge of the benefits of maternal exercise. The tables below provide a brief summary of how these recommendations from the ACSM and ACOG have changed over time and how the most recent recommendations differ between the ACSM, ACOG, and the DHHS. For a more detailed summary of these guidelines, see Appendix A.

Table 1
Summary of the ACSM's guidelines for exercise prescription during pregnancy.

Year	Frequency	Intensity	Time	Type	Progression
1975	-	-	-	-	-
1980	-	-	-	-	-
1986	-	Lower intensity, use HR or RPE (around 12).	-	Non-weight-bearing activities in the 3rd trimester. No contact sports.	-
1991	3-5 days/week.	12-14 RPE, "talk test."	15-30 minutes.	Walking, non-weight-bearing activities. No competitive athletic training. Weight training controversial.	Gradually increase intensity and time only in the 2nd trimester.
1995	-	-	-	-	-
2000	-	-	-	-	-
2006	Most, if not all, days. 3 days/week minimum.	Moderate intensity (11-13 RPE), no overly vigorous activity in the 3rd trimester.	30-40 minutes.	No contact activities or those with high risk for falling, abdominal trauma, or excessive joint stress. No activities at high altitudes or scuba diving.	Those sedentary prior to pregnancy should begin with light intensity activity (20-39% HRR) and low- or non-impact activities.
2010	Most, if not all, days. 3 days/week minimum.	Moderate intensity (40-60% VO_2 reserve, 12-14 RPE, 125-155 BPM, "talk test").	15-30 minutes (150 minutes/week).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Previously sedentary should gradually increase to the recommended levels.
2014	3-4 days/week.	Light intensity if BMI $\geq$ 25 (101-124 BPM) or moderate intensity if BMI < 25 (129-160 BPM).	15-30 minutes with 10-15 minute warm-up and 10-15 minute cool-down (150 minutes/week total).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Gradually progress to recommended levels after the 1st trimester. Minimum of 15 minutes/day, 3 days/week at appropriate HR or RPE to max of 30 minutes/day, 4 days/week at appropriate HR or RPE.

HR = heart rate
RPE = rating of perceived exertion
HRR = heart rate reserve
BPM = beats per minute
BMI = body mass index

While over time the ACSM's recommendations for exercise during pregnancy have generally increased in frequency, intensity, and duration, the most recent recommendations are more conservative than the previous guidelines, particularly for women with a body mass index (BMI) greater than or equal to 25. Much remains unknown to the precise frequency, intensity, time, and types of exercise to be prescribed to this population, and further research that can provide a strong evidence base for these types of recommendations is surely needed.

Table 2
Summary of the ACOG's guidelines for exercise prescription during pregnancy.

Year	Frequency	Intensity	Time	Type	Progression
1985	-	HR < 140 BPM.	≤ 15 minutes.	-	-
1994	3 days/week minimum.	Mild to moderate intensity. No data in humans to suggest limiting exercise intensity, but women should not exercise to exhaustion.	-	Non-weight-bearing exercises, such as cycling or swimming. Weight-bearing exercises may be continued under some circumstances. Avoid activities that have the potential for abdominal trauma.	-
2002/2009	Most, if not all days of the week.	Moderate intensity.	30 minutes or more.	Avoid activities with a high risk of falling or abdominal trauma, as well as scuba diving and activity at altitudes > 6,000 feet.	Women with a history or risk of PTB or IUGR should reduce activity in the 2nd and 3rd trimesters.

BPM = beats per minute
PTB = preterm birth
IUGR = intrauterine growth restriction

Similar to the ACSM guidelines, the recommendations for exercise during pregnancy from the ACOG began relatively conservatively, but have become more liberal over time. In comparison with to the ACSM's recommendations, the most current recommendations from the ACOG are less conservative in terms of frequency and duration, and potentially in some cases, intensity. Again, further research is needed to provide a stronger evidence base for the prescription of exercise frequency, intensity, and duration in this population.

Table 3
Summary of the current guidelines for exercise prescription during pregnancy from the ACSM, ACOG, and the DHHS.

Organization	Year	Frequency	Intensity	Time	Type	Progression
ACSM	2014	3-4 days/week.	Light intensity if BMI $\geq$ 25 (101-124 BPM) or moderate intensity if BMI < 25 (129-160 BPM).	15-30 minutes with 10-15 minute warm-up and 10-15 minute cool-down (150 minutes/week total).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Gradually progress to recommended levels after the 1st trimester. Minimum of 15 minutes/day, 3 days/week at appropriate HR or RPE to max of 30 minutes/day, 4 days/week at appropriate HR or RPE.
ACOG	2002/2009	Most, if not, all days of the week.	Moderate intensity.	30 minutes or more.	Avoid activities with a high risk of falling or abdominal trauma, as well as scuba diving and activity at altitudes > 6,000 feet.	Women with a history or risk of PTB or IUGR should reduce activity in the 2nd and 3rd trimesters.
DHHS	2008	-	Moderate intensity for women who were previously inactive and vigorous intensity for women who are already highly active.	At least 150 minutes throughout the week.	Avoid activities with a high risk for falling or abdominal trauma, which includes contact or collision sports. Women who habitually strength train should continue during pregnancy.	Women who were previously inactive should increase the amount of activity gradually over time.

BMI = body mass index
BPM = beats per minute
HR = heart rate
RPE = rating of perceived exertion
PTB = preterm birth
IUGR = intrauterine growth restriction

The recommendations from the DHHS are probably the most liberal of the three organizations, given their encouragement of the continuation of high-intensity exercise during pregnancy and longer durations of exercise, while the current recommendations from the ACSM are probably the most conservative, limiting the frequency, intensity (specifically among women with a BMI of 25 or more), and duration of exercise. Only the ACSM and the DHHS make any suggestions concerning resistance training, albeit very general. All of the organizations advise that pregnant women avoid activities with a high risk for falling or abdominal trauma.

While the DHHS guidelines discuss the evidence base for its recommendations, they do not provide any references to scholarly literature. However, the DHHS guidelines rightly point out that some of the evidence is not conclusive and the effects of high-intensity activity during pregnancy have not been studied carefully. While the ACOG does cite some scholarly literature in its document, these are not cited as the basis for their recommendations to pregnant women, but instead cite the ACSM's 2000 exercise guidelines for the general population. The ACSM does provide references to primary sources in some of its recommendations, but unfortunately, these studies are also not conclusive and are not the best data available to date. It should be reiterated that there are still considerable questions as to the optimal exercise prescription for the pregnant woman in terms of the frequency, intensity, time, and type of activities that can maximize maternal and child health while also minimizing the risk to the maternal-fetal unit. Further research that is conclusive and compelling is necessary.

Exercise during Pregnancy and Maternal and Child Health

Prenatal exercise appears to present multiple health benefits and limited risk to both the mother and her offspring. Some evidence suggests that exercise during pregnancy can reduce excess GWG, specifically among overweight and obese women and especially when combined with a dietary intervention and supervision (Choi et al. 2013; Oteg-Ntim et al. 2012; Sui et al. 2012). A recent randomized controlled trial found that, irrespective of a dietary intervention, exercise reduced excess GWG among obese pregnant women (Renault et al. 2013). Among previously sedentary women, prenatal exercise increases placental volume at delivery and placental growth rate, but with no difference in placental weight at delivery (Kramer and McDonald 2006; Price et al. 2012). Exercise does not appear to affect the risk for gestational diabetes mellitus (GDM), maternal hyperglycemia, or preeclampsia and other hypertensive disorders of pregnancy (Han, Middleton, and Crowther 2012; Kasawara et al. 2012; Kramer and McDonald 2006; Meher and Duley 2006; Price et al. 2012). Given that GDM only occurs in roughly seven percent of pregnancies (ADA 2012) and preeclampsia only up to eight percent of pregnancies (NHLBI 2000), relatively small randomized controlled trials are likely underpowered to detect differences in the risk for GDM or hypertensive disorders of pregnancy. Randomized controlled trials of exercise during pregnancy have not found any differences between groups in offspring birth weight, Ponderal Index (ratio of body mass to length cubed), risk of small-for-gestational-age (SGA), or risk of large-for-gestational-age (LGA) or macrosomia (Han et al. 2012; Kramer and McDonald 2006; Price et al. 2012). There has only been one clinical trial, which involved an increase and then a decrease in exercise among previously active women, which indicated that prenatal exercise increases birthweight and the Ponderal Index among offspring (Kramer and McDonald 2006). Exercise during pregnancy also has no effect on gestational age at birth or the risk for preterm birth (PTB) (Han et al. 2012; Kramer and McDonald 2006; Price et al. 2012). While compelling evidence that exercise during pregnancy reduces the risk for adverse perinatal outcomes (GDM, hypertensive disorders of pregnancy, SGA, LGA, or PTB) is limited, neither is there any evidence that such exercise increases these adverse outcomes. One randomized controlled trial found that previously sedentary women who exercised during pregnancy had a dramatically lower risk for C-section (Price et al. 2012). Overall, there is some evidence that exercise during pregnancy is beneficial, at least in terms of GWG, placental volume, and risk of C-section, but further research examining exercise and perinatal outcomes is still needed. Furthermore, it appears that pregnant women without medical contraindications to exercise are at low risk for adverse events during moderate levels of exercise, regardless of physical activity or fitness levels prior to pregnancy (Bredin et al. 2013).

Prevalence and Patterns of Prenatal Exercise

Despite the encouragement of prenatal exercise from the ACSM, ACOG, and the DHHS and the potential health benefits of exercise during pregnancy for both the mother and the offspring, exercise adherence among pregnant women is low in the US. Most women do not meet recommended levels of exercise during pregnancy (Borodulin et al. 2008). Only 22 percent of pregnant women participate in at least 30 minutes of moderate or vigorous activity at least three times per week in mid-pregnancy and only 26 percent in late pregnancy (Smith and Campbell 2013). Furthermore, the prevalence of adhering to leisure-time physical activity (LTPA) recommendations is lower among pregnant women than among nonpregnant women: 15.8 percent vs. 26.1 percent, respectively (Evenson et al. 2004; Gaston and Vamos 2013). In addition, longitudinal data indicates that overall physical activity levels tend to decrease over the course of gestation (Borodulin et al. 2008; Duncombe et al. 2009). Women who are active prior to pregnancy and continue their exercise during pregnancy tend to decrease their activity in terms of intensity and duration of exercise (Ning et al. 2003).

Previous Exercise Interventions during Pregnancy

Not only is adherence to the exercise recommendations among the general population of pregnant women low, but also previous randomized controlled trials in this population have had low levels of adherence to the exercise interventions. One randomized controlled trial of exercise among pregnant women reported that only 40 percent of the women in the exercise group attended 80 percent or more of the prescribed exercise sessions (Haakstad and Bo 2011b). The same trial had only 27 percent of the women in the exercise group attend 100 percent of the 24 exercise sessions (Haakstad and Bo 2011a). Another clinical trial reported only 16.3 percent of the women attended at least 50 percent of the exercise sessions and compliance was higher in the first 24 weeks of pregnancy (33.3 percent) than after the first 24 weeks of pregnancy (11.1 percent). While the demographic characteristics of the women who were adherent in early pregnancy were similar to those who were not adherent, in later pregnancy, those who were compliant tended to be White, more highly educated, working, and nulliparous (Oostdam et al. 2012). In the Lifestyle in Pregnancy Study in obese women, only 56 percent of the women in the intervention attended at least half of the aerobic classes (Vinter et al. 2011). This trial also included a free gym membership and only 10 percent of participants in the intervention arm used the membership (Vinter et al. 2011; Vinter 2013). Low levels of adherence to exercise interventions make interpretation of the results of a given study problematic; it is difficult to attribute any changes in the outcomes to the intervention itself and not to some other characteristics of the participants who complied with the intervention. In order to further our understanding of prenatal exercise and perinatal health outcomes, future clinical trials must be conducted and obtain higher levels of adherence among their participants. Doing so could inform and potentially improve exercise prescriptions to pregnant women.

Correlates of Prenatal Exercise

Socioeconomic Status and Attitudes

Income and education are positively related to physical activity levels during pregnancy (Ning et al. 2003). Having an income less than $25,000 per year is associated with a reduced likelihood of participating in any exercise activity in pregnancy (Mudd et al. 2009). More years of school increase the likelihood of being active during pregnancy (Dumith et al. 2012). Those with a college education are more likely to engage in any LTPA (Amezcua-Prieto et al. 2013; Evenson et al. 2004), including exercise in late pregnancy (Foxcroft et al. 2011). In addition, those with a high school education or greater are more likely to meet the recommended levels of prenatal activity (Evenson et al. 2004; Gaston and Vamos 2013). Conversely, those pregnant women who have not completed high school are less likely to participate in any exercise activity during pregnancy. There is also an increased likelihood of perceiving moderate physical activity during pregnancy as unsafe among those who have not completed high school. Having this perception is associated with an increased likelihood of avoiding moderate or vigorous physical activity (Mudd et al. 2009). More specifically, believing low- to moderate-intensity exercise to be unsafe is linked with reduced amounts of exercise activity in pregnancy; likewise, believing weight-bearing exercise to be unsafe correlates to reduced exercise intensity in pregnancy (Duncombe et al. 2009). On the contrary, the number of perceived benefits of prenatal exercise is positively related to exercise during pregnancy (Symons Downs and Ulbrecht 2006). SES may be seen as a fundamental cause of exercise levels during pregnancy, as those with higher incomes may have greater access to resources to support the implementation of exercise behaviors, and those with higher levels of education may adopt this behavior more readily because they may be better informed about the benefits of exercise during pregnancy (Cockerham 2010; Link and Phelan 1995). While sociological theory and previous work suggests that attitudes towards exercise during pregnancy may explain the association between SES and prenatal exercise levels, previous research has not specifically tested for mediation.

Social Support

There is also some evidence to suggest that social support is positively related to exercise levels during pregnancy. Women report that their husbands or partners have the strongest normative influence on their exercise behavior during pregnancy, followed by other family members, doctors/nurses, and then friends and coworkers (Symons Downs and Ulbrecht 2006). Among women who were inactive prior to pregnancy, family social support for exercise is inversely related to perceived barriers to exercise during pregnancy (Da Costa and Ireland 2013). Receiving advice in prenatal care to exercise is also associated with an increased likelihood of being active in pregnancy (Dumith et al. 2012). One clinical trial, which consisted of exercise counseling and monthly group meetings, found that the intervention group had a smaller decrease in the frequency of exercise from early pregnancy to mid-pregnancy (Aittasalo et al. 2012). However, to the best of the author's knowledge, no studies have tested for an association between social support for exercise and exercise behavior during pregnancy specifically. In addition, no previous studies have tested for an interaction between SES and social support for exercise in relation to exercise during pregnancy. Overall, the existing evidence suggests that there are potential underlying causes, such as SES and social support, of women's exercise attitudes and behaviors in pregnancy.

CHAPTER 4

CONCEPTUAL MODEL AND HYPOTHESES

Summary and Conceptual Model

The recommendations for exercise prescription during pregnancy have changed over time, becoming less conservative since the 1980s, which supports the notion that the beliefs related to pregnancy, and specifically exercise during pregnancy, are socially constructed. While there is evidence that prenatal exercise provides health benefits to both the mother and the offspring, few women meet the recommendations for exercise during pregnancy and previous exercise trials have failed to obtain high levels of adherence to the interventions. Previous work has indicated that SES and social support may influence exercise attitudes and behaviors during pregnancy. These findings suggest that SES and social support may be underlying causes or “fundamental causes” of exercise behavior and may be potential avenues for increasing exercise adherence among pregnant women.

In the conceptual model in this study, SES is positively related to prenatal exercise and this relationship is explained at least in part by attitudes towards exercise during pregnancy, although SES may have influences through other mechanisms. Social support is also positively related to prenatal exercise, but this relationship may be dependent on the level of SES. Figure 1 below depicts the conceptual model for the current study, based on the previous review of sociological theory and the existing scientific literature.

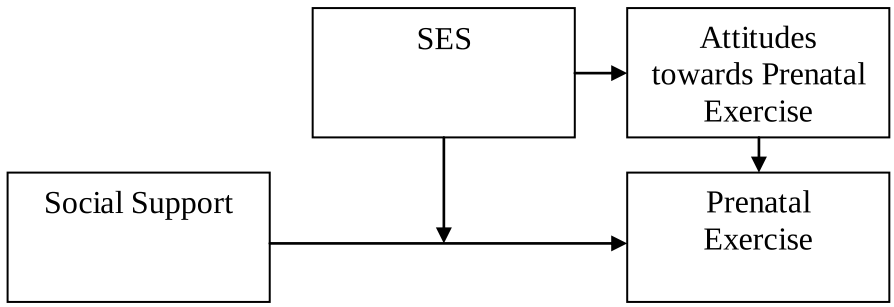

Figure 1. Conceptual model for the study.

Specific Aims and Hypotheses

Specific Aim 1

To examine the associations between SES, attitudes towards prenatal exercise, and prenatal exercise levels.

Hypothesis 1a. Years of school are positively associated with PPAQ-exercise activity.

Hypothesis 1b. The association between years of school and PPAQ-exercise activity is mediated by attitudes towards prenatal exercise.

Hypothesis 1c. Household income is positively associated with PPAQ-exercise activity.

Hypothesis 1d. The association between household income and PPAQ-exercise activity is mediated by attitudes towards prenatal exercise.

Specific Aim 2

To examine the relationship between social support for exercise and prenatal exercise levels.

Hypothesis 2a. Family social support for exercise is positively associated with PPAQ-exercise activity.

Hypothesis 2b. Friends' social support for exercise is positively associated with PPAQ-exercise activity.

Specific Aim 3

To test for interactions between social support for exercise and SES in relation to prenatal exercise levels.

Hypothesis 3a. There is a positive interaction between family social support for exercise and years of school in their relation to PPAQ-exercise activity.

Hypothesis 3b. There is a positive interaction between family social support for exercise and household income in their relation to PPAQ-exercise activity.

Hypothesis 3c. There is a positive interaction between friends' social support for exercise and years of school in their relation to PPAQ-exercise activity.

Hypothesis 3d. There is a positive interaction between friends' social support for exercise and household income in their relation to PPAQ-exercise activity.

Based on the conceptual model and these specific aims and hypotheses, the following chapter details the methodology utilized to test these hypotheses and address these aims.

CHAPTER 5

METHODOLOGY

Study Population and Sampling

The population of interest is pregnant women able to be active during pregnancy, i.e. women who have no medical contraindications to exercise during pregnancy. Women were recruited from the waiting rooms of UAB's Center for Women's Reproductive Health (CWRH). Women waiting for prenatal care were approached by informing them of the study, asking whether they were interested in participating, and screening them for eligibility. Women were considered eligible if they were pregnant, at least 19 years of age, and read and spoke English fluently. Pregnant women were also recruited by placing flyers at other prenatal care offices, mainly UAB's Women and Infants Center, as well as around UAB's campus and local libraries. Flyers were also distributed to educators of local Lamaze and other child birthing classes or directly to pregnant women. Interested women were screened for eligibility by telephone or email; those who also met the inclusion/exclusion criteria were scheduled to come to UAB's campus to go over the consent form and fill out the questionnaire. Prior to recruitment, the study protocol was approved by the UAB Institutional Review Board (X140730004) and prior to data collection, informed consent from all participants was obtained and documented.

In addition, data from the first study visit of women enrolled in the Pregnancy and Early Life in the South (PEARLS) Study were included. This is an observational longitudinal study of the potential determinants of GWG of Black and White women in the Deep South. These women were also recruited from UAB's CWRH and other UAB Obstetrics Clinics at area Health Departments. The automated obstetric record was prescreened for potentially eligible women using the inclusion/exclusion criteria. Women who were potentially eligible were sent a letter and received a telephone call to inform them of the study. If they were reached by telephone, they were further prescreened by telephone. If they were not reached by telephone, a study recruiter informed them of the study at their dating ultrasound appointment. The PEARLS Study was also advertised by placing brochures in the waiting rooms of the various clinics of the CWRH. If a woman was eligible and interested in the study, study staff scheduled the first study visit between 10 and 14 weeks gestation to complete the screening process, go over the study protocol, obtain and document informed consent, and fill out the questionnaires, among other study assessments. The inclusion and exclusion criteria for the PEARLS Study are listed below.

PEARLS Inclusion Criteria

- Self-identify as Black/African-American or White/Caucasian
- At least 16 years of age
- BMI $\geq$ 25 kg/m^2 at enrollment
- Pregnant with singleton gestation
- Presenting for prenatal care prior to 14 weeks gestation (but not screened until 8 weeks gestation)
- No plans to move or change obstetric providers with the next 18 months

PEARLS Exclusion Criteria

- Self-identify as a race other than Black/African-American or White/Caucasian
- BMI > 45 kg/m^2
- Pregnant with multiple gestation
- Known fetal anomaly (lethal or major)
- Serious medical illness including, but not limited to, hypertension requiring > 1 medication for control, connective tissue disorders, asthma requiring maintenance medication, transplant, HIV, and sickle cell disease
- Diabetes prior to gestation (Type 1 or Type 2)
- Major psychiatric illness
- Alcohol and/or drug use during pregnancy
- History of PTB prior to 34 weeks gestation (spontaneous or indicated)
- Prior bariatric surgery
- Recent participation in a weight loss program
- Live outside of the Birmingham metropolitan area
- Unwillingness or inability to participate in multiple planned assessments

Women who reported they were told to limit their physical activity to prevent miscarriage and/or were placed on bed rest by a health care provider were excluded from the final analyses.

Survey Methodology

After screening participants for eligibility and obtaining informed consent, participants were given a paper and pencil questionnaire to fill out. The author was available to the participants to assist with filling out the questionnaire or to answer any questions. If they did not wish to complete the questionnaire while they were at the clinic, they were provided with a pre-addressed and stamped envelope so that they could fill out the survey and return it at their convenience. PEARLS Study participants were administered the questionnaires via interview by study staff. Participants were compensated for their time with a small incentive, such as an infant toy, baby wipes, or outlet plugs. Women in the PEARLS Study received monetary compensation in the amount of $20 for the first study visit, which was commensurate with the study burden as there were further and more invasive assessments associated with participation in the PEARLS Study.

Survey Measures

Pregnancy Physical Activity Questionnaire

The Pregnancy Physical Activity Questionnaire (PPAQ) is a questionnaire that was developed and validated among pregnant women to assess activity levels during the current trimester. It ascertains information about the time spent in 32 various activities and responses are converted to MET-hours per week for each of the following types of activity: total, sedentary, light, moderate, vigorous, household/caregiving, occupational, and sports/exercise (Chasan-Taber et al. 2004). One MET or metabolic equivalent is the energy expenditure of the average person at rest, which is assumed to be

3.5 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$. A MET value of less than 3.00 corresponds to light activity, between 3.00 and 5.99 moderate activity, and 6.00 and above vigorous activity (Freedson, Melanson, and Sirard 1998). Activities are assigned an activity code and intensity level from the Compendium of Physical Activities (Ainsworth et al. 2000). However, the MET values from this compendium are based on data from men and nonpregnant women, so MET intensities based on data from pregnant women are used when available, which only include walking and light- to moderate-intensity housework (Chasan-Taber et al. 2004). The test-retest reliability of the PPAQ is strong, ranging from 0.78 to 0.81 for activity of varying intensities and from 0.83 to 0.93 for the various types of activities. When comparing the PPAQ to ActiGraph data, an objective measure of activity, correlations are considerably more moderate, ranging from 0.20 to 0.49 for moderate activity, depending on the ActiGraph algorithms used. Exercise activity from the PPAQ was the primary dependent variable since increasing exercise, not just any physical activity, is the predominant interest of the current study.

Socioeconomic Status

SES, which comprises some of the primary independent variables of interest, was assessed in multiple ways. Education was measured by two questions: "How many years of school have you completed?" and "What is the highest grade or year of school completed?" Responses for the latter question included never attended school or only attended kindergarten, Grades 1 through 8 (Elementary), Grades 9 through 11 (Some high school), Grade 12 or GED (high school graduate), College 1 year to 3 years (Some college or technical school), College 4 years or more (College graduate), and Post-

College graduate (Master's degree, Doctoral degree, or professional degree). This measure was adapted from the 2013 Behavioral Risk Factor Surveillance System Survey. However, years of school, as opposed to education completed, were utilized in the analyses to maintain statistical power. Total family income was obtained by asking the question, "What was your total household income last year?" and responses included less than $10,000; $10,000 to $19,999; $20,000 to $29,999; $30,000 to $39,999; $40,000 to $49,999; $50,000 to $59,999; $60,000 to $69,999; $70,000 to $79,999; $80,000 to $89,999; $90,000 to $99,999; and $100,000 or more. These responses were coded 0 through 10. This question was adapted from the 2009 Pregnancy Risk Assessment Monitoring System (PRAMS), Phase 6 Core Questionnaire, and prior work by investigators at UAB.

Attitudes towards Prenatal Exercise

Attitudes towards exercise were assessed by six seven-point differential scales following this statement: "I feel my participation in exercise at the present time is...". Three adjective pairs measure cognitive attitudes (useless/useful, harmful/beneficial, and foolish/wise) and three pairs measure affective attitudes (unenjoyable/enjoyable, unpleasant/pleasant, and stressful/relaxing). The responses scale from one to seven with lower scores indicating a more negative attitude and higher scores indicating a more positive attitude. All of the items were summed to create an overall attitude towards exercise scale. Internal consistency based on Chronbach's alpha for each of the cognitive and affective subscales is 0.85 (Jordan et al. 2002).

Social Support for Exercise

Social support for exercise is a scale to assess social support specific to exercise behaviors from both family and friends. These scales use 13 items following the statement, "During the past 3 months my family (or members of my household)…" or "…friends...". Examples of items include "Exercised with me", "Offered to exercise with me", and "Gave me helpful reminders to exercise". Respondents indicate the frequency of these various items, which include none (1), rarely (2), a few times (3), often (4), and very often (5). There are two subscales for family, participation and rewards/punishment, and one for friends, participation. The test-retest reliabilities of the social support for exercise scales range from 0.55 to 0.79 and the Chronbach's alphas range from 0.61 to 0.91. These subscales are also moderately correlated with self-reported vigorous exercise (r ranging from 0.23 to 0.46, $p < 0.001$) (Sallis et al. 1987). Only the participation subscales for family and friends' social support for exercise were used as independent variables for the current study with higher scale scores indicating greater social support for exercise.

Covariates

Previous research indicates that those who tend to adhere more to exercise interventions are generally White, working, and nulliparous (Oostdam et al. 2012). The following factors were assessed for potential use as covariates: gravity, parity, prepregnancy BMI, gestational age in weeks at the time of survey, gestational age in weeks at first prenatal care visit, advice to limit physical activity to prevent miscarriage or to take complete bed rest by a health care provider, maternal age in years, race/ethnicity, and marital status, among others. These measures came from National Health and Nutrition Examination Survey, the National Maternal and Infant Health Survey, the National Survey of Family Growth, PRAMS, and the National Longitudinal Study of Adolescent Health. Race was coded as 0 for White and 1 for Other races (Black/African-American; American Indian or Alaskan Native; Asian, Hawaiian, or Pacific Islander; Hispanic or Latina; Multiracial; or Other). Marital status was also dichotomized with 0 corresponding to married or living with a partner and 1 corresponding to single, which consisted of widowed, divorced, separated, or never married.

Analytic Strategy

Women who reported they were advised by a health care provider to limit physical activity to prevent miscarriage or to take bed rest were excluded from the final analyses. Women who did not have complete data on all the variables of interest were also excluded. There was no evidence that those who did not have complete data were systematically different from those who had complete data. Prior to any inferential statistical analyses, descriptive statistics were calculated on all variables. In addition, the distributions of all variables were checked for skewness. Many variables were skewed, so Spearman correlation coefficients were considered appropriate for the bivariate analyses. Plots of the primary independent variables of interest (years of school, household income, attitudes towards exercise, family social support for exercise, and friends' social support for exercise) and the dependent variable (PPAQ-exercise activity) were inspected to check for potential nonlinear relationships and none were detected.

Prior to the multivariate analyses, all continuous variables were mean centered to minimize any potential multicollinearity issues. Additionally, all variance inflation factors (VIF) were inspected during the multivariate analyses and all VIFs were below 10.0, indicating that multicollinearity was not an issue (DeMaris 2004).

To test Hypotheses 1a, 1b, 1c, and 1d, which state that SES, whether years of school or household income, is positively associated with PPAQ-exercise activity and that these relationships can be explained by attitudes towards exercise, Oaxaca-blinder decomposition analyses were run. However, there was no statistically significant difference between higher income (at least $20,000) and lower income ($19,999 or less) women in their PPAQ-exercise activity, likely due to the loss of statistical power when dichotomizing this variable. Therefore, ordinary least squares (OLS) regressions were run to test these hypotheses, using the Baron and Kenny (1986) approach for testing for mediation. OLS regressions were also utilized to test Hypotheses 2a and 2b, which states that social support for exercise, whether from family or friends, is positively associated with PPAQ-exercise activity and to test Hypotheses 3a through 3d, which state that SES moderates the association between social support for exercise and PPAQ-exercise activity. Statistical analyses were run in SPSS 22 (Armonk, NY) and Stata 14 (College Station, TX).

CHAPTER 6

RESULTS

Descriptive Statistics

Descriptive statistics for the study sample are reported in Table 4. The mean age of participants at the time of the survey was 27.53 years. Almost one-third of respondents were White or Caucasian (30.53 percent), with a vast majority of the remainder of the sample self-identifying as Black or African-American (65.26 percent). The rest identified as American Indian or Alaskan Native (1.05 percent), Multiracial (2.10 percent), or Other (1.05 percent). Roughly half of the sample reported being married (29.47 percent) or living with a partner (28.42 percent) and the rest of the sample reported being divorced (5.26 percent), separated (4.21 percent), or never married (32.63 percent). The mean prepregnancy BMI was about 30, so, on average, participants were obese prior to pregnancy. The mean number of pregnancies of respondents was 2.87 and the mean number of deliveries was 1.36. Every woman reported access to prenatal care, with the mean gestational age at first prenatal care visit being 8.15 weeks. The mean gestational age at the time of the survey was 20.84 weeks, roughly mid-pregnancy for human gestation, the full length of which is 40 weeks. Only about 10 percent of women reported currently being in school, and about 50 percent reported being currently employed. Twenty percent of the sample had private insurance, with the remaining having Medicaid or some other form of government insurance (75.79 percent) or no insurance (4.21 percent). In addition, 60.00 percent of the sample reported receiving benefits from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). On average, women reported 13.58 years of school, and 17.89 percent reported having completed a college degree or more. A little less than one-third of participants had a total household income of $20,000 or more. Means for the various scales (attitude towards exercise and social support for exercise) are also reported in Table 4. Descriptives for each of the scale items, as well as confirmatory factor analyses and Chronbach's alphas for each of the scales, are reported in Appendix B. The average PPAQ-exercise activity for the women in the sample was 10.84 MET-hours/week. Most of the variables were positively skewed, with the exception of attitudes towards exercise, which was negatively skewed.

Table 4
Descriptive statistics for the study sample (*N* = 95).

	Mean/ Percentage	Standard Deviation	Minimum	Maximum
Age (years)	27.53	5.61	19.18	43.54
Race[1]				
American Indian or Alaskan Native	1.05	-	-	-
Black	65.26	-	-	-
Multiracial	2.10	-	-	-
Other	1.05	-	-	-
White	30.53	-	-	-
Marital status[1]				
Married	29.47	-	-	-
Living with partner	28.42	-	-	-
Divorced	5.26	-	-	-
Separated	4.21	-	-	-
Never married	32.63	-	-	-
Prepregnancy BMI (lbs/in^2*703)	30.49	8.55	14.82	60.76
Gravity	2.87	1.75	1.00	9.00
Parity	1.36	1.30	0.00	6.00
Gestational age at 1st PNC (weeks)	8.15	3.96	2.00	28.00
Gestational age at survey (weeks)	20.84	10.19	9.00	41.00
Currently in school	10.53	-	-	-
Currently employed	50.53	-	-	-
Health insurance				
Private	20.00	-	-	-
Government	75.79	-	-	-
No insurance	4.21	-	-	-
WIC	60.00	-	-	-
Years of school	13.58	2.82	9.00	21.50
Education[1]				
College degree or higher	17.89	-	-	-
High school diploma or less	82.10	-	-	-
Household income				
< $20,000	70.53	-	-	-
$\geq$ $20,000	29.47	-	-	-
Attitude towards exercise	30.74	8.60	9.00	42.00
Family social support for exercise	20.26	9.53	10.00	46.00
Friends' social support for exercise	16.29	7.53	10.00	40.00
PPAQ-exercise activity (MET-hours/week)	10.84	15.14	0.00	76.55

Notes:
[1]Does not sum to 100.00 due to rounding error
BMI = body mass index
PNC = prenatal care visit
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Bivariate Analyses

Because the variables of interest were skewed, Spearman correlation coefficients among interval/ratio variables are reported in Table 5. Years of school are positively related to PPAQ-exercise activity ($r = 0.26$, $p < 0.05$), although this relationship is weak. There is also a weakly positive relationship between household income and PPAQ-exercise activity that is nearly statistically significant ($r = 0.14$, $p = 0.16$). Attitude towards prenatal exercise is moderately and positively related to PPAQ-exercise activity ($r = 0.57$, $p < 0.001$). Family social support for exercise is also weakly related to PPAQ-exercise activity ($r = 0.34$, $p < 0.001$). There is also a weakly positive relationship between friends' social support for exercise and PPAQ-exercise activity ($r = 0.21$, $p < 0.05$).

Both gravity and parity are moderately positively correlated with maternal age ($r = 0.34$, $p < 0.001$ and $r = 0.40$, $p < 0.001$, respectively) and gravity and parity are strongly positively correlated with each other ($r = 0.85$, $p < 0.001$). Maternal age is also weakly positively associated with years of school and household income ($r = 0.27$, $p < 0.01$ and $r = 0.28$, $p < 0.01$, respectively). There is also a weakly positive association between maternal age and PPAQ-exercise activity that is approaching statistical significance ($r = 0.16$, $p = 0.11$). Prepregnancy BMI is inversely related to gestational age at first prenatal care visit ($r = -0.27$, $p < 0.01$), albeit this relationship is weak. There is a weakly negative association between prepregnancy BMI and years of school that is nearly statistically significant ($r = -0.18$, $p = 0.08$). Prepregnancy BMI is also weakly inversely related to attitude towards exercise, meaning that as prepregnancy BMI increases, positive attitudes towards exercise during pregnancy decrease ($r = -0.27$,

$p < 0.01$). Gravity is weakly negatively associated with both years of school and household income ($r = -0.23$, $p < 0.05$ and $r = -0.22$, $p < 0.01$, respectively). There is also a weakly inverse relationship between parity and years of school that is almost statistically significant ($r = -0.18$, $p = 0.08$). Gestational age either at first prenatal care visit or at the time of survey are not related to any other variables, although there is a weakly positive relationship between gestational age at the time of survey and friends' social support for exercise that is approaching statistical significance ($r = 0.17$, $p = 0.09$). Years of school are moderately positively associated with household income ($r = 0.50$, $p < 0.001$). Years of school are also weakly positively related to family social support for exercise ($r = 0.24$, $p < 0.05$). Family social support for exercise is also weakly positively associated with attitude towards exercise ($r = 0.26$, $p < 0.01$). There is a weakly positive association between friends' social support for exercise and attitude towards exercise that is nearly statistically significant ($r = 0.18$, $p = 0.09$). Family social support for exercise is weakly positively associated with friends' social support for exercise ($r = 0.29$, $p < 0.01$). Because gravity, parity, and gestational age at the first prenatal care visit are unrelated to any of the exercise variables of interest, they were not included in the multivariate analyses.

Table 5
Spearman correlation coefficients among covariates, SES, attitude, social support for exercise, and PPAQ-exercise activity (MET-hours/week) (N = 95).

	Age	Pre-pregnancy BMI	Gravity	Parity	Gestational age at 1st PNC	Gestational age at survey	Years of school	Household income	Attitude towards exercise	Family social support for exercise	Friends' social support for exercise	PPAQ-exercise activity
Age	1.00											
Prepregnancy BMI	0.05	1.00										
Gravity	0.34***	-0.01	1.00									
Parity	0.40***	0.04	0.85***	1.00								
Gestational age at 1st PNC	-0.08	-0.27**	0.06	-0.02	1.00							
Gestational age at survey	0.06	-0.08	-0.03	-0.03	0.12	1.00						
Years of school	0.27**	-0.18†	-0.23*	-0.18†	-0.11	0.03	1.00					
Household income	0.28**	-0.16	-0.22*	-0.13	-0.08	0.00	0.50***	1.00				
Attitude towards exercise	0.04	-0.27**	-0.06	0.02	0.03	0.05	0.04	-0.05	1.00			
Family social support for exercise	-0.02	-0.07	-0.08	-0.04	0.07	0.09	0.24*	0.08	0.26**	1.00		
Friends' social support for exercise	-0.08	-0.01	-0.07	-0.08	-0.11	0.17†	0.11	0.01	0.18†	0.29**	1.00	
PPAQ-exercise activity	0.16	-0.17	-0.13	-0.08	-0.04	0.01	0.26*	0.14	0.57***	0.34***	0.21*	1.00

Notes:
BMI = body mass index
PNC = prenatal care visit
† 0.05 < p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 6 displays the differences in reported exercise activity by six groupings: race, marital status, educational status, employment status, health insurance, and WIC status. There is no statistically significant difference in PPAQ-exercise activity between respondents who identify as White and those who identify as either American Indian or Alaskan Native, Black, Multiracial, or Other. The difference in PPAQ-exercise activity between those who are married or living with a partner (13.10 MET-hours/week) and those who are single (7.74 MET-hours/week) is nearly statistically significant ($p = 0.09$). On average, those who are married or living with a partner have a higher PPAQ-exercise activity, roughly five more MET-hours per week. There are no statistically significant differences in PPAQ-exercise activity between groups for educational status, employment status, health insurance, or WIC status, and therefore they were not included in the multivariate analyses.

Table 6
Independent-samples t-tests with PPAQ-exercise activity (MET-hours/week) as the dependent variable (N = 95).

			p-value
Race	White (29)	Other races (66)	
	10.30	10.64	0.85
Marital status	Married or living with partner (55)	Single (40)	
	13.10	7.74	0.09
Currently in school	No (85)	Yes (10)	
	11.52	5.10	0.21
Currently employed	No (47)	Yes (48)	
	8.88	12.76	0.21
Health insurance	Private (19)	Government or none (76)	
	15.74	9.62	0.12
WIC	No (38)	Yes (57)	
	10.97	10.76	0.95

Notes:
n for each group in parenthesis
Other races = American Indian or Alaskan Native, Black, Multiracial, or Other
Single = widowed, separated, divorced, or never married
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Multivariate Analyses

Specific Aim 1

In general, the relationships found in the bivariate analyses were confirmed in the multivariate analyses. For the first aim of this study, it was hypothesized that SES, whether years of school or household income, would be positively related to PPAQ-exercise activity (Hypothesis 1a and 1c) and that attitudes towards exercise during pregnancy would explain these relationships (Hypothesis 1b and 1d).

Hypotheses 1a and 1b. Table 7 displays the coefficients for PPAQ-exercise activity regressed on years of school (Model 1); years of school and attitude towards exercise (Model 2); and years of school, attitude towards exercise, and covariates, which include age, race, marital status, prepregnancy BMI, and gestational age at the time of survey (Model 3). Model 1 indicates that a one-year increase in school corresponds to a 1.13 MET-hour increase in exercise activity per week ($p < 0.05$), but only explains three to four percent of the variance in PPAQ-exercise activity ($r^2 = 0.04$). When attitude towards exercise is added to the model, results indicate that attitudes are positively related to PPAQ-exercise activity ($\beta = 0.71$, $p < 0.001$) and years of school are still statistically significant, but there is a decrease in magnitude ($\beta = 1.10$, $p < 0.05$). Years of school and attitude towards exercise explain about 21 percent of the variance in PPAQ-exercise activity ($r^2 = 0.21$). These results support the first hypothesis (Hypothesis 1a), but not the second (Hypothesis 1b). In Model 3, when the covariates are added, years of school is no longer statistically significant, but attitude towards exercise does remain statistically significant ($\beta = 0.65$, $p < 0.001$). Model 3 explains 25 percent of the variability in PPAQ-exercise activity. The change in r^2 from Model 1 to Model 2

(0.17) is statistically significant ($p < 0.001$), but the change in r^2 from Model 2 to Model 3 (0.04) is not ($p = 0.42$). The adjusted r^2 increases from Model 1 to Model 2 (0.03 to 0.19), but remains the same from Model 2 to Model 3. Additionally, the Akaike information criterion (AIC) and Bayesian information criterion (BIC) decrease from Model 1 to Model 2, but increase from Model 2 to 3, indicating that Model 2 is the best-fitting model.

Table 7
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from years of school, attitude towards exercise, and covariates ($N = 95$).

	Model 1		Model 2		Model 3	
Intercept	10.84	***	10.84	***	9.35	**
Years of school	1.13	*	1.10	*	0.83	
Attitude towards exercise			0.71	***	0.65	***
Age					0.10	
Other races[a]					5.02	
Single[b]					-4.74	
Prepregnancy BMI					-0.28	
Gestational age at survey					-0.17	
r^2	0.04		0.21		0.25	
Adjusted r^2	0.03		0.19		0.19	
AIC	784.56		768.77		773.48	
BIC	789.67		776.43		793.91	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hypotheses 1c and 1d. Table 8 presents the results of the linear regression analyses to test the third and fourth hypotheses, which stated that household income would be positively related to PPAQ-exercise activity (Hypothesis 1c) and that attitudes towards exercise would explain this relationship (Hypothesis 1d). These results are very similar to the previous analyses. Model 1 includes household income; Model 2 includes household income and attitude towards exercise; and Model 3 includes household income, attitude towards exercise, and covariates. Each unit increase in the household income scale (roughly $10,000) is associated with a 1.37 MET-hour per week increase in PPAQ-exercise activity ($p < 0.05$), which supports Hypothesis 1c, but again only explains about five percent of the variance in this outcome ($r^2 = 0.05$). After adding attitude towards exercise in Model 2 ($\beta = 0.71$, $p < 0.001$), the coefficient for household income decreases, but remains statistically significant ($\beta = 1.22$, $p < 0.05$), which does not provide strong support for Hypothesis 1d. Household income and attitude towards exercise explain 22 percent of the variance in PPAQ-exercise activity ($r^2 = 0.22$). Similar to the previous analyses, when the covariates are added in Model 3, household income is no longer statistically significant, but attitude towards exercise is ($\beta = 0.67$, $p < 0.001$). Model 3 with household income, attitude towards exercise, and the covariates explain 26 percent of the variability in PPAQ-exercise activity ($r^2 = 0.26$). The change in r^2 from Model 1 to Model 2 (0.17) is statistically significant at the 0.001 level, but the change in r^2 from Model 2 to Model 3 (0.04) is not statistically significant ($p = 0.36$). Similar to the previous analyses, the adjusted r^2 increases from 0.04 to 0.20 in Models 1 and 2, but remains the same in Models 2 and 3. Again, the AIC and BIC decrease from Model 1 to

Model 2, but increase from Model 2 to Model 3, which suggests that Model 2 is the best-fitting model.

Table 8
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from household income, attitude towards exercise, and covariates (*N* = 95).

	Model 1		Model 2		Model 3	
Intercept	10.84	***	10.85	***	7.61	*
Household income	1.37	*	1.22	*	1.34	
Attitude towards exercise			0.71	***	0.67	***
Age					0.05	
Other races[a]					6.78	
Single[b]					-3.50	
Prepregnancy BMI					-0.27	
Gestational age at survey					-0.15	
r^2	0.05		0.22		0.26	
Adjusted r^2	0.04		0.20		0.20	
AIC	783.80		767.89		771.98	
BIC	788.90		775.55		792.42	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Specific Aims 2 and 3

For the second and third aims of this study, it was hypothesized that family social support for exercise would be positively related to PPAQ-exercise activity (Hypothesis 2a) and that it would interact with both years of school (Hypothesis 3a) and household income (Hypothesis 3b), such that family social support for exercise would work more strongly for those of higher SES, compared to those of lower SES. The same was hypothesized for friends' social support for exercise, in that it would be positively associated with PPAQ-exercise activity (Hypothesis 2b) and would interact with both years of school (Hypothesis 3c) and household income (Hypothesis 3d) by working more strongly for those of higher SES than those of lower SES. Tables 9 and 10 display the results from the linear regression analyses testing the Hypotheses 2a, 3a, and 3b for family social support for exercise, and Tables 11 and 12 display the results for the analyses testing the Hypotheses 2b, 3c, and 3d for friends' social support for exercise.

Hypotheses 2a and 3a. Table 9 shows PPAQ-exercise activity regressed on family social support for exercise, years of school, and the covariates (Model 1). Model 2 adds the interaction term between family social support for exercise and years of school. As was hypothesized, family social support for exercise is positively associated with PPAQ-exercise activity ($\beta = 0.60$, $p < 0.001$). Family social support for exercise, years of school, and the covariates explain 26 percent of the variability in PPAQ-exercise activity ($r^2 = 0.26$). The interaction term in Model 2 ($\beta = 0.10$) is not statistically significant at the 0.05 level, but the p-value for this coefficient was 0.058, indicating that the interaction between family social support for exercise and years of school is nearly statistically significant. This result indicates that as years of school increase, the relationship between family social support for exercise and PPAQ-exercise activity likely increases. In both models, prepregnancy BMI is inversely related to PPAQ-exercise activity ($\beta = -0.48$, $p < 0.05$ and $\beta = -0.45$, $p < 0.05$, respectively). Model 2 explains 29 percent of the variability in PPAQ-exercise activity. The change in the r^2 from Model 1 to Model 2 (0.03) nearly statistically significant ($p = 0.058$) and the adjusted r^2 increases from 0.20 to 0.22. From Model 1 to Model 2, the AIC decreases slightly and the BIC increases negligibly, which suggests that Model 2 may be the best-fitting model. These results provide support for Hypothesis 2a and partial support for Hypothesis 3a in that family social support for exercise is positively related to PPAQ-exercise activity and likely interacts with years of school in this relationship.

Table 9
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from family social support for exercise, years of school, and covariates (N = 95).

	Model 1		Model 2	
Intercept	8.67	**	8.29	**
Family social support for exercise	0.60	***	0.60	***
Years of school	0.40		0.17	
Age	0.23		0.16	
Other races[a]	6.64		6.57	
Single[b]	-5.79		-5.91	
Prepregnancy BMI	-0.48	*	-0.45	*
Gestational age at survey	-0.17		-0.17	
Family social support for exercise X years of school			0.10	
r^2	0.26		0.29	
Adjusted r^2	0.20		0.22	
AIC	772.66		770.67	
BIC	793.09		793.66	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hypothesis 3b. Table 10 displays the regression coefficients for PPAQ-exercise activity regressed on family social support for exercise, household income, and the covariates (Model 1), as well as the interaction between family social support for exercise and household income (Model 2). In Model 1, family social support for exercise is still positively related to PPAQ-exercise activity ($\beta = 0.59$, $p < 0.001$) and this model explains 26 percent of the variability in PPAQ-exercise activity ($r^2 = 0.26$). In Model 2, the interaction term between family social support for exercise and household income is statistically significant ($\beta = 0.14$, $p < 0.05$), indicating that as household income increases, the positive association between family social support for exercise and PPAQ-exercise activity also increases. For ease of interpretation, the interaction is depicted graphically in Figure 2. Model 2 explains 32 percent of the variance in PPAQ-exercise activity ($r^2 = 0.32$). These results support Hypotheses 2a and 3b, which stated that family social support for exercise would be positively related to PPAQ-exercise activity and would interact positively with household income in this relationship. It should also be noted that when accounting for family social support for exercise, on average, those who identify as Other races have higher PPAQ-exercise activity scores than those who identify as White ($\beta = 7.68$, $p < 0.05$ in Model 1 and $\beta = 7.42$, $p < 0.05$ in Model 2). Similar to the previous analyses, prepregnancy BMI is inversely related to PPAQ-exercise activity ($\beta = -0.48$, $p < 0.05$ in Model 1 and $\beta = -0.44$, $p < 0.05$ in Model 2). The r^2 increases from 0.26 to 0.32 in Models 1 and 2, which is a statistically significant change ($p < 0.05$). In addition, the adjusted r^2 increases from 0.20 to 0.25 in Models 1 and 2. Both the AIC and BIC are lower for Model 2, indicating that Model 2 is the better-fitting model.

Table 10
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from family social support for exercise, household income, and covariates (*N* = 95).

	Model 1		Model 2	
Intercept	7.61	*	7.51	*
Family social support for exercise	0.59	***	0.60	***
Household income	0.79		0.04	
Age	0.18		0.10	
Other races[a]	7.68	*	7.42	*
Single[b]	-5.01		-5.67	
Prepregnancy BMI	-0.48	*	-0.44	*
Gestational age at survey	-0.16		-0.20	
Family social support for exercise X household income			0.14	*
r^2	0.26		0.32	
Adjusted r^2	0.20		0.25	
AIC	771.85		766.78	
BIC	792.28		789.77	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The interaction between family social support for exercise and household income is depicted in Figure 2. On the x-axis are different values of family social support for exercise scale and on the y-axis are predicted values of PPAQ-exercise activity (MET-hours/week).[1] Each line represents a different income group. As displayed in the figure, the relationship between family social support for exercise and PPAQ-exercise activity increases as household income increases from $10,000-$19,999, to $20,000-$29,999, to $40,000-$49,999. More specifically, for those with a household income between $10,000 and $19,999 (the dotted line), the coefficient for family social support for exercise is 0.52, $p < 0.01$.[2] For those with a household income between $20,000 and $29,999 (the solid line), the coefficient for family social support for exercise is 0.66, $p < 0.001$.[3] For those with a household income between $40,000 and $49,999 (the dashed line), the coefficient for family social support for exercise is 0.99, $p < 0.001$.[4] Another way of looking at these relationships would be that as one's household income increases, the benefit of family social support for exercise also increases in terms of PPAQ-exercise activity.

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[1] $\hat{Y} = \beta_0 + (\beta_{\text{Family Social Support}} * \text{Family social support}) + (\beta_{\text{Income}} * \text{Income}) + (\gamma_{\text{Family Social Support*Income}} * \text{Family social support} * \text{Income})$

[2] $\beta = \beta_{\text{Family Social Support}} + (\gamma_{\text{Family Social Support*Income}} * \text{Income})$
$0.52 = 0.60 + (0.14 * -0.56)$

[3] $0.66 = 0.60 + (0.14 * 0.44)$

[4] $0.99 = 0.60 + (0.14 * 2.44)$

[3] $0.66 = 0.60 + (0.14 * 0.44)$

[4] $0.99 = 0.60 + (0.14 * 2.44)$

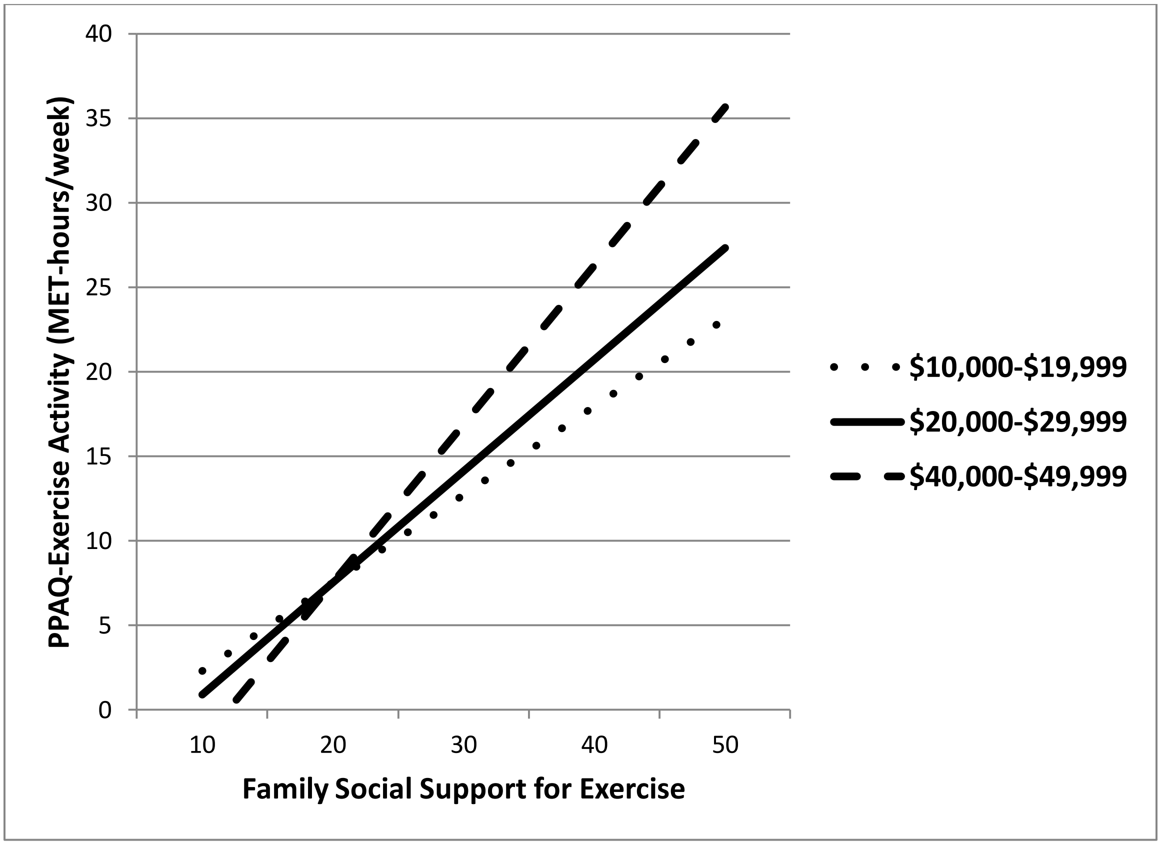

Figure 2. Interaction between family social support for exercise and household income in relation to PPAQ-exercise activity (MET-hours/week).

Hypotheses 2b and 3c. Table 11 displays the regression coefficients for PPAQ-exercise activity regressed on friends' social support for exercise, years of school, and covariates (Model 1), as well as the interaction between friends' social support for exercise and years of school (Model 2). Friends' social support for exercise is positively related to PPAQ-exercise activity ($\beta = 0.74$, $p < 0.001$), which supports Hypothesis 2b. Model 1 explains 24 percent of the variance in PPAQ-exercise activity ($r^2 = 0.24$).

However, friends' social support for exercise does not interact with years of school, and thus Model 2 does not explain any additional variability in PPAQ-exercise activity (r^2 = 0.24), which does not provide evidence to support Hypothesis 3c. Similar to previous analyses, prepregnancy BMI is inversely related to PPAQ-exercise activity (β = -0.39, $p < 0.05$). Neither the r^2 (0.24) nor the adjusted r^2 (0.18) increases from Model 1 to Model 2. Both the AIC and BIC increase from Model 1 to Model 2, which signifies that Model 1 is the best-fitting model.

Table 11
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from friends' social support for exercise, years of school, and covariates (N = 95).

	Model 1		Model 2	
Intercept	9.89	***	9.91	***
Friends' social support for exercise	0.74	***	0.73	***
Years of school	0.63		0.61	
Age	0.20		0.20	
Other races[a]	4.22		4.16	
Single[b]	-4.71		-4.70	
Prepregnancy BMI	-0.39	*	-0.38	
Gestational age at survey	-0.27		-0.27	
Friends' social support for exercise X years of school			0.01	
r^2	0.24		0.24	
Adjusted r^2	0.18		0.18	
AIC	774.21		776.19	
BIC	794.64		799.18	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hypothesis 3d. Table 12 also displays the regression coefficients predicting PPAQ-exercise activity from friends' social support for exercise and covariates, but including household income instead of years of school (Model 1) and the interaction between friends' social support for exercise and household income (Model 2). Similar to the previous analysis, friends' social support for exercise is still positively associated with PPAQ-exercise activity ($\beta = 0.74$, $p < 0.001$) and does not interact with household income, which does not support Hypothesis 3d. Again, prepregnancy BMI is inversely related to PPAQ-exercise activity ($\beta = -0.38$, $p < 0.05$). Both models explain 25 percent of the variance in PPAQ-exercise activity ($r^2 = 0.25$). Similar to the previous analyses, the r^2 (0.25) does not change from Model 1 to Model 2, but the adjusted r^2 actually decreases from 0.19 to 0.18. Again, the AIC and BIC increase from Model 1 to Model 2, which indicates that Model 1 is the best-fitting model.

Table 12
Ordinary least squares regression coefficients predicting PPAQ-exercise activity (MET-hours/week) from friends' social support for exercise, household income, and covariates (N = 95).

	Model 1		Model 2	
Intercept	8.54	**	8.55	**
Friends' social support for exercise	0.74	***	0.74	***
Household income	1.04		1.03	
Age	0.16		0.15	
Other races[a]	5.59		5.58	
Single[b]	-3.77		-3.79	
Prepregnancy BMI	-0.38	*	-0.38	*
Gestational age at survey	-0.25		-0.25	
Friends' social support for exercise X household income			0.00	
r^2	0.25		0.25	
Adjusted r^2	0.19		0.18	
AIC	773.25		775.24	
BIC	793.68		798.23	

Notes:
[a] Compared to White.
[b] Compared to married or living with partner.
BMI = body mass index
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CHAPTER 7

DISCUSSION

Summary

Using a cross-sectional observational survey of pregnant women, this study addressed two broad research aims concerning the associations between SES and social support and exercise during pregnancy. The first hypothesis (Hypothesis 1a) stated that years of school would be positively associated with exercise levels during pregnancy and the second hypothesis (Hypothesis 1b) stated that this relationship would be explained by attitudes towards exercise during pregnancy. The results of this study supported Hypothesis 1a, but not Hypothesis 1b, in that years of school are directly related to exercise, but women's attitudes towards exercise during pregnancy do not mediate this relationship. Additionally, it was hypothesized that household income would be positively related to exercise during pregnancy and that this relationship would be explained by attitudes towards exercise during pregnancy (Hypotheses 1c and 1d, respectively). Similarly, the results supported Hypothesis 1c that income is positively associated with exercise in pregnant women, but they did not support Hypothesis 1d as this association is not explained by their attitudes towards exercise during pregnancy.

It was also hypothesized that both family social support for exercise and friends' social support for exercise would be positively associated with exercise during pregnancy (Hypotheses 2a and 2b, respectively). The results of the current study supported these hypotheses as both family social support for exercise and friends' social support for exercise are directly related to exercise levels in pregnant women. It was also hypothesized that family social support for exercise would interact with both years of school and household income in its relationship with exercise during pregnancy (Hypotheses 3a and 3b, respectively), such that family social support for exercise would have a greater association with exercise for women of higher SES, relative to women of lower SES. Support was found for an interaction using household income (Hypothesis 3b), but not years of school (Hypothesis 3a), although that interaction was nearly statistically significant. Similar hypotheses were made for friends' social support for exercise in that its relationship with exercise during pregnancy would be moderated by years of school and household income (Hypotheses 3c and 3d, respectively). However, the results did not support either of these hypotheses.

In summary, SES is positively related to exercise levels in pregnant women; that is to say, as SES increases, their levels of exercise also increase. These findings support fundamental cause theory (Cockerham 2010; Link and Phelan 1995) and previous studies in pregnant women (Amezcua-Prieto et al. 2013; Dumith et al. 2012; Evenson et al. 2004; Foxcroft et al. 2011; Gaston and Vamos 2013; Mudd et al. 2009; Ning et al. 2013). The relationship between SES and exercise is not mediated by attitudes towards exercise, as neither years of school nor household income are associated with attitudes towards exercise (See Table 5), meaning that any potential effect of SES on exercise levels during pregnancy is operating through some other mechanism. These findings are not consistent with fundamental cause theory, as the theory suggests that those of higher SES may be more aware of the benefits of exercise or have a more positive attitude towards exercise and would therefore be more likely to adopt this behavior (Cockerham 2010; Link and

Phelan 1995). These findings are also not consistent with previous work in pregnant women finding that women of lower SES are more likely to think of exercise during pregnant as unsafe—a perception that is associated with reduced levels of exercise (Duncombe et al. 2009; Mudd et al. 2009). Previous studies did not explicitly test any mediation hypotheses, but one of the primary aims of this study was to examine attitudes towards exercise as a mediator. The difference in the findings of these studies is perhaps due to the focus on safety in previous studies, whereas the current study assessed various aspects of attitudes towards exercise, including both cognitive and affective attitudes.

Regardless, attitude towards exercise is positively related to exercise during pregnancy, meaning that as positive attitudes towards exercise increase, so does exercise behavior during pregnancy. This finding corroborates previous work in pregnant women finding that as the number of perceived benefits of prenatal exercise increases, exercise during pregnancy also increases (Symons Downs and Ulbrecht 2006). Overall, the results suggest that positive attitudes need to increase to adopt exercise behaviors, but attitudes towards exercise are not related to SES. In other words, high SES women are just as vulnerable to negative exercise attitudes as low SES women and positive attitudes towards exercise should be increased to increase exercise behavior, irrespective of SES.

Both SES and attitudes towards exercise are independently and positively related to exercise levels in pregnant women. Furthermore, the relationship between SES and exercise during pregnancy is not mediated by attitudes, or at least not the attitudes assessed in the current study. SES may affect exercise behavior through other mechanisms, such as amount of leisure time, living in an area with a built environment conducive to being active (sidewalks, better lighting, parks, etc.), and access to other resources such as a gym. For example, findings from previous research in nonpregnant populations indicate those who live in low-SES areas have higher perceived neighborhood crime and fewer trails (Wilson et al. 2004), as well as fewer physical activity resources like parks or community centers (Estabrooks, Lee, and Gyurcsik 2003). In general, SES matters when it comes to exercise behavior, but it is not the only determinant. Attitudes towards exercise matter too, but even if an individual's attitudes towards exercise are positive, an individual still requires access to resources to adopt and maintain exercise behaviors.

The findings of the current study also indicated that social support for exercise, whether from family or friends, is directly related to exercise levels during pregnancy. These results are consistent with previous findings that family social support for exercise is negatively associated with perceived barriers to exercise during pregnancy (Da Costa and Ireland 2013) and reports by pregnant women that their partners have the strongest normative influence on their exercise behaviors, followed by other family members (Symons Downs and Ulbrecht 2006). These findings are also consistent with the existing literature correlating social support for exercise and exercise behavior in nonpregnant populations (Sallis et al. 1987; Sallis, Hovell, and Hofstetter 1992; Treiber et al. 1991).

However, this study adds to the social support literature with the finding that SES moderates social support for exercise in the case of family. Although one would also expect individuals to be likely to have friends of a similar SES, these results may be because individuals' SES is much more closely tied to family or household members' SES than that of their friends (McPherson, Smith-Lovin, and Cook 2001). As SES increases, so does the positive association between family social support for exercise and exercise behavior during pregnancy; i.e., family social support for exercise appears to be more effective among those of higher SES, given that they have more resources to increase their exercise levels. Another way of looking at these relationships could be that as family social support for exercise increases, women may take more advantage of the benefits of a higher SES in terms of their exercise behavior.

The current study findings again support fundamental cause and social support theories as both SES and social relationships are seen as fundamental causes of health behaviors and outcomes (Cohen et al. 2000; Link and Phelan 1995), but take a step further the findings of previous work, family social support for exercise being inversely related to perceived barriers to exercise during pregnancy, by examining actual exercise behavior as the outcome (Da Costa and Ireland 2013). The finding that SES moderates family social support for exercise in pregnant women is novel as, to the best of the author's knowledge, this study is the first to examine these interactive relationships in a pregnant population. Fundamental cause theory suggests that higher SES individuals have access to more and better resources, such as knowledge or social relationships (Cockerham 2010; Link and Phelan 1995), and previous research in a nonpregnant population indicate those of higher SES perceive they have more physical activity support (Edwardson et al. 2014); the interaction found in the current study is consistent with these conclusions.

Another interesting finding of this study is the persistent inverse relationship between prepregnancy BMI and exercise levels during pregnancy, when not accounting for attitudes towards exercise (see multivariate analyses in Tables 9 through 12). In addition, the bivariate analyses indicated prepregnancy BMI is inversely related to attitudes towards exercise (see Table 5). These findings suggest that heavier women may have more negative attitudes towards exercise and less exercise activity prior to pregnancy, which may carry over to pregnancy. Future research could examine women's attitudes towards exercise, exercise behavior, and prepregnancy BMI and how these relationships relate to their attitudes and exercise activity during pregnancy longitudinally. It should also be noted that maternal age, race/ethnicity, and gestational age were not related to levels of prenatal exercise in this study, which is inconsistent with previous research indicating that women tend to decrease their exercise over the course of gestation (Borodulin et al. 2008; Duncombe et al. 2009; Ning et al. 2003). The difference in the results of these studies may be due to the positive skew of gestational age at the time of survey in the current study because of the recruitment and sampling methods. These limitations are addressed in the section below.

Strengths and Limitations

One of the major strengths of this study is the research question and analyses, which, to the author's knowledge, is the first of its kind to be conducted in the pregnant population. While previous studies may have considered similar factors in women's exercise behaviors during pregnancy, such as SES and attitudes, they did not test for mediation (Mudd et al. 2009). In addition, while previous research has examined the relationship between social support and barriers to exercise during pregnancy, it has not tested hypotheses related to social support and actual exercise behavior in pregnant women or examined moderators in these relationships (Da Costa and Ireland 2013). The biggest strength of this study is the applicability of the results to a real-world problem, the low levels of exercise adherence among pregnant women (Haakstad and Bo 2011b; Oostdam et al. 2012; Vinter et al. 2011). While the knowledge of the health benefits of maternal exercise has increased in recent decades, including potentially reducing excess GWG, increasing placental volume and growth rate, and decreasing C-section rates (Choi et al. 2013; Kramer and McDonald 2006; Oteg-Ntim et al. 2012; Price et al. 2012; Renault et al. 2013; Sui et al. 2012), pregnant women continue to meet very low rates of recommended exercise levels and tend to decrease their exercise activity over the course of pregnancy (Borodulin et al. 2008; Borodulin et al. 2009; Duncombe et al. 2009; Evenson et al. 2004; Gaston and Vamos 2013; Ning et al. 2003; Smith and Campbell 2013). The results of this study may be able to inform future work and increase exercise adherence in this population, ultimately helping to improve maternal and child health outcomes. This possibility is discussed further in the implications section below.

There are also a few limitations to this study, mainly the study design, which was cross-sectional and observational; measurement issues and the lack of randomization make inferring causality difficult. While this study utilized a tool specifically designed for and validated in a pregnant population, the PPAQ, it is still based on self-report. Self-report poses problems, especially in the case of physical activity behaviors (Dhurandhar et al. 2014). Future research should use objective measures of exercise activity, such as accelerometry (Chasan-Taber et al. 2004). There is also the possibility of omitted variable bias; in other words, other factors or some extraneous variable could explain low levels of exercise in this population leading to the relationships that were observed in the current study. SES only explained about four percent of the variance in exercise activity, and attitudes explained about another 16 percent, indicating there are likely other factors that are important in explaining exercise behavior during pregnancy. These factors could include, but may not limited to, barriers and facilitators (like lack of time, or like access to a gym, respectively), the built environment, self-efficacy, depressive symptomology, fatigue, etc. (Chandler-Laney et al. 2010; Cramp and Bray 2009; Estabrooks et al. 2003; Krans and Chang 2011; Marquez et al. 2009; Wilson et al. 2004). This study included several measures of physical activity, attitudes, social support, and demographic factors. The pros and cons of including additional survey items in the study were carefully weighed, and including these measures would have considerably increased respondent burden and potentially decreased response rates (Fowler 2014). Were future studies to include these measures, additional hypotheses could be tested, such as whether barriers or facilitators mediate the association between SES and exercise activity. Such studies could also examine other conceptual models and hypotheses, such as social support mediating the association between SES and exercise activity, or attitudes towards exercise during pregnancy mediating the association between social support and exercise activity. Although these additional hypotheses could be tested with the data from this study, they were not within its scope or specific aims.

Because of the cross-sectional study design, there is also the possibility of reverse causation, particularly in the case of attitudes towards exercise or social support for exercise: exercise behaviors may affect one's attitudes towards exercise, or they may affect how much social support for exercise one receives from family or friends. Future studies could address these limitations with longitudinal data. For example, such studies could use attitudes towards exercise in the first trimester to predict the change in exercise activity from the first trimester to the second trimester and then use the change in exercise activity between the first and second trimesters to predict attitudes towards exercise in the third trimester. Similar analyses could also be conducted for social support for exercise and exercise activity.

Future work could also address these limitations with a stronger study design, such as a randomized controlled trial. For example, such a study could randomize women either to an exercise program individually or to an exercise program with their family and assess adherence to the intervention as the outcome. Furthermore, future randomized controlled trials of exercise may consider three arms: exercise with social support, social support (not specifically related to exercise), and a true control to isolate the effects of exercise from increased social support on the outcomes of interest. While the current study is limited in terms of design relative to longitudinal studies or randomized controlled trials, the findings are still useful as these are analyses that have not been conducted previously and lay the groundwork for future work with stronger study designs.

In addition, the generalizability of this study is limited because of the sampling of women predominantly out of one clinic and the use of only the first study visit from the PEARLS Study. This sampling of pregnant women resulted in many variables being skewed, particularly the SES variables and gestational age at the time of survey. The main clinic that participants were recruited from frequently treats women with complicated pregnancies or women who have been referred to this clinic for routine ultrasounds from the health department, where women on Medicaid obtain their prenatal care. Sampling from this clinic resulted in many women being excluded from the final analyses, resulting in a smaller sample size, or having a lower SES. Despite the smaller sample size and bias towards lower SES patients, associations between SES and exercise activity were still detected. The use of only the first study visit from the PEARLS Study, which is between 10 and 14 weeks gestation, resulted in gestational age at the time of survey also being positively skewed. The skew in this variable could potentially explain why the inverse association between gestational age at the time of survey and exercise activity that has been observed in other studies was not detected in the current study (Borodulin et al. 2008; Duncombe et al. 2009; Ning et al. 2003). However, there was, in fact, a negative relationship between gestational age at the time of survey and exercise activity in the study sample; however, it was not statistically significant at the 0.05 level. With a larger sample size, it likely would have been found to be statistically significant. Future work, whether observational or interventional, could aim to include larger ranges of SES and gestational age to increase generalizability.

Implications

Overall, this study reiterates the importance of SES and access to resources in terms of health behaviors (Cockerham 2010; Link and Phelan 1995), specifically exercise in pregnant women (Amezcua-Prieto et al. 2013; Dumith et al. 2012; Evenson et al. 2004; Foxcroft et al. 2011; Gaston and Vamos 2013; Mudd et al. 2009; Ning et al. 2013). These findings are consistent with the principle of ensuring access to resources, such as exercise classes or gym memberships, in randomized controlled trials to encourage compliance to the exercise interventions, although this recommendation does go beyond the findings of this study. Additionally, while access to resources, such as enjoyed by those with a high SES, is essential to support exercise behaviors, such access alone is not the only determinant, as attitudes are predictive of exercise activity even after controlling for SES. Future exercise interventions in pregnant women, be it a public health intervention at the population level or a smaller randomized controlled trial, could potentially benefit from addressing women's attitudes towards exercise during pregnancy. Future interventions could work to improve women's attitudes by informing them of the health benefits of maternal exercise, both for the mother and the child. They may also benefit from promoting or including exercises that pregnant women enjoy.

In addition, future clinical trials may also benefit from including women's families and friends in the intervention because of the positive association between social support for exercise, whether it is from friends or family, and exercise activity. However, randomized controlled trials may get the most returns in adherence by ensuring access to resources, such as exercise classes or gyms, and by intervening in the family due to the positive interaction between family social support for exercise and SES. By providing access to these kinds of resources, in theory, all participants would be able to take the advantage of the family social support for exercise, regardless of their SES. As discussed in the previous section, future clinical trials should also consider three arms: exercise intervention with social support, social support (not related to exercise), and a true control. Such a study would theoretically increase adherence to the exercise intervention and make any differences in health outcomes attributable to the exercise itself, and not the social support of the intervention, increasing causal inference in these types of studies. Increasing exercise adherence, as well as having the two control groups, would allow researchers to draw stronger conclusions about prenatal exercise and perinatal outcomes, improve exercise prescription to this population, and ultimately improve maternal and child health outcomes.

Conclusion

A cross-sectional observational survey was conducted and results indicated that SES is positively associated with exercise levels during pregnancy. Women's attitudes towards exercise during pregnancy are also associated with exercise activity in this population. Furthermore, social support for exercise from both family and friends are positively related to exercise during pregnancy. However, only family social support for exercise interacts with SES in this relationship, such that family social support for exercise has a stronger association with exercise activity among those with a higher SES. Future exercise interventions could potentially benefit in terms of adherence and causal inference by providing access to the appropriate resources to support exercise activity and increasing women's positive attitudes towards exercise during pregnancy, as well as by intervening in the family. Improving exercise prescriptions and adherence in this population could ultimately better the health of both mothers and their children.

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APPENDIX A

RECOMMENDATIONS FOR EXERCISE DURING PREGNANCY

American College of Sports Medicine

The first and second editions of the *Guidelines for Graded Exercise Testing and Exercise Prescription* by the American College of Sports Medicine (ACSM) in 1975 and 1980 did not outline any specific recommendations for exercise testing or prescription during pregnancy. Toxemia of pregnancy (eclampsia or preeclampsia) or complications of pregnancy (not specified) were considered relative contraindications to exercise and exercise testing. In general, the benefits of exercise testing were considered to outweigh the risk for these populations (ACSM 1975; ACSM 1980). However, preeclampsia and hypertensive disorders of pregnancy are now considered absolute contraindications to exercise during pregnancy (ACOG 2002).

It was not until 1986 that the ACSM put out specific guidelines for exercise prescription during pregnancy (the 3rd edition). Cardiovascular diseases and toxemia were considered contraindications for exercise. Exercise was cautioned also among women with hypertension, diabetes, and obesity. Sports that involved violent movements or physical contact were not advised. Non-weight-bearing activities were encouraged due to the weight gain associated with pregnancy. Lower-intensity exercise was also recommended to minimize oxygen debt and potential excessive increases in core temperature. Because of the changing heart rate response to exercise over the course of pregnancy, exercise prescription was to be based on the rating of perceived exertion (RPE).

In the 4th edition of its guidelines in 1991, the ACSM expanded its recommendations for pregnant women as the scientific knowledge concerning exercise in this population began to grow. While some potential benefits of prenatal exercise were acknowledged (increased fitness, improved labor and recovery from labor, psychological well-being, etc.), there were still concerns of competition between the maternal muscles and the fetus for blood flow (and thus substrates such as oxygen and glucose) and of heat stress. Due to these concerns, increases in the intensity and/or duration of exercise during the first and third trimesters was discouraged. Maximal exercise testing was also not recommended for pregnant women in nonclinical settings. Walking and non-weight-bearing activities were still recommended, while it was advised that competitive athletic training be discontinued because of the change in the center of gravity in this state. At the time, weight training was considered controversial and any exercise in the supine position was considered ill-advised because of concerns of the uterus compressing the descending aorta and inferior vena cava leading to decreased cardiac output and blood flow to the conceptus. Nevertheless, it was recommended that women exercise three to five times per week for 15 to 30 minutes, but not for longer durations, to avoid excessive hypoxic or thermal stresses on the fetus. To prescribe intensity, it was still recommended that the RPE be applied, with a target intensity of 12 to 14 on the Borg scale (which ranges from 6 to 20). An additional recommendation was the “talk test” to prevent overexertion (being indicated by the ability to carry on a conversation during exercise). Lastly, it was advised that high ambient temperatures and humidity be avoided during exercise because it was believed that problems with thermoregulation accompanied pregnancy.

The 1995 ACSM guidelines (5th edition) for exercise testing and prescription for pregnant women were very similar to the preceding guidelines. The same potential benefits and risks of prenatal exercise were outlined, among others, but it was acknowledged that “[t]here are no data in humans to indicate that pregnant women should limit exercise intensity and lower target heart rates because of potential adverse effects” (p. 235). Furthermore, the authors pointed out that “[o]lder guidelines limited maternal [heart rate] to 140 beats/min, yet, no adverse maternal or fetal effects were reported as a result of a higher training [heart rate]” (p. 237). These guidelines also acknowledged that data from human studies did not provide any evidence of fetal distress or abnormalities with normal increases in core temperature during exercise. In contrast to previous recommendations, women who were not previously active and beginning an exercise regimen after becoming pregnant were advised to obtain authorization from their physician and begin with low-intensity and low-impact activities. Women who were regularly active prior to their pregnancy could continue their regimen during pregnancy.

Recommendations for the frequency, intensity, time, and type (FITT) for exercise among pregnant women were unchanged in the 2000 ACSM guidelines (6^{th} edition). However, concerns of potentially increased uterine contractions with prenatal exercise were introduced, although the authors stated that there had been no reports of increased spontaneous abortion or rupture, preterm birth (PTB), or fetal distress or abnormalities among exercisers. Previous concerns of the competing demands for blood, oxygen, and glucose were allayed by citing the physiological adaptations that accompany both pregnancy and exercise (e.g. blood plasma expansion and increase in red blood cell mass) to accommodate the maternal muscle and the fetus simultaneously.

In the 2006 ACSM guidelines (7^{th} edition), the same concerns in the 2000 guidelines were raised: inadequate substrate for both the mother and the fetus, fetal distress or birth abnormalities, and increased uterine contractions. Again, it was pointed out that healthy women do not need to limit their exercise and women who were active prior to pregnancy could continue their exercise program. However, vigorous exercise in the third trimester, high contact activities, activities with a high risk for falling, activities with a risk for abdominal trauma (i.e. softball, basketball, and racquet sports), activities with excessive joint stress, exercise at high altitudes (6,000 feet or greater), and scuba diving were cautioned against. It was advised that women exercise indoors to avoid excess heat, cold, or air pollution and avoid exercise in the supine position after the first trimester. Women who were previously sedentary or less active were advised again to obtain medical clearance from their physician and begin with light intensity (20 to 39 percent heart rate reserve) and low- to non-impact activities like walking or swimming. These were the first guidelines in which cardiorespiratory, resistance, and flexibility exercise were recommended to pregnant women. It was advised that women engage in these activities at least three days per week and ideally on most, if not, all days of the week. It was also advised that women engage in activity for 30 to 40 minutes at a RPE of 11 to 13 (light to somewhat hard), which was a lower intensity than previous recommendations. To address the concerns of inadequate substrate in the exercising pregnant women, it was advised that gravidas intake an additional 300 kilocalories per day to sustain the pregnancy itself along with the additional calories required to support the activity. To avoid maternal hypoglycemia, particularly in the third trimester, it was advised that women increase their carbohydrate intake (30 to 50 grams) prior to exercise. To address the concerns of maternal hyperthermia and fetal abnormalities, exercising gravidas were advised to wear appropriate clothing, avoid brisk exercise in hot and humid weather or with a fever, and remain adequately hydrated.

Previous guidelines raised concerns of the potential risks associated with prenatal exercise but generally acknowledged it did not appear to be unsafe. In contrast, the 2010 ACSM recommendations (8^{th} edition) were the first guidelines to actively encourage healthy, pregnant women without medical contraindications to exercise throughout their pregnancies. They emphasized that regular prenatal exercise provides health benefits to both the mother and the offspring, including reduced risk for conditions such as gestational diabetes mellitus (GDM) and pregnancy-induced hypertension (PIH). The recommendations for exercise prescription in this population were similar to those for the general adult population, although it was advised that these be adjusted according to the individual woman's symptoms during pregnancy. The specifications for FITT were as follows: at least three, but preferably all, days of the week; moderate intensity (40 to 60% of VO_2 reserve, 12–14 RPE, a heart rate range of 125–155 beats per minute (BPM) depending on age, or the "talk test"); at least 15 to 30 minutes (for a total of 150 minutes per week); and dynamic, rhythmic activities using large muscle groups, such as walking or cycling. It was also suggested that women participate in strength training that incorporated all the major muscle groups, performing 12–15 repetitions to moderate fatigue. Contact sports and activities that could cause a loss of balance or trauma, such as soccer, basketball, ice hockey, horseback riding, and vigorous-intensity racquet sports were considered ill-advised. These were the first guidelines to advise exercise intensities above 140 BPM (for women 39 years old or less). They were also the first guidelines to advocate that previously sedentary women gradually increase their activity to the recommended levels. Similar to previous guidelines, exercising in the supine position after the first trimester, use of the Valsalva maneuver during exercise, and isometric exercises were not advised, while exercising in a thermoneutral environment and staying well-hydrated to avoid heat stress, as well as increasing caloric intake to support both the demands of the pregnancy and exercise, were suggested.

The current recommendations for exercise during pregnancy (ACSM 2014) are similar to the previous guidelines, but with some decreases in the frequency, intensity, and duration of exercise. These are the first guidelines to be specific to prepregnancy body mass index (BMI) and the fitness level of the mother. It is currently proposed that women should exercise three to four days per week, at a light (if BMI $\geq$ 25) or moderate intensity (if BMI $<$ 25), for 15 to 30 minutes with a 10–15 minute warm-up and a 10–15 minute cool-down (for a total of 150 minutes per week), and involve dynamic and rhythmic activities using large muscle groups, such as walking or cycling. These guidelines also provide recommendations for progression, advising that women increase their activity gradually to the recommended levels after the first trimester, because many of the discomforts and risks have minimized after that time. According to the ACSM, women who are low-risk and normal weight (BMI $<$ 25) should exercise at moderate intensity with heart-rate targets ranging from 129 BPM to 160 BPM, depending on the mother's age and fitness level. Women who are low-risk and overweight or obese (BMI $\geq$ 25) are advised to exercise at only a light intensity with heart-rate target zones ranging from 101 BPM to 124 BPM, depending only on the age of the mother. Consistent with previous guidelines, pregnant women may participate in resistance training, incorporating all of the major muscle groups at a resistance allowing 12–15 repetitions to moderate fatigue, avoiding isometric muscle contractions, the Valsalva maneuver, and exercising in the supine position after 16 weeks gestation. During pregnancy, it is still advised that women avoid contact sports or activities that can cause a loss of balance or trauma (e.g., soccer, basketball, ice hockey, roller blading, horseback riding, skiing/snowboarding, scuba diving, and vigorous intensity racquet sports) and exercising in hot and humid environments. Women should stay well-hydrated and dress to avoid heat stress. As before, pregnant women should increase their food intake to meet the metabolic demands of the pregnancy in addition to the caloric costs of her activity. Table A1 summarizes the FITT recommendations for women who are pregnant from the ACSM.

Table A1
Summary of the ACSM's guidelines for exercise prescription during pregnancy.

Year	Frequency	Intensity	Time	Type	Progression
1975	-	-	-	-	-
1980	-	-	-	-	-
1986	-	Lower intensity, use HR or RPE (around 12).	-	Non-weight-bearing activities in the 3rd trimester. No contact sports.	-
1991	3-5 days/week.	12-14 RPE, "talk test."	15-30 minutes.	Walking, non-weight-bearing activities. No competitive athletic training. Weight training controversial.	Gradually increase intensity and time only in the 2nd trimester.
1995	-	-	-	-	-
2000	-	-	-	-	-
2006	Most, if not all, days. 3 days/week minimum.	Moderate intensity (11-13 RPE), no overly vigorous activity in the 3rd trimester.	30-40 minutes.	No contact activities or those with high risk for falling, abdominal trauma, or excessive joint stress. No activities at high altitudes or scuba diving.	Those sedentary prior to pregnancy should begin with light intensity activity (20-39% HRR) and low- or non-impact activities.
2010	Most, if not all, days. 3 days/week minimum.	Moderate intensity (40-60% VO_2 reserve, 12-14 RPE, 125-155 BPM, "talk test").	15-30 minutes (150 minutes/week).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Previously sedentary should gradually increase to the recommended levels.
2014	3-4 days/week.	Light intensity if BMI $\geq$ 25 (101-124 BPM) or moderate intensity if BMI < 25 (129-160 BPM).	15-30 minutes with 10-15 minute warm-up and 10-15 minute cool-down (150 minutes/week total).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Gradually progress to recommended levels after the 1st trimester. Minimum of 15 minutes/day, 3 days/week at appropriate HR or RPE to max of 30 minutes/day, 4 days/week at appropriate HR or RPE.

HR = heart rate
RPE = rating of perceived exertion
HRR = heart rate reserve
BPM = beats per minute
BMI = body mass index

American Congress of Obstetricians and Gynecologists

The first published guidelines for leisure-time physical activity (LTPA) during pregnancy came from the American Congress of Obstetricians and Gynecologists (formerly known as the American College of Obstetricians and Gynecologists) (ACOG) in 1985. These recommendations were very conservative and based on limited empirical data that was available at the time. The 1985 recommendations included not exceeding a heart rate of 140 BPM and to limit vigorous activity to durations of 15 minutes. However, these guidelines were meant for a "general cross-section of the population" and the authors noted, "a physically fit pregnant patient may tolerate a more strenuous program" (ACOG 1985 as cited in Pivarnik & Mudd 2009).

The next guidelines for LTPA during pregnancy published by the ACOG were published in 1994. Most of the ACOG recommendations for exercise prescription for women in general were considered to apply to pregnant women as well. These guidelines noted that the normal morphologic and physiologic changes that occur with pregnancy might require consideration of modifications of these general guidelines. For example, concerns were raised regarding the shift in the center of gravity with pregnancy that may affect balance or the increase of substrate mobilization with exercise that may limit substrate available to the fetus. However, the authors emphasized that these recommendations did not have a solid backing with prospective, randomized, clinical trials, but instead followed from a critical analysis of the available data concerning the physiology of exercise during pregnancy and extrapolations from that data. The authors also pointed out that there was little to no data at that time to indicate that exercise during pregnancy had deleterious effects on the offspring, while there was likewise no conclusive data that prenatal exercise could improve perinatal outcomes. The ACOG recommendations were for pregnant women who did not have any other risk factors for adverse perinatal outcomes. The ACOG also outlined various contraindications to prenatal exercise, which included PIH, preterm rupture of the membranes, PTB either in a previous pregnancy and/or the current pregnancy, incompetent cervix or cerclage, persistent second- or third-trimester bleeding, or intrauterine growth restriction (IUGR). Relative contraindications to exercise during pregnancy included chronic hypertension or active thyroid, cardiac, vascular, or pulmonary disease. It was recommended that women participate in regular exercise and not intermittent activity, preferably at least three times per week. In contrast to its first guidelines, the ACOG stated that there was no clinical data to indicate that pregnant women should limit exercise intensity, although it was recommended that women not exercise to exhaustion and that they should stop exercising when fatigued. It was also noted that women can accrue health benefits from even mild- or moderate-intensity exercise routines and that women who were fit prior to pregnancy should be able to maintain their level of fitness throughout pregnancy safely. Women were also advised to avoid any exercise that had the potential for any abdominal trauma, and thus non-weight-bearing activities such as cycling or swimming were encouraged to minimize the risk of injury, although weight-bearing exercise could also be continued during pregnancy. Women were also to avoid exercise in the supine position after the first trimester, ensure an adequate diet to support the metabolic demands of pregnancy and exercise, and enhance heat dissipation through adequate hydration, appropriate clothing, and optimal environmental temperatures during activity.

The ACOG came out with its most recent guidelines for exercise during pregnancy in 2002 and reaffirmed them in 2009. These guidelines included recommendations for exercise for pregnant women without medical or obstetric complications that are the same for nonpregnant individuals: at least 30 minutes of moderate-intensity exercise on most, if not all, days of the week. In fact, this committee opinion actively encourages regular activity and pointed out its potential for the primary prevention and treatment of GDM, which contrasts with the 1994 guidelines that stated that there was no conclusive data that prenatal exercise improves perinatal outcomes. Similar to the previous guidelines, women are advised to avoid exercise in the supine position and activities with a high risk of falling or abdominal trauma. Women are also advised to avoid scuba diving and exercise at altitudes above 6,000 feet. Also similar to the 1994 guidelines, women who were previously active and have an uncomplicated pregnancy can remain active during their pregnancies, but women with a history of PTB or IUGR should reduce their activity, particularly in the second and third trimesters. These most recent guidelines also included additional absolute and relative contraindications to exercise during pregnancy, as well as warning signs to terminate exercise during pregnancy, which are shown in Boxes A1, A2, and A3. Table A2 summarizes the FITT recommendations for exercise during pregnancy from the ACOG.

Box A1. Absolute Contraindications to Aerobic Exercise During Pregnancy

- Hemodynamically significant heart disease
- Restrictive lung disease
- Incompetent cervix/cerclage
- Multiple gestation at risk for premature labor
- Persistent second- or third-trimester bleeding
- Placenta previa after 26 weeks of gestation
- Premature labor during the current pregnancy
- Ruptured membranes
- Preeclampsia/pregnancy-induced hypertension

Box A2. Relative Contraindications to Aerobic Exercise During Pregnancy

- Severe anemia
- Unevaluated maternal cardiac arrhythmia
- Chronic bronchitis
- Poorly controlled type 1 diabetes
- Extreme morbid obesity
- Extreme underweight (BMI < 12)
- History of extremely sedentary lifestyle
- Intrauterine growth restriction in current pregnancy
- Poorly controlled hypertension
- Orthopedic limitations
- Poorly controlled seizure disorder
- Poorly controlled hyperthyroidism
- Heavy smoker

Box A3. Warning Signs to Terminate Exercise While Pregnant

- Vaginal bleeding
- Dyspnea prior to exertion
- Dizziness
- Headache
- Chest pain
- Muscle weakness
- Calf pain or swelling (need to rule out thrombo-phlebitis)
- Preterm labor
- Decreased fetal movement
- Amniotic fluid leakage

Table A2
Summary of the ACOG's guidelines for exercise prescription during pregnancy.

Year	Frequency	Intensity	Time	Type	Progression
1985	-	HR < 140 BPM.	$\leq$ 15 minutes.	-	-
1994	3 days/week minimum.	Mild to moderate intensity. No data in humans to suggest limiting exercise intensity, but women should not exercise to exhaustion.	-	Non-weight-bearing exercises, such as cycling or swimming. Weight-bearing exercises may be continued under some circumstances. Avoid activities that have the potential for abdominal trauma.	-
2002/2009	Most, if not all days of the week.	Moderate intensity.	30 minutes or more.	Avoid activities with a high risk of falling or abdominal trauma, as well as scuba diving and activity at altitudes > 6,000 feet.	Women with a history or risk of PTB or IUGR should reduce activity in the 2nd and 3rd trimesters.

BPM = beats per minute
PTB = preterm birth
IUGR = intrauterine growth restriction

U.S. Department of Health and Human Services

In 2008 the U.S. Department of Health and Human Services (DHHS) published the *Physical Activity Guidelines for Americans,* which were the first exercise guidelines issued by the government for the American public and included recommendations for women during pregnancy. The guidelines from the DHHS are probably the most liberal of the three governing bodies, recommending that healthy women who are not already active gradually increase their activity until they accumulate at least 150 minutes of moderate-intensity aerobic exercise throughout the week and women who already engage in vigorous-intensity exercise continue their regimens, given they remain healthy and discuss their activity with their health-care provider. In addition, it is recommended that women who habitually participate in strength training continue to do so during pregnancy. These guidelines stress that moderate-intensity activity is safe for healthy pregnant women and does not increase the risk of early pregnancy loss, PTB, or low birth weight, although the evidence base for these statements is unclear. These guidelines also state that there is some evidence that prenatal physical activity reduces the risk for GDM and preeclampsia, as well as the length of labor, but also points out that this evidence is inconclusive. Similar to the guidelines from the ACSM and the ACOG, the DHHS advises that pregnant women avoid activities in the supine position after the first trimester of pregnancy and those with a high risk for falling or abdominal trauma, such as contact or collision sports. The current FITT recommendations for exercise prescription in pregnant women from the three relevant governing bodies are listed in Table A3.

Table A3
Summary of the current guidelines for exercise prescription during pregnancy from the ACSM, ACOG, and the DHHS.

Organization	Year	Frequency	Intensity	Time	Type	Progression
ACSM	2014	3-4 days/week.	Light intensity if BMI $\geq$ 25 (101-124 BPM) or moderate intensity if BMI < 25 (129-160 BPM).	15-30 minutes with 10-15 minute warm-up and 10-15 minute cool-down (150 minutes/week total).	Dynamic, rhythmic activities using large muscle groups (e.g., walking, cycling). Resistance training incorporating all major muscle groups (12-15 repetitions to moderate fatigue). No contact sports or activities with a high risk for loss of balance or trauma.	Gradually progress to recommended levels after the 1st trimester. Minimum of 15 minutes/day, 3 days/week at appropriate HR or RPE to max of 30 minutes/day, 4 days/week at appropriate HR or RPE.
ACOG	2002/2009	Most, if not, all days of the week.	Moderate intensity.	30 minutes or more.	Avoid activities with a high risk of falling or abdominal trauma, as well as scuba diving and activity at altitudes > 6,000 feet.	Women with a history or risk of PTB or IUGR should reduce activity in the 2nd and 3rd trimesters.
DHHS	2008	-	Moderate intensity for women who were previously inactive and vigorous intensity for women who are already highly active.	At least 150 minutes throughout the week.	Avoid activities with a high risk for falling or abdominal trauma, which includes contact or collision sports. Women who habitually strength train should continue during pregnancy.	Women who were previously inactive should increase the amount of activity gradually over time.

BMI = body mass index
BPM = beats per minute
HR = heart rate
RPE = rating of perceived exertion
PTB = preterm birth
IUGR = intrauterine growth restriction

APPENDIX B

CONFIRMATORY FACTOR ANALYSES

Descriptive statistics for all of the items from the attitude towards exercise, family social support for exercise, and friends' social support for exercise questionnaires are reported in Tables B1, B2, and B3, respectively. Confirmatory factor analysis was done for each of the scales with 1.0 as the threshold for the Eigenvalues and 0.60 as the threshold for the loadings on the components. In addition, Chronbach's alpha was calculated for each of the resulting scales and all were above 0.80, which indicate high levels of inter-tem reliability.

Table B1
Descriptive statistics for attitude towards exercise scale items (N = 95).

	Mean	Standard Deviation	Minimum	Maximum
Exercise useless to useful	5.24	1.80	1	7
Exercise harmful to beneficial	5.48	1.69	1	7
Exercise foolish to wise	5.52	1.85	1	7
Exercise unenjoyable to enjoyable	4.60	2.02	1	7
Exercise unpleasant to pleasant	4.83	1.83	1	7
Exercise stressful to relaxing	5.06	1.66	1	7

All of the items for the attitude towards exercise scale loaded onto one factor with the six items explaining 62.91 percent of the variability in this factor. Therefore, all of the items were kept for this scale and Chronbach's alpha in this sample was 0.88. No other components were extracted so no subscales were computed.

Table B2
Descriptive statistics for the family social support for exercise scale items (N = 95).

	Mean	Standard Deviation	Minimum	Maximum
Exercised with me	2.28	1.39	1	5
Offered to exercise with me	2.49	1.47	1	5
Gave me helpful reminders to exercise	2.30	1.42	1	5
Gave me encouragement to stick with my exercise program	2.34	1.51	1	5
Changed their schedule so we could exercise together	1.54	0.95	1	5
Discussed exercise with me	2.46	1.44	1	5
Complained about the time I spend exercising	1.29	0.86	1	5
Criticized me or made fun of me for exercising	1.06	0.32	1	5
Gave me rewards for exercising	1.32	0.82	1	5
Planned for exercise on recreational outings	1.64	1.11	1	5
Helped plan activities around my exercise	1.64	1.12	1	5
Asked me for ideas on how they can get more exercise	1.60	1.14	1	5
Talked about how much they like to exercise	1.96	1.43	1	5

Three components were extracted from the 13 family social support for exercise items, but only the first factor had loadings above 0.60. However, three items—"family complained about the time I spend exercising", "family criticized me or made fun of me for exercising", and "family gave me rewards for exercising"—had loadings below 0.60 on this first factor so they were dropped, consistent with the original scale validation and scoring (Sallis et al. 1987). Then two components were extracted from the ten items, but again, only the first factor had loadings above 0.60. The ten items explained 53.48 percent of the variance in the first factor, family social support for exercise (participation). Chronbach's alpha based on these ten items was 0.90 in the study sample.

Table B3
Descriptive statistics for the friends' social support for exercise scale items (*N* = 95).

	Mean	Standard Deviation	Minimum	Maximum
Exercised with me	1.70	1.10	1	5
Offered to exercise with me	1.89	1.22	1	5
Gave me helpful reminders to exercise	1.73	1.07	1	5
Gave me encouragement to stick with my exercise program	1.81	1.20	1	5
Changed their schedule so we could exercise together	1.34	0.74	1	4
Discussed exercise with me	1.97	1.22	1	5
Complained about the time I spend exercising	1.14	0.56	1	5
Criticized me or made fun of me for exercising	1.05	0.30	1	3
Gave me rewards for exercising	1.15	0.62	1	5
Planned for exercise on recreational outings	1.39	0.78	1	4
Helped plan activities around my exercise	1.36	0.87	1	4
Asked me for ideas on how they can get more exercise	1.43	0.95	1	5
Talked about how much they like to exercise	1.67	1.20	1	5

Similarly, three components were extracted from the 13 friends' social support for exercise items. Although the second component did have two items with loadings above 0.60, these were two of the three items that were dropped from the original scale (Sallis et al. 1987) so this component was not used. The third component did not have any loadings above 0.60. All of the items except the same three items that were dropped from the original scale—"friends complained about the time I spend exercising", "friends criticized me or made fun of me for exercising", and "friends gave me rewards for exercising" —had loadings above 0.60 for the first component, so only those ten items were kept, consistent with the original scoring (Sallis et al. 1987). Then two components were extracted from the ten items, but again, only the first component had loadings above 0.60. These ten items explained 52.99 percent of the variance in the first component, friends' social support for exercise (participation). Chronbach's alpha for the ten scale items used was 0.89 in the study sample.

APPENDIX C

INSTITUTIONAL REVIEW BOARD APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

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

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

Principal Investigator:	FLAGG, LEE A
Co-Investigator(s):	
Protocol Number:	**X140730004**
Protocol Title:	*Exercise Adherence among Pregnant Women: The Role of Socioeconomic Status, Beliefs and Attitudes towards Prenatal Exercise, and Social Support*

The IRB reviewed and approved the above named project on 8/21/14. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.

IRB Approval Date: 8/21/14

Date IRB Approval Issued: 8-21-14

IRB Approval No Longer Valid On: 8-21-15

Julius Linn, M.D.
Acting Chair of the Institutional
Review Board for Human Use (IRB)

Investigators please note:

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

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

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

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

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

The University of
Alabama at Birmingham
Mailing Address:
AB 470
1720 2ND AVE S
BIRMINGHAM AL 35294-0104