2-2009

Physical Activity and Maternal/Fetal Outcomes in a Pregnant Latina Population

Audra Lynn Gollenberg
University of Massachusetts - Amherst, algollenberg@gmail.com

PHYSICAL ACTIVITY AND MATERNAL/FETAL OUTCOMES IN A PREGNANT LATINA POPULATION

A Dissertation Presented

by

AUDRA L. GOLLENBERG

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

February 2009

Public Health
Biostatistics and Epidemiology

PHYSICAL ACTIVITY AND MATERNAL/FETAL OUTCOMES IN A PREGNANT LATINA POPULATION

A Dissertation Presented

by

AUDRA L. GOLLENBERG

Approved as to style and content by:

____
Lisa Chasan-Taber, Chair

____
Elizabeth Bertone-Johnson, Member

____
Penelope S. Pekow, Member

____
Patty S. Freedson, Member

____
Michael Begay, Chair
School of Public Health

____
Elaine Puleo, Graduate Program Director
School of Public Health

ACKNOWLEDGMENTS

I would like to acknowledge the guidance and support provided by my advisor, Dr. Chasan-Taber and my committee members without which this would not have been possible. I also want to acknowledge the love, patience and support provided by my husband, Brian, throughout this entire process.

ABSTRACT

PHYSICAL ACTIVITY AND MATERNAL/FETAL OUTCOMES IN A PREGNANT LATINA POPULATION

FEBRUARY 2009

AUDRA L. GOLLENBERG, B.S., RENSSELAER POLYTECHNIC INSTITUTE

Ph.D., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Lisa Chasan-Taber

Physical activity guidelines encouraging activity among healthy pregnant women have been issued by the Centers for Disease Control and Prevention, yet Latina women remain more sedentary than non-Latina white women. Latina women are also at higher risk for gestational diabetes mellitus and, among Latina women, Puerto Rican women have the highest rates of low birth weight and preterm-related infant death. This dissertation utilized data from the Latina GDM study, a prospective cohort study of 1,231 Latina women recruited early in pregnancy and followed through delivery. Participants were interviewed in early and mid pregnancy for assessment of sociodemographics, acculturation, medical, and behavioral factors, in addition to administration of the Kaiser Physical Activity Survey for assessment of physical activity and sedentary behaviors. Birth outcomes were abstracted from medical records following delivery.

In the first chapter, we assessed the prevalence of three health behaviors (meeting physical activity guidelines, meeting fruit/vegetable consumption guidelines, and cigarette smoking) in early and mid pregnancy and identified multiple factors associated

with meeting health behavior guidelines in pregnancy. In the second chapter, we examined participation in sedentary behaviors, such as time spent TV watching, sitting at work, and low levels of sports and exercise, in pre, early and mid pregnancy in relation to maternal glucose intolerance and gestational diabetes mellitus. In the final chapter, we analyzed four types of physical activity (sports/exercise, household/caregiving, occupational, and active transportation) as well as total activity in relation to risk of preterm birth and small-for-gestational age.

Findings represent the first study of physical activity and maternal/fetal outcomes conducted exclusively among Latina women, a group largely understudied in epidemiologic research. Results will guide culturally specific intervention programs in this high risk population.

TABLE OF CONTENTS

Page

LIST OF TABLES

CHAPTER 1

DIETARY BEHAVIORS, PHYSICAL ACTIVITY, AND CIGARETTE SMOKING AMONG PREGNANT LATINA WOMEN

1.1 Introduction

In the U.S., the Latin American population is the fastest growing ethnic group due to increased fertility rates and immigration (1, 2). By 2030, Latin Americans are expected to be the largest minority group in the United States (2). Substantial health disparities exist between Latinos and non-Latino whites; Latinas are more likely to have lower income and education, to be uninsured and report worse overall health than non-Latino whites (3). Important disparities also exist between the heterogeneous Latin subgroups (4-9). For example, while Latinas more often have delayed prenatal care as compared to non-Latina white counterparts, this difference is most marked among women of Puerto Rican descent (10). Latina women are more likely to be overweight or obese during pregnancy and to gain excessive weight (11). Despite the increasing size of this population and the observed health disparities, little is known regarding prenatal health behaviors and factors associated with these behaviors in Latina women.

Increasing evidence suggests that health behaviors during pregnancy such as dietary intake, physical activity, weight gain, and substance use can affect the health of both the mother and fetus (12-19). For example, physical activity in pregnancy has been associated with reduced risk of gestational diabetes mellitus (GDM) (19, 20), pre-eclampsia (16, 21) and excessive maternal weight gain while inadequate maternal nutrition has been linked with preterm delivery and intrauterine growth restriction (22-

24). However, little is known regarding prenatal health behaviors and factors associated with these behaviors in Latina women. Latina women have two to four times the risk of developing GDM compared with non-Latina white women (25). While Latinas have been reported to have a low risk of adverse fetal outcomes (termed the "epidemiologic paradox") (26, 27), this has been mainly noted among Mexican-Americans. Indeed, Latinas of Puerto Rican descent have an elevated risk of low birth weight (LBW) and poor neonatal health outcomes as compared to other Latina groups (10, 27-29), suggesting that the "epidemiologic paradox" may not hold true for Puerto Rican women (26, 27).

In response to mounting evidence regarding the effects of substance use, diet, and physical activity on perinatal morbidity and mortality, the Institute of Medicine (IOM), the American College of Obstetricians and Gynecologists (ACOG), and the American Dietetic Association (ADA) have set forth guidelines for health promoting behaviors in the prenatal period (15, 18, 30). Specifically, the IOM recommends that physicians prioritize prevention or cessation of cigarettes, alcohol, and drugs during pregnancy (18). Similarly, the ADA and ACOG recommend that pregnant women consume 7 or more servings of fruits and vegetables per day for optimal nutrition (15, 31). ACOG also suggests that, in the absence of either medical or obstetric contraindications, pregnant women adopt the Center for Disease Control and Prevention's guideline of 30 minutes or more of moderate-intensity physical activity on most, and preferably all, days of the week (30, 32).

The proposed study will identify risk and protective factors for engaging in health behaviors during pregnancy that may be used for targeted intervention strategies in Latina women. Specific goals are to: 1) estimate the prevalence of meeting guidelines for pregnancy health behaviors set by the IOM, ACOG, and ADA in both early and mid-pregnancy among Latina women of predominantly Puerto Rican descent; and 2) identify demographic, acculturation, medical, and behavioral factors associated with meeting guidelines in this ethnic group.

1.2 Review of the Literature

Few studies have examined predictors of meeting health guidelines in pregnancy among Latina women and those that have been conducted were largely restricted to Latinas of Mexican descent (33-35). Prior studies were further limited by a single measure of behavior during pregnancy, although prenatal behaviors are likely to change over the course of gestation.

1.2.1 Diet

Studies examining predictors for meeting fruit and vegetable intake guidelines in pregnancy are sparse. In a study of Mexican-origin pregnant women, Harley et al. analyzed the association between social support and acculturation factors with quality of diet in pregnancy. Latina pregnant women (N=571) of largely Mexican descent were enrolled during prenatal care as part of the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), a longitudinal birth cohort study of the health of pregnant women and their children living in the Salinas Valley, an agricultural region of California. Diet was assessed once in pregnancy via a 72-item food frequency questionnaire at the mid-pregnancy interview and rated for quality using the Diet Quality

Index for Pregnancy (DQI-P). Women who reported immigrating to the United States in childhood were less likely to have a high quality diet than those who immigrated as adults (OR=0.50, 95% C.I. 0.3-1.0). Similarly, Mexican-born immigrants were more likely to follow a high quality diet than U.S.-born Mexican-American pregnant women (36). Finally, high paternal social support was associated with a two-fold increased likelihood of having a high quality diet compared to those with low paternal social support (OR=2.0, 95% C.I. 1.1, 3.8).

In another study analyzing diet quality, Kieffer et al. utilized data from the 2001-2003 wave of the Behavior Risk Factor Surveillance System (BRFSS) to analyze health behaviors in nonpregnant, reproductive aged women. The authors defined meeting fruit/vegetable guidelines as consuming five or more fruit juices and/or fruits and vegetables a day based on ADA recommendations. Among 177,420 women aged 18-44 years, the authors found that those with greater than a high school education, who met physical activity guidelines, and were married or partnered were more likely to meet fruit/vegetable guidelines (37). Obesity, smoking, and current employment were associated with a decreased likelihood of meeting fruit/vegetable guidelines.

1.2.2 Physical Activity

Few studies have examined predictors of meeting physical activity guidelines in pregnant women. The existing studies have been limited by including predominantly white populations, single measures of physical activity during the pregnancy period, and assessment tools with unmeasured validity.

Using data from the BRFSS from 1994, 1996, 1998, and 2000 of which 18% of participants were Latina, Petersen et al. analyzed physical activity information from 6,528 pregnant women. BRFSS participants were recruited from monthly, year-round random digit dialing telephone interviews in all 50 states, the District of Columbia, Puerto Rico, Guam and the U.S. Virgin Islands. Physical activity was assessed by the following question, "During the past month, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?" If the participant answered "yes," then the type, frequency, and duration of the most common leisure activities were queried and each activity was assigned a metabolic equivalent (MET) value. Participants were divided into mutually exclusive categories for leisure time activity based on CDC recommendations of 30 minutes of moderate activity on 5 or more days of the week: recommended, insufficient, or inactive. The authors found that 16-20% of pregnant women met the physical activity guidelines. These women were more likely to be younger, more educated, unmarried, nonsmokers, and to have higher incomes (38).

In a second study examining predictors of meeting physical activity guidelines among 1,979 pregnant women using 2000 BRFSS data, Evenson et al. observed that 16% of pregnant women met the physical activity guidelines (39). Meeting guidelines was associated with younger age, higher education, and excellent or very good health. Marital status, employment, and number of children were unassociated with likelihood of meeting these guidelines (39).

1.2.3 Cigarette Smoking

Predictors of smoking have been widely studied among pregnant women, but few studies have focused on Latinas. In general, lower education, white race, age <25 years, unmarried status, and greater parity have been associated with smoking during pregnancy (40). Among studies that included Latinas, predictors were similar (35, 41). These studies found that increasing time in the U.S. and poorer health behaviors in pregnancy, including drug use, were associated with an increased likelihood of smoking (35, 41).

Using nationally-representative data from 20 large U.S. cities in the Fragile Families and Child Wellbeing Study, Perreira & Cortes analyzed data from over 3,000 (n=3,311) non-Latina white, non-Latina black, and Latina women representing 200,000 births from 1999. Women were interviewed within 3 days of giving birth regarding prenatal alcohol, cigarette, and illicit drug use. The authors observed that foreign-born Latina women were significantly less likely to smoke than their U.S.-born counterparts (OR=0.10, 95% C.I. 0.04-0.3) and that smoking was increased among the poor and less educated (41). Previous alcohol or drug treatment (OR=7.6, 95% C.I. 1.8-32.6) and having a partner who smokes were positively associated with prenatal cigarette use (OR=3.3, 95% C.I. 2.2-5.1) (41).

In summary, epidemiologic studies on meeting health behavior guidelines in pregnancy are sparse and few have been conducted exclusively among Latina women. Limitations among the aforementioned studies include only one assessment of health behaviors during pregnancy, the use of behavior assessment tools that have not been validated, and inclusion of small proportions of Latina women. This study was conducted exclusively among Latina women, a group at particularly high risk for adverse maternal and fetal outcomes as compared to other ethnic groups, and assessed health behaviors at two time points, early and mid pregnancy.

1.3 Summary

Latinas are the fastest-growing ethnic group in the United States and will become the largest minority group by 2030 (2). Despite the growing size of this population, little is known regarding their prenatal health behaviors and factors associated with compliance with behavior guidelines in this ethnic group.

Existing epidemiologic literature on meeting health behavior guidelines in pregnancy are sparse and few have been conducted exclusively among Latina women. Limitations among existing epidemiologic studies include using only one assessment of health behaviors during pregnancy, the lack of validated behavior assessment tools, and inclusion of small proportions of Latina women. Studies on predictors of meeting prenatal physical activity guidelines are few in number and were conducted among predominantly white, affluent populations. In terms of smoking determinants, studies of prenatal smoking are more numerous than other health behaviors; however, limitations include assessing smoking only once in pregnancy or retrospectively after birth. Moreover, predictors of meeting dietary guidelines in pregnancy are lacking among Latinas, although one study examined dietary quality.

In conclusion, few studies have examined predictors of meeting health guidelines in pregnancy among Latina women and those that have been conducted were largely restricted to Latinas of Mexican descent (33, 34). Latina women are largely understudied in pregnancy research and even more so in studies of prenatal health behaviors. Factors related to engagement in both healthy and risky behaviors in pregnancy need to be explored in this population.

1.4 Study Aims

Using a population of predominantly Puerto Rican prenatal care patients, we conducted a study to address the following aims:

1) To identify socioeconomic, behavioral, acculturation, and medical predictors of compliance with ADA and ACOG prenatal fruit/vegetable guidelines.

2) To identify socioeconomic, behavioral, acculturation, and medical predictors of compliance with ACOG prenatal physical activity guidelines.

3) To identify socioeconomic, behavioral, acculturation, and medical predictors of cigarette smoking in pregnancy.

1.5 Methods

1.5.1 Study Design and Population

Participants were self-identified Latinas enrolled in prenatal care in the public Obstetrics and Gynecology (OB/GYN) and Midwifery Practice of a large tertiary care facility in Western Massachusetts, Baystate Medical Center. Study design and methods of the Latina GDM Study have been described elsewhere (42, 43). Briefly, participants were recruited by bilingual interviewers at prenatal care visits up to 24 weeks of gestation (mean = 15 weeks gestation) from September 2000 to December 2003. Eligibility criteria included Latina ethnicity, age 16-40 years, <24 weeks gestational age at first interview, singleton pregnancy, no prior diagnosis of hypertension, chronic renal disease, or type 2 diabetes, and no prior participation in the study. Interviewers obtained informed consent from participants approved by the Institutional Review Boards of the University of Massachusetts-Amherst and Baystate Medical Center.

Interviewers collected information on substance use, medical and obstetric history, physical activity, and sociodemographic factors at the time of recruitment. Dietary information was assessed in mid pregnancy (mean = 23 weeks). Medical and obstetric history as well as clinical characteristics of the pregnancy were collected from medical records by trained medical abstractors. A subgroup of participants (n=750) were interviewed a second time later in pregnancy to update information on substance use and physical activity (mean = 28 weeks gestation). Women not reached for this second interview either did not deliver at Baystate Medical Center (n=157), had a miscarriage, pregnancy termination, or preterm birth <28 weeks (n=34), or failed to attend a prenatal care visit or were not located by the interviewer at the clinic or by telephone (n=300).

1.5.2 Fruit and vegetable consumption

Pregnancy diet was assessed using a mid-pregnancy food frequency questionnaire (FFQ) adapted from the National Cancer Institute (NCI/Block) FFQ designed for Latinos in Northeastern United States (of mainly Puerto Rican and Dominican heritage) (44). This questionnaire, adapted from the Block FFQ designed for non-Latino whites, was validated in a population of Latinos and non-Latino whites using 24 hour recalls (44). When 24-hour recalls were coded into original Block and adapted FAQs, intraclass correlation coefficients between the adapted FFQ and 24-hour recalls were generally greater than that of the Block FFQ, ranging from 0.84 for vitamin E to 0.97 for energy (kcal) and 0.98 for protein (g) (44).

Total servings of fruit and vegetables were calculated by summing the reported daily number of fruits and vegetables listed on the FFQ and adjusting by a summary measure of usual number of servings. Based on ADA and ACOG recommendations for daily consumption of fruit and vegetables during pregnancy, those who consumed seven or more servings/day were considered as meeting dietary guidelines during pregnancy.

1.5.3 Physical activity participation

Physical activity in pregnancy was measured using a modified version of the Kaiser Physical Activity Survey (KPAS) (45, 46). The modified KPAS was validated among a sample of 54 pregnant women at Baystate Medical Center using seven days of accelerometer measurements (47). Intraclass correlation coefficients used to measure the reproducibility of the KPAS ranged from r=0.76 to 0.86 and Spearman correlation coefficients between the KPAS and three published cut points used to classify accelerometer data ranged from r=0.49 to 0.59.

Participants who reported participating in sports or exercise in pregnancy listed the activity type, frequency, and duration for up to three activities. MET-hrs/week, were calculated for each activity using the Compendium of Physical Activities (48) and summed to create a measure of total sports/exercise activity. Pregnant women are advised to participate in 30 minutes of moderate activity on most days of the week, which corresponds to a total of 2.5 hours per week. Moderate activities range from 4 to 6 METs (a measure of physical activity intensity). Therefore, we multiplied 4 METs by 2.5 hrs to obtain a minimum of 10 MET-hrs per week as our definition of meeting the physical activity guidelines. Meeting the physical activity guidelines was calculated separately for both early and mid pregnancy time periods.

1.5.4 Cigarette smoking and alcohol consumption

Cigarette smoking was assessed using questions designed by the Pregnancy Risk Assessment Monitoring System (PRAMS), a surveillance project of the Centers for Disease Control and Prevention. Participants were asked to self-report the number of cigarettes/packs of cigarettes smoked on an average day. Participants were also asked to report the average number of days that alcohol was consumed per week or month and the average number of drinks consumed per session.

1.5.5 Covariate Assessment

We collected information on sociodemographic variables including age, education level, and employment by questionnaire. Medical factors including parity, pregnancy weight gain, pre-pregnancy BMI, personal history of gestational diabetes, history of adverse pregnancy outcome (a prior preterm birth, low birth weight neonate, infant with congenital anomalies or stillbirth) and family history of type 2 diabetes were abstracted from medical records after delivery. Acculturation measures included language preference for speaking, reading, and writing, along with place of birth assessed by questionnaire. Because cigarette smoking, alcohol consumption, and illicit drug use may be highly correlated, we created a variable defined as engagement in 0, 1, 2, or 3 “risky behaviors” (i.e., smoking, drinking, or using illicit drugs in pregnancy) in pregnancy.

1.5.6 Data Analysis

Statistical analysis was conducted using SAS 9.1.3 software by SAS Institute Inc. (SAS Campus Drive, Cary, North Carolina). Dichotomous variables for meeting each guideline in pregnancy were evaluated as outcomes in separate multiple logistic regression models. The likelihood of alcohol consumption was not modeled due to low prevalence in this population (1.6%). Meeting fruit/vegetable guidelines was analyzed both with and without high starch vegetables (legumes, potatoes, root crops and plantains).

Sociodemographic, acculturation, and medical factors were assessed as predictors of meeting health behavior guidelines in these models. Predictors that showed significant ($p<0.05$) or borderline significant ($p<0.2$) association with outcomes at the bivariate level were added to the multivariable models along with maternal age. Those predictors that were not borderline significant at the bivariate level were added singly to the model to determine additional improvement in model fit. Compliance with each health behavior guideline was also considered as a potential predictor of meeting the other health behavior guidelines. The likelihood ratio test was used to determine the best fitting model for the data. Final multivariable logistic models were used to calculate adjusted odds ratios and 95% confidence intervals. Tests for linear trend were calculated by modeling ordinal variables as continuous variables using the category mid-point. For the assessment of acculturation, only language preference was used in multivariable models as language preference and birth place were highly correlated ($p<0.0001$). We evaluated history of GDM and history of adverse pregnancy outcome as predictors of health behaviors in analyses restricted to parous women. Finally, maternal age was not statistically significantly associated with cigarette smoking and meeting fruit/vegetable guidelines, but was controlled for in these final multivariable models and not included in the tables.

1.6 Results

Approximately 70% of the population was less than age 25 years and 55% had not completed high school (Table 1). Nearly 90% of participants born in the continental United States had at least 1 parent born in Puerto Rico with the remaining 10% having parents born in Central or South America. Among those born outside the continental United States, 84.5% were born in Puerto Rico with the remainder born in Mexico (2.4%), the Dominican Republic (2.0%), and smaller proportions born in Central and South America. With regard to medical factors, over 60% of participants were parous, over 60% had a family history of diabetes mellitus and almost 50% were considered overweight or obese by pre-pregnancy BMI standards (>25 kg/m^2).

Overall, 21.1% of participants reported cigarette smoking, 1.4% used alcohol, and 5.5% reported illicit drug use during pregnancy, while 13.1% met the physical activity guidelines (Table 2). Regarding fruit and vegetable intake guidelines, 18.5% met the guidelines when including starchy vegetables, while 5% met the guidelines after excluding these items. Overall, less than 1% of participants engaged in all three risky behaviors (defined as cigarette smoking, alcohol use, or illicit drug in pregnancy), 4% engaged in two risky behaviors, and 18% engaged in one risky behavior only.

We considered a variety of behavioral, sociodemographic, acculturation and medical factors as potential factors associated with health behaviors in pregnancy. In univariate cross-tabulations, increasing education ($p=0.004$) and illicit drug use ($p=0.004$) were significantly associated with meeting fruit/vegetable guidelines (Table 3). Of those who met the fruit/vegetable guidelines, 20% had completed some college or more, as compared to 10% among those who did not meet these guidelines. Age ($p=0.003$), language preference (English vs. Spanish/bilingual) ($p=0.01$), history of adverse pregnancy outcome ($p=0.0007$), cigarette smoking ($p=0.04$), and illicit drug use ($p=0.003$) were statistically significantly associated with meeting physical activity guidelines in pregnancy (Table 4). For instance, of those who met the physical activity guidelines, 85% were <25 years of age and 79% preferred to speak only English, as compared to 71% and 66%, respectively, of those who did not meet these guidelines.

With regard to cigarette smoking in pregnancy, employment ($p=0.002$), educational attainment ($p<0.0001$), language preference ($p=0.001$), birth place (Continental U.S. vs. Puerto Rico/other) ($p=0.01$), meeting physical activity guidelines ($p=0.02$), alcohol use ($p<0.0001$) and illicit drug use ($p<0.0001$) were significantly associated with cigarette smoking in pregnancy (Table 5). Among smokers in pregnancy, 71% had less than a high school education, 63% were U.S.-born, 72% were parous, and 18% reported illicit drug use during pregnancy, as compared to 53%, 53%, 57% and 3%, respectively, among nonsmokers.

In unadjusted analysis, those with a history of adverse pregnancy outcome were significantly more likely to meet the physical activity guidelines, while those born outside the continental U.S. and who preferred Spanish or were bilingual were significantly less likely to meet the physical activity guidelines (Table 6). When evaluating smoking during pregnancy, in unadjusted analyses, those with a high school education compared to those without a high school education, and those with greater parity were more likely to smoke. Alternatively, those who had a college education, current employment, birthplace outside the U.S. and those who preferred Spanish were less likely to smoke. With regard to the fruit and vegetable guidelines, in unadjusted analyses, those who had a college education were more likely to consume adequate fruit and vegetables while increasing pre-pregnancy BMI was associated with decreased likelihood of meeting these guidelines ($P_{trend} = 0.009$). Compliance with IOM weight gain guidelines and total pregnancy weight gain were not associated with health behaviors.

The final multivariable model for meeting fruit and vegetable guidelines included educational attainment, cigarette smoking, pre-pregnancy body mass index, and illicit drug use while controlling also for maternal age (Table 7). College-educated women were more than twice as likely to consume adequate fruits and vegetables as compared to those who did not finish high school (including starchy vegetables: OR = 2.2; 95% C.I. 1.1-4.3; p-trend = 0.025; excluding starchy vegetables: OR=2.5; 95% C.I. 0.9-7.1; p-trend=0.17). Those who smoked in early or mid pregnancy were half as likely to meet the fruit and vegetable guidelines compared to nonsmokers; however, this association was not statistically significant when excluding the high starch vegetables (including starchy vegetables: OR = 0.5; 95% C.I. 0.3-0.9; excluding starchy vegetables: OR=0.4; 95% C.I. 0.1-4.5). Self-reported illicit drug use was associated with increased likelihood of meeting fruit and vegetable guidelines, both including and excluding the high starch vegetables, as compared to nonuse. Meeting physical activity guidelines in mid pregnancy and a personal history of GDM were also included in final multivariable models ($p<0.20$) but the association with physical activity guidelines was only statistically significant ($p<0.05$)

when excluding high starch vegetables (OR=3.7; 95% C.I. 1.2-11.3). Finally, increasing pre-pregnancy BMI was associated with a decreased likelihood of meeting fruit/vegetable guidelines when including all fruits/vegetables (P_{trend} = 0.01) and the subset (P_{trend} = 0.05).

Similar to the unadjusted results, the final multivariable model for meeting physical activity guidelines included reproductive history, drug use, preferred language, age, and education (Table 8). Those with a history of adverse pregnancy outcome were almost 5 times as likely to meet the physical activity guidelines in early pregnancy (OR = 4.8; 95% C.I. 2.3-10.2) and 3 times as likely to meet the guidelines in mid pregnancy (OR = 3.3; 95% C.I. 1.0-10.6) as compared to those without a history of adverse pregnancy outcome. Those who preferred Spanish were less likely to meet the physical activity guidelines in early pregnancy (OR = 0.6, 95% C.I. 0.3-1.0) and in mid pregnancy (OR = 0.5, 95% C.I. 0.2-1.2) compared to those who preferred English. Increasing age was associated with a decreased likelihood of meeting the physical activity guidelines in mid-pregnancy (p-trend = 0.025). There was no clear association between educational attainment and meeting physical activity guidelines in early pregnancy; however college educated women were almost 3 times as likely to meet the guidelines in mid pregnancy as compared to those with less than a high school degree (OR = 2.8; 95% C.I. 1.1-7.1). Self-reported drug use was associated with meeting the physical activity guidelines in both early (OR = 2.1, 95% C.I. 1.0-4.4) and mid pregnancy (OR = 2.6, 95% C.I. 1.0-6.8). Overall, findings were similar for both early and mid-pregnancy assessments, with the exception of educational attainment. Unlike the unadjusted analyses, smoking status was not significantly associated with meeting physical activity guidelines once adjusted for the other factors in the model.

Consistent with unadjusted results, the final multivariable model for cigarette smoking in pregnancy included alcohol use, illicit drug use, parity, language preference, and educational attainment while also controlling for maternal age (Table 9). For example, those who consumed alcohol while pregnant were 4.4 times more likely to smoke in early pregnancy as compared those who abstained from alcohol (95% C.I. 1.3-14.7), while drug users were 8.2 times more likely to smoke cigarettes in early pregnancy (95% C.I. 4.6-14.6). Parous women were more than twice as likely to smoke in early pregnancy (OR = 2.1, 95% C.I. 1.4-3.2) and mid pregnancy (OR = 2.6, 95% C.I. 1.6-4.3) compared to nulliparous women. Women who were bilingual or spoke only Spanish were significantly less likely to report smoking in early pregnancy (OR=0.6, 95% C.I. 0.4-0.8) and non-significantly less likely to smoke in mid-pregnancy (OR=0.7, 95% C.I. 0.4-1.1) as compared to those who prefer English. Increasing education was associated with a decreased likelihood of smoking in early pregnancy (p-trend <0.0001). Findings were similar for both early and mid-pregnancy assessments. However, meeting physical activity and fruit and vegetable guidelines, employment status, and birth place were no longer statistically significantly associated with cigarette smoking in multivariable analyses.

Finally, we repeated the analysis re-categorizing the place of birth variable as Continental U.S. or Puerto Rico vs. foreign born (as opposed to Continental U.S. vs. Puerto Rico or foreign born) because acculturation to American behaviors may also occur on the island of Puerto Rico (49). Findings were virtually unchanged.

1.7 Discussion

In this prospective cohort of predominantly Puerto Rican pregnant Latinas, we found that behavioral, medical, acculturation, and demographic factors were predictive of meeting prenatal health behavior guidelines. Spanish language preference, an indicator of lesser acculturation, was associated with an approximate 40% decreased likelihood of both smoking and meeting physical activity guidelines, but was unassociated with meeting fruit/vegetable guidelines. Illicit drug use, predominantly marijuana, was associated with a substantial increased likelihood of smoking cigarettes in pregnancy, and was positively associated with meeting physical activity and fruit/vegetable guidelines. College education was associated with a 2-3 fold increased likelihood of healthy behaviors, such as meeting physical activity and fruit/vegetable guidelines and a decreased likelihood of smoking. Increasing age was associated with a decreased likelihood of meeting mid pregnancy physical activity guidelines and was unassociated with smoking or fruit/vegetable intake in this population. Furthermore, those who met the physical activity guidelines were somewhat more likely to also meet the fruit/vegetable guidelines, suggesting an association between healthy behaviors. Prevalence of meeting guidelines and the association with predictive factors were largely similar in direction and magnitude for early and mid pregnancy assessments.

Although few studies have examined predictors of meeting physical activity guidelines in pregnant women, our findings are, in general, consistent with prior studies. Using data from 6,528 participants in the Behavioral Risk Factor Surveillance System in 1994, 1996, 1998, and 2000 (BRFSS) of which 18% were Latina, Petersen et al. found that 16-20% of pregnant women met the physical activity guidelines. These women were more likely to be younger, more educated, unmarried, nonsmokers and to have higher incomes (38). Similarly, in the current study, we observed that 13% of pregnant women met the activity guidelines and these women were more likely to be younger and of higher education. In contrast, we did not observe an association between cigarette smoking and meeting these guidelines. This lack of association may be due, in part, to differences in smoking patterns between our predominantly Puerto Rican population and the largely non-Latina white population of the BRFSS. In a second study examining predictors of meeting physical activity guidelines among 1,979 pregnant women using 2000 BRFSS data, Evenson et al. observed that 16% of pregnant women met the physical activity guidelines (39). Consistent with our findings, meeting guidelines was associated with younger age, higher education, and excellent or very good health. Marital status, employment, and number of children were unassociated with likelihood of meeting these guidelines (39).

Predictors of smoking have been widely studied among pregnant women, but less so among Latinas. In general, lower education, white race, age <25, unmarried status, and greater parity have been associated with smoking during pregnancy (40). Among studies which included Latinas, predictors were similar (35, 41). These studies found that increasing time in the U.S. and poorer health behaviors in pregnancy, including drug use, were associated with an increased likelihood of smoking (35, 41). Using nationally-representative data from 20 large U.S. cities in the Fragile Families and Child Wellbeing Study (n=3301), Perreira & Cortes observed that foreign-born Latina women were over 80% less likely to smoke than their U.S.-born counterparts and that smoking was increased among the poor and less educated (41). Similarly, we observed an association between Spanish language preference, a measure of lower acculturation, and decreased likelihood of smoking as compared to those who preferred English.

In addition, studies evaluating smoking among Latina women demonstrate that Puerto Rican women tend to report higher smoking and substance use rates than other Latina sub-groups (6, 49-51). The Puerto Rican Maternal and Infant Health Study found that 16.5% of US-born Puerto Rican women self-reported smoking during pregnancy (49), while another study found 17.9% of US-born Hispanic women smoked during pregnancy (41). We found that 21% of our participants (23% of US-born and 16.7% of foreign-born) self reported smoking in pregnancy making it unlikely that cigarette smoking was substantially underestimated.

Studies examining predictors for meeting fruit and vegetable intake guidelines in pregnancy are sparse. In a study of Mexican-origin pregnant women, Harley and colleagues observed that Mexican-born immigrants consumed more fruit and vegetables than U.S. born Mexican-American pregnant women (36), whereas we did not observe differences in meeting the guidelines by place of birth or language preference. This difference in findings may result from cultural differences between the Mexican and Puerto Rican native diet. In a non-pregnant, 80% white population of women, Kieffer et al. found that those with greater than a high school education, who met physical activity guidelines, and were nonsmokers were more likely to meet fruit/vegetable guidelines (37). These findings were consistent with those of the present study.

A second measure of health behaviors, later in pregnancy, was available for a subgroup (62%) of the sample. Women with this second measure did not differ significantly from women missing this measure in terms of the majority of factors, however this group was older, more highly educated, and less likely to have a history of GDM. However, after controlling for level of education, there were no significant differences between the groups in terms of age and history of GDM. The finding that the majority of predictors of meeting health behavior guidelines were similar in the first as well as second time period reduces the likelihood of this sample representing a select group.

The association between reported illicit drug use in pregnancy and the increased likelihood of meeting physical activity and fruit/vegetable guidelines was unexpected, but studies of these behaviors among pregnant as well as non-pregnant women are sparse. Indeed, patterns of perinatal drug use among predominantly Puerto Rican Latinas have not been adequately described. Among non-pregnant women, smoking and alcohol consumption, often gateways to illicit drug use, have been inconsistently related to physical activity with some studies among multiethnic populations indicating that current smokers are less active, while others have found no relationship, and one study among black women found the reverse (52). Furthermore, to our knowledge, only one other study has examined the relationship between sports/exercise and illicit drug use. In this cross-sectional study of young adults (<25 years of age), those who participated in organized sports and recreation reported higher usage of marijuana and alcohol as compared to those who did not (53).

Similarly, studies of correlates of fruit/vegetable consumption have been inconsistent and limited to non-pregnant populations, with two studies showing that marijuana use is associated with greater caloric intake explained by greater intake of all macronutrients but with lower fruit intake and no difference in vegetable intake (54, 55) and a third study among college students finding that marijuana use was not associated with diet (56). In our study, women who used drugs during pregnancy were predominately users of marijuana (89%) and were more likely to be young in age (<25 years: 84% users vs. 70% nonusers) and of lower education (<high school: 67% users vs. 52% nonusers). While we controlled for these factors in multivariable analysis, it is still possible that confounding by other factors associated with drug use, such as partner usage or unknown factors, may be responsible for these findings.

1.8 Study Limitations

As in any study relying on self-reported smoking information, some degree of misclassification of smoking status is possible. Several recent studies demonstrate that pregnant women can accurately self report prenatal smoking behaviors as assessed by urinary cotinine measurements (57-59). Other studies have shown that pregnant women are more accurate about reporting any smoking rather than actual dose (60). Determination of smoking status (yes or no) in early and mid pregnancy would be misclassified if smokers inaccurately claim to be non-smokers due to social desirability. If misclassification of smoking status is unrelated to the predictor variables, then misclassification of this type would most likely bias our results toward the null.

Misclassification may also arise from the use of the KPAS to measure adherence to physical activity guidelines during pregnancy. Our assessment of participation in leisure time activities allowed participants to report up to 3 sports/exercise activities in both early and mid pregnancy. It is possible that participants may engage in more than 3 activities in a given week; however, of those reporting sports/exercise, only 12% reported >2 activities in early pregnancy and only 10% reported the same in mid pregnancy, thus minimizing this concern. In addition, women may also satisfy physical activity guidelines through participation in moderate household and occupational activities. Although a strength of the KPAS is the collection of activity in 4 domains of activity (household/care giving, occupational, active living, and sports/exercise), response choices for the first three domains are based on a Likert-type scale ranging from never to always. This precludes the calculation of MET-hrs/week of activity within these domains and they are therefore not taken into account in the total measure of moderate intensity activity. Such misclassification would result in biasing our results toward the null.

We used an FFQ designed and validated for northeastern U.S. Puerto Rican and Dominican Latina groups and administered during mid-pregnancy to assess usual pregnancy diet. However, diet may change over the course of pregnancy. The range of timing of dietary assessments occurred from 5 weeks to 40 weeks gestational age, potentially causing misclassification of usual pregnancy diet. Furthermore, the FFQ was completed over multiple visits in some cases. In the only study to date to assess the change in maternal dietary intake between trimesters, Rifas-Shiman and co-authors showed no appreciable change in mean food group intake between trimesters. The authors observed the highest correlations for fruit and vegetable intake between the first and second trimesters (r=0.68) (61) suggesting that our measure of dietary intake in mid pregnancy may be sufficient to characterize compliance with fruit/vegetable guidelines in this population. As in any study of self-reported dietary intake, participants may over-report healthy foods, such as fruits and vegetables, and/or inaccurately estimate portion size as it relates to reporting the number of servings of fruits and vegetables. However, if misclassification of meeting fruit/vegetable guidelines occurs and is unrelated to our predictor variables, it will most likely bias our results toward the null.

Furthermore, we analyzed fruit/vegetable guidelines in two ways; one analysis included all fruits/vegetables and the second analysis excluded starchy vegetables (plantains, legumes, root crops and potatoes). Most associations were similar in magnitude and direction for both analyses, whereas some associations were somewhat stronger, but similar in direction when starchy vegetables were excluded, such as meeting physical activity guidelines, history of GDM, and pre-pregnancy BMI, suggesting that some misclassification may have occurred when starchy vegetables were included in meeting the guidelines.

In addition, dietary information is available for a subset of the entire cohort (62%). Therefore, fewer data points results in limited statistical precision and greater type I error, (i.e. the potential to reject the null hypothesis when it is actually true). This limitation is similar to nondifferential misclassification in that the findings may be weakened as a result. Those who were missing dietary information did not differ from those with available information on the majority of socioeconomic, behavioral and medical factors; however, they were more likely to be parous. Given that parity was not strongly associated with meeting fruit/vegetable guidelines in unadjusted or multivariable analysis and that those missing dietary information did not differ from the analytic group by the majority of factors, the potential for selection bias is likely minimal.

Due to the prospective nature of this study, selection bias may occur through loss to follow-up of cohort participants. Differential loss to follow-up in this study may be defined as a loss of outcome information (health behaviors) on a subset of participants who differ from followed participants on certain characteristics (predictor variables). Furthermore, those lost to follow-up must differ in terms of both outcome and exposure status as compared to those remaining in the cohort to produce a bias. Selection bias may affect results differently depending on the situation, either toward or away from the null. However, we suspect selection bias to be minimal given that measures of association were largely similar for both early and mid pregnancy assessments and those missing information did not differ from those with available information on the majority of factors.

The use of self-reported exposure information on maternal characteristics may be subject to information bias if reporting is differential based on health behavior status. Due to the cross-sectional nature of data collection for early pregnancy behaviors and socioeconomic and acculturation factors at baseline, it is possible for reporting of certain characteristics to influence health behavior reporting. However, this cross-sectional assessment in early pregnancy will not affect the reporting of mid-pregnancy behaviors collected at a later date. This type of bias may cause the observed associations to be driven away or toward the null depending on the situation. However, the majority of associations were similar in magnitude and direction for early and mid pregnancy analyses suggesting that the likelihood of this bias is minimal.

A second type of information bias relates to biased surveillance or assessment of the outcome. Findings may be biased if younger women were asked more in-depth questions on physical activity with the hypothesis that younger women may be more active in pregnancy. However, the likelihood of this bias is low give than all women were interviewed with the same questionnaire designed to assess health behaviors in pregnancy.

To assess potential factors that may bias the association between maternal lifestyle, demographic, and behavioral factors and prenatal health behaviors, we collected information on a large number of characteristics that may be associated with health behaviors. We will analyze the potential for confounding using multivariable regression. Our population is restricted to Latina women, and this accounts for some confounding by ethnicity by design. In addition our population is restricted to women 16-40 years of age, thus limiting confounding by extreme age in the reproductive span. Although we collected information on all known or suspected factors related to maternal characteristics and health behaviors, it is possible for residual confounding by unknown variables or inadequate control for available factors to affect the estimated associations.

Furthermore, for a factor to be a strong confounder it must be associated with both the exposure and outcome. Given that we have collected information on a large number of factors known to be associated with health behaviors, the risk of uncontrolled confounding is unlikely. However, we do not have information on paternal social support or marital status, factors known to be associated with physical activity and other health behaviors. If paternal support is positively associated with physical activity and age, and perhaps older age is associated with meeting physical activity guidelines, then the observed association may be over estimated. Moreover, this confounding factor would only bias estimates that involve associated factors. For instance, if paternal social support is only associated with age and is not associated with other characteristics like educational attainment, then only the association between age and physical activity would be biased. Occupational activity level may also confound the association between select characteristics and meeting physical activity guidelines; however, when we controlled for employment in multivariable models, the estimates did not change appreciably. In addition, educational level was adjusted for in all analyses and may account for occupational activity to some extent.

1.9 Generalizability

Findings of this study may be generalized to behaviors of pregnant Puerto Rican women, a sub-group of Latina women who report worse overall health and have higher rates of substance use and adverse birth outcomes as compared to other Latina groups (6, 10, 27-29, 51). Indeed, there is substantial heterogeneity between and within the various Latina subgroups in terms of genetics, acculturation, and health disparities (4-6, 8, 9) and such differences should be addressed in culturally-specific intervention programs.

1.10 Conclusion

In summary, in our cohort of predominantly Puerto Rican Latinas, we prospectively identified a number of modifiable predictors of smoking and meeting physical activity and fruit/vegetable intake guidelines in pregnancy. Factors related to engagement in prenatal health behaviors should be addressed when designing targeted intervention strategies in this underserved and rapidly growing population.

Table 1.1 Distribution of study participants according to socioeconomic, acculturation and medical factors. Latina GDM Study, 2000-2004.

Characteristic	N (%)
Socioeconomic Factors	
Age categories (years)	
16-19	417 (33.9)
20-24	455 (37.0)
25-29	225 (18.3)
30-40	134 (10.9)
Employed	
No	574 (49.5)
Yes	586 (50.5)
Education level	
Less than high school	603 (55.6)
High school/tech school	345 (31.8)
>=Some college	137 (12.6)
Income ($)	
<=15 k	390 (31.7)
>15-30 k	219 (17.8)
>30 k	73 (5.9)
Don't know	549 (44.6)
Acculturation Factors	
Birth place	
U.S. (Continental)	597 (54.6)
Other	496 (45.4)
Preferred language	
English only	808 (66.8)
Spanish/Both	401 (33.2)
Medical Factors	
Parity	
Nulliparous	466 (38.7)
Parous	739 (61.3)
Pre-pregnancy BMI[a]	
Underweight (<20 kg/m^2)	156 (13.2)
Normal (20-<25 kg/m^2)	447 (37.8)
Overweight (25-<30 kg/m^2)	303 (25.6)
Obese (>=30 kg/m^2)	278 (23.5)
IOM pregnancy weight gain[a]	
Within guidelines	251 (20)
Inadequate weight gain	173 (14)
Excessive weight gain	346 (27)
Missing information	495 (39)
History of GDM[a,c]	
No	701 (95.8)
Yes	31 (4.2)
History of adverse pregnancy outcome[b,c]	
No	640 (89.9)
Yes	72 (10.1)

a = BMI denotes body mass index; IOM denotes Institute of Medicine guidelines; GDM denotes gestational diabetes mellitus; DM denotes diabetes mellitus

b = Prior infant with anomalies, stillbirth, low birth weight, or preterm birth

c= Restricted to parous women.

Table 1.2. Distribution of health behaviors among participants in the Latina GDM Study, 2000-2004.

	Timing of Assessment					
Behaviors during pregnancy	**Overall Pregnancy**		**Early Pregnancy**		**Mid Pregnancy**	
	#	**%**	**#**	**%**	**#**	**%**
Cigarette smoking						
No (meets guidelines)	884	78.9	823	80.1	618	82.4
Yes	237	21.1	205	20	132	17.6
<1 cigarette/day	20	1.8	16	1.6	11	1.5
1+ cigarette/day	217	19.4	189	18.4	121	16.1
Alcohol consumption						
No (meets guidelines)	1114	98.6	1033	98.7	764	99.7
Yes	16	1.4	14	1.3	2	0.3
1-3/week	14	1.2	12	1.1	2	0.3
>=4/week	2	0.2	2	0.2	0	0
Any illicit drug use						
No (meets guidelines)	1068	94.5	986	94.6	741	97.8
Yes	62	5.5	56	5.4	17	2.2
[a]Meets physical activity guidelines						
<10 MET-hrs/wk	978	86.9	935	89.7	690	93.4
>=10 MET-hrs/wk (meets guidelines)	148	13.1	108	10.4	49	6.6
[b]Meets fruit/vegetable guidelines						
0 to <4 servings/day	282	39.3	n/a	n/a	n/a	n/a
4 to <7 servings/day	304	42.3	n/a	n/a	n/a	n/a
7+ servings/day (meets guidelines)	132	18.4	n/a	n/a	n/a	n/a
[c]Meets fruit/vegetable guidelines						
0 to <4 servings/day	526	73.3	n/a	n/a	n/a	n/a
4 to <7 servings/day	154	21.5	n/a	n/a	n/a	n/a
7+ servings/day (meets guidelines)	38	5.3	n/a	n/a	n/a	n/a

[a]Meeting physical activity guidelines is defined as moderate activity at least 30/min per day on 5 days/week or vigorous activity at least 20 min/day on 3 days/week, or at least 10 MET-hrs per week.
[b]Meeting fruit/vegetable guidelines is defined as 7 or more servings per day of all fruits and vegetables and fruit juices.
[c]Meeting fruit/vegetable guidelines is defined as above without including starchy vegetables- legumes, root crops, plantains and potatoes.

Table 1.3. Distribution of characteristics according to meeting fruit/vegetable guidelines. Latina GDM Study, 2000-2004.

Characteristics	Meets Fruit/vegetable Guidelines[c]		
	Yes	No	P-value
Socioeconomic Factors			
Age categories (years)			
16-19	46 (34.9)	205 (34.9)	0.43
20-24	45 (34.1)	228 (38.8)	
25-29	23 (17.4)	101 (17.2)	
30-40	18 (13.6)	54 (9.2)	
Employed			
No	62 (48.1)	286 (49.3)	0.80
Yes	67 (51.9)	294 (50.7)	
Education level			
Less than high school	59 (46.1)	329 (57.8)	0.004
High school/technical school	44 (34.4)	184 (32.3)	
>= Some college	25 (19.5)	56 (9.8)	
Income ($)			
<15 k	49 (62.8)	212 (58.7)	0.64
15-<30 k	20 (25.6)	112 (31.0)	
>= 30 k	9 (11.5)	37 (10.3)	
Acculturation Factors			
Birth place			
U.S. (Continental)	66 (52.4)	315 (55.1)	0.58
Other	60 (47.6)	257 (44.9)	
Preferred language			
English only	86 (65.2)	389 (66.7)	0.73
Spanish/Both	46 (34.9)	194 (33.3)	
Medical Factors			
Parity			
Nulliparous	55 (41.7)	239 (40.8)	0.85
Parous	77 (58.3)	347 (59.2)	
Pre-pregnancy BMI[a]			
Underweight (<20 kg/m^2)	22 (18.8)	58 (11.3)	0.05
Normal (20-<25 kg/m^2)	50 (42.7)	198 (38.5)	
Overweight (25-<30 kg/m^2)	26 (22.2)	138 (26.9)	
Obese (>=30 kg/m^2)	19 (16.2)	120 (23.4)	
IOM pregnancy weight gain[a]			
Within guidelines	24 (18.2)	130 (22.1)	0.74
Inadequate weight gain	20 (15.2)	78 (13.3)	
Excessive weight gain	44 (33.3)	198 (33.7)	
Missing information	44 (33.3)	182 (31.0)	

Table 1.3. Continued

History of GDM[a,d]			
No	71 (92.2)	331 (95.7)	0.24
Yes	6 (7.8)	15 (4.3)	
Family history of DM[a]			
No	41 (31.8)	198 (34.5)	0.56
Yes	88 (68.2)	376 (65.5)	
History of adverse pregnancy outcome[b,d]			
No	69 (90.8)	300 (89.3)	0.71
Yes	7 (9.2)	36 (10.7)	
Behavioral Factors			
Meets physical activity guidelines			
No	118 (89.4)	531 (90.3)	0.75
Yes	14 (10.6)	57 (9.7)	
Cigarette smoking			
No	99 (83.9)	417 (80.2)	0.36
Yes	19 (16.1)	103 (19.8)	
Alcohol use			
No	127 (97.7)	571 (99.0)	0.22
Yes	3 (2.3)	6 (1.0)	
Illicit drug use			
No	115 (88.5)	549 (95.2)	0.004
Yes	15 (11.5)	28 (4.9)	

a = BMI denotes body mass index; IOM denotes Institute of Medicine guidelines;
GDM denotes gestational diabetes mellitus; DM denotes diabetes mellitus
b = includes infant with anomalies, stillbirth, low birth weight, or preterm birth
c=Meeting fruit/vegetable guidelines including all fruits, vegetables and fruit juices.
d=Analysis restricted to parous women

Table 1.4. Distribution of characteristics according to meeting physical activity guidelines. Latina GDM Study, 2000-2004.

Characteristics	Meets Physical Activity Guidelines Early Pregnancy		
	Yes	No	P-value
Socioeconomic Factors			
Age categories (years)			
16-19	41 (38.0)	326 (34.9)	0.003
20-24	51 (47.2)	334 (35.7)	
25-29	6 (5.6)	181 (19.4)	
30-40	10 (9.3)	94 (10.1)	
Employed			
No	50 (46.7)	451 (48.4)	0.74
Yes	57 (53.3)	480 (51.6)	
Education level			
Less than high school	66 (66.0)	473 (54.4)	0.07
High school/technical school	26 (26.0)	284 (32.6)	
>= Some college	8 (8.0)	113 (13.0)	
Income ($)			
<15 k	36 (54.6)	294 (55.4)	0.74
15-<30 k	21 (31.8)	181 (34.1)	
>= 30 k	9 (13.6)	56 (10.6)	
Acculturation Factors			
Birth place			
U.S. (Continental)	64 (64.0)	478 (54.4)	0.07
Other	36 (36.0)	400 (45.6)	
Preferred language			
English only	84 (78.5)	615 (66.3)	0.01
Spanish/Both	23 (21.5)	312 (33.7)	
Medical Factors			
Parity			
Nulliparous	42 (39.6)	368 (40.0)	0.95
Parous	64 (60.4)	553 (60.0)	
Pre-pregnancy BMI[a]			
Underweight (<20 kg/m^2)	15 (14.6)	115 (13.4)	0.74
Normal (20-<25 kg/m^2)	43 (41.8)	318 (37.1)	
Overweight (25-<30 kg/m^2)	22 (21.4)	212 (24.8)	
Obese (>=30 kg/m^2)	23 (22.3)	211 (24.7)	
IOM pregnancy weight gain[a]			
Within guidelines	19 (17.6)	195 (20.9)	0.27
Inadequate weight gain	12 (11.1)	124 (13.3)	
Excessive weight gain	27 (25.0)	275 (29.4)	
Missing information	50 (46.2)	341 (36.5)	

Table 1.4. Continued.

History of GDM[a,c]			
No	61 (96.8)	526 (95.6)	1.00
Yes	2 (3.2)	24 (4.4)	
Family history of DM[a]			
No	39 (37.9)	322 (36.0)	0.71
Yes	64 (62.1)	573 (64.0)	
History of adverse pregnancy outcome[b,c]			
No	47 (78.3)	491 (92.0)	0.0006
Yes	13 (21.7)	43 (8.0)	
Behavioral factors			
Cigarette smoking			
No	75 (70.8)	721 (79.2)	0.04
Yes	31 (29.3)	189 (20.8)	
Meets fruit/vegetable guidelines			
No	57 (80.3)	464 (82.6)	0.64
Yes	14 (19.7)	98 (17.4)	
Alcohol use			
No	105 (98.1)	902 (98.6)	0.67
Yes	2 (1.9)	13 (1.4)	
Illicit drug use			
No	94 (87.9)	869 (95.0)	0.003
Yes	13 (12.2)	46 (5.0)	

a = BMI denotes body mass index; IOM denotes Institute of Medicine guidelines; GDM denotes gestational diabetes mellitus; DM denotes diabetes mellitus

b = Includes infant with anomalies, stillbirth, low birth weight, or preterm birth

c= Analysis restricted to parous women

Table 1.5. Distribution of characteristics according to cigarette smoking. Latina GDM Study, 2000-2004.

Characteristics	Cigarette smoking		
	Yes	No	P-value
Socioeconomic Factors			
Age categories (years)			
16-19	70 (34.2)	294 (35.7)	0.47
20-24	79 (38.5)	296 (36.0)	
25-29	40 (19.5)	142 (17.3)	
30-40	16 (7.8)	91 (11.1)	
Employed			
No	119 (58.6)	380 (46.3)	0.002
Yes	84 (41.4)	440 (53.7)	
Education level			
Less than high school	138 (70.8)	409 (52.6)	<0.0001
High school/technical school	48 (24.6)	254 (32.7)	
>= Some college	9 (4.6)	115 (14.8)	
Income ($)			
<15 k	83 (63.9)	267 (54.8)	0.046
15-<30 k	40 (30.8)	160 (32.9)	
>= 30 k	7 (5.4)	60 (12.3)	
Acculturation Factors			
Birth place			
U.S. (Continental)	124 (62.6)	414 (52.8)	0.013
Other	74 (37.4)	370 (47.2)	
Preferred language			
English only	156 (76.1)	525 (64.3)	0.001
Spanish/Both	49 (23.9)	291 (35.7)	
Medical Factors			
Parity			
Nulliparous	58 (28.6)	347 (42.7)	0.0002
Parous	145 (71.4)	465 (57.3)	
Pre-pregnancy BMI[a]			
Underweight (<20 kg/m^2)	33 (16.3)	104 (13.0)	0.57
Normal (20-<25 kg/m^2)	74 (36.6)	302 (37.6)	
Overweight (25-<30 kg/m^2)	45 (22.3)	203 (25.3)	
Obese (>=30 kg/m^2)	50 (24.8)	194 (24.2)	
IOM pregnancy weight gain[a]			
Within guidelines	38 (18.5)	167 (20.3)	0.56
Inadequate weight gain	27 (13.2)	111 (13.5)	
Excessive weight gain	55 (26.8)	247 (30.0)	
Missing information	85 (41.5)	298 (36.2)	

Table 1.5. Continued.

History of GDM[a,c]			
No	138 (95.2)	444 (96.3)	0.53
Yes	7 (4.8)	17 (3.7)	
Family history of DM[a]			
No	81 (41.1)	280 (35.2)	0.12
Yes	116 (58.9)	516 (64.8)	
History of adverse pregnancy outcome[b,c]			
No	126 (90.7)	403 (90.4)	0.92
Yes	13 (9.4)	43 (9.6)	
Behavioral Factors			
Meets physical activity guidelines			
No	175 (85.4)	748 (90.9)	0.02
Yes	30 (14.6)	75 (9.1)	
Meets fruit/vegetable guidelines			
No	103 (84.4)	417 (80.8)	0.36
Yes	19 (15.6)	99 (19.2)	
Alcohol use			
No	196 (95.6)	817 (99.3)	<0.0001
Yes	9 (4.4)	6 (0.7)	
Illicit drug use			
No	167 (81.5)	800 (97.2)	<0.0001
Yes	38 (18.5)	23 (2.8)	

a = BMI denotes body mass index; IOM denotes Institute of Medicine guidelines;

GDM denotes gestational diabetes mellitus; DM denotes diabetes mellitus

b = includes infant with anomalies, stillbirth, low birth weight, or preterm birth

c=Analysis restricted to parous women

Table 1.6. Unadjusted odds ratios for meeting health behavior guidelines in early and mid pregnancy. Latina GDM Study, 2000-2004.

Characteristic	Meets Physical Activity Guidelines		Cigarette Smoking		Meets Fruit & Vegetable
	Early pregnancy	Mid pregnancy	Early pregnancy	Mid pregnancy	Overall pregnancy
Socioeconomic Factors					
Age categories (years)					
16-19	Ref	Ref	Ref	Ref	Ref
20-24	1.2 (0.8-1.9)	0.8 (0.4-1.6)	1.1 (0.8-1.6)	1.8 (1.2-2.9)	0.9 (0.6-1.4)
25-29	0.3 (0.1-0.6)	0.6 (0.3-1.5)	1.2 (0.8-1.8)	1.4 (0.8-2.4)	1.0 (0.6-1.8)
30-40	0.8 (0.4-1.8)	0.5 (0.2-1.8)	0.7 (0.4-1.3)	1.0 (0.4-2.0)	1.5 (0.8-2.8)
P-trend	0.06	0.18	0.73	0.67	0.32
Employed					
No	Ref	Ref	Ref	Ref	Ref
Yes	1.1 (0.7-1.6)	1.4 (0.8-2.6)	0.6 (0.4-0.8)	0.6 (0.4-0.9)	1.1 (0.7-1.5)
Education level					
Less than high school	Ref	Ref	Ref	Ref	Ref
High school/tech school	1.5 (0.9-2.5)	1.2 (0.6-2.5)	1.8 (1.2-2.6)	1.5 (0.9-2.3)	1.3 (0.9-2.1)
>=Some college	0.8 (0.3-1.8)	2.4 (1.0-6.0)	0.4 (0.2-0.9)	1.0 (0.5-2.1)	2.5 (1.4-4.3)
P-trend	0.03	0.3	<0.0001	0.09	0.002
Income ($)					
<=15 k	Ref	Ref	Ref	Ref	Ref
>15-30 k	0.9 (0.5-1.7)	1.0 (0.5-2.2)	0.8 (0.5-1.2)	0.7 (0.4-1.2)	0.8 (0.4-1.4)
>30 k	1.3 (0.6-2.9)	0.3 (0.04-2.2)	0.4 (0.2-0.9)	0.3 (0.1-0.8)	1.0 (0.5-2.3)
P-trend	0.66	0.33	0.02	0.01	0.74
Acculturation Factors					
Birth place					
U.S. (Continental)	Ref	Ref	Ref	Ref	Ref
Other	0.7 (0.4-1.0)	0.6 (0.3-1.1)	0.7 (0.5-0.9)	0.5 (0.4-0.8)	1.1 (0.8-1.6)
Preferred language					
English only	Ref	Ref	Ref	Ref	Ref
Spanish/Both	0.5 (0.3-0.9)	0.4 (0.2-0.9)	0.6 (0.4-0.8)	0.7 (0.4-1.0)	1.1 (0.7-1.6)
Medical Factors					
Parity					
Nulliparous	Ref	Ref	Ref	Ref	Ref
Parous	1.0 (0.7-1.5)	1.0 (0.5-1.8)	1.9 (1.3-2.6)	2.2 (1.5-3.4)	1.0 (0.7-1.4)
Pre-pregnancy BMI[a] (kg/m^2)					
Underweight (<20)	1.1 (0.6-2.0)	1.3 (0.5-3.0)	1.0 (0.7-1.4)	0.8 (0.5-1.4)	1.4 (0.8-2.5)
Normal (20-<25)	Ref	Ref	Ref	Ref	Ref
Overweight (25-<30)	0.8 (0.5-1.6)	1.0 (0.5-2.1)	1.8 (0.8-1.4)	0.9 (0.5-1.4)	0.7 (0.4-1.1)
Obese (>=30)	0.8 (0.5-1.3)	0.9 (0.4-2.0)	0.9 (0.6-1.2)	1.2 (0.8-2.0)	0.6 (0.4-1.1)
P-trend	0.24	0.54	0.57	0.28	0.009
IOM pregnancy weight gain[a]					
Within guidelines	Ref	Ref	Ref	Ref	Ref
Inadequate weight gain	1.0 (0.5-2.1)	0.6 (0.2-1.7)	1.1 (0.6-1.9)	0.9 (0.5-1.7)	1.7 (0.9-3.0)
Excessive weight gain	1.0 (0.5-1.9)	1.1 (0.5-2.3)	1.0 (0.6-1.5)	0.8 (0.5-1.4)	1.2 (0.7-2.0)
Missing information	1.5 (0.9-2.6)	0.9 (0.4-2.0)	1.3 (0.8-1.9)	1.1 (0.7-1.9)	1.3 (0.8-2.1)
History of GDM[a]					
No	Ref	Ref	Ref	Ref	Ref
Yes	0.7 (0.2-3.1)	0.7 (0.1-5.1)	1.4 (0.7-2.8)	0.7 (0.2-2.1)	1.9 (0.7-4.0)

Table 1.6. Continued.

Family history of DM[a]					
No	Ref	Ref	Ref	Ref	Ref
Yes	0.9 (0.6-1.4)	1.3 (0.7-2.5)	0.8 (0.6-1.1)	0.9 (0.6-1.3)	1.1 (0.8-1.7)
History of adverse pregnancy outcome[b]					
No	Ref	Ref	Ref	Ref	Ref
Yes	3.2 (1.6-6.3)	2.2 (0.8-6.1)	1.2 (0.7-1.9)	0.5 (0.2-1.3)	0.8 (0.4-2.0)
Behavioral factors					
Cigarette smoking					
No	Ref	Ref	NA	NA	Ref
Yes	1.6 (1.0-2.5)	1.5 (0.8-2.8)	NA	NA	0.7 (0.4-1.2)
Meets physical activity guidelines					
No	NA	NA	Ref	Ref	Ref
Yes	NA	NA	1.7 (1.1-2.7)	1.3 (0.7-2.5)	1.1 (0.6-2.1)
Meets fruit/vegetable guidelines					
No	Ref	Ref	Ref	Ref	NA
Yes	1.2 (0.6-2.2)	1.9 (0.9-4.1)	0.8 (0.5-1.3)	0.5 (0.2-0.9)	NA
Alcohol use					
No	Ref	Ref	Ref	Ref	Ref
Yes	1.3 (0.3-5.9)	1.6 (0.2-12.9)	6.2 (2.2-17.8)	5.8 (1.8-19.4)	2.2 (0.6-9.1)
Illicit drug use					
No	Ref	Ref	Ref	Ref	Ref
Yes	2.9 (1.5-5.7)	4.9 (1.5-15.6)	8.6 (4.8-15.1)	9.4 (3.4-26.0)	3.6 (1.1-11.4)

a = BMI denotes body mass index; IOM denotes Institute of Medicine guidelines; GDM denotes gestational diabetes mellitus; DM denotes diabetes mellitus; b = includes infant with anomalies, stillbirth, low birth weight, or preterm birth

Table 1.7. Multivariable associations between socioeconomic characteristics and meeting fruit and vegetable intake guidelines: odds ratios (ORs) and 95% confidence intervals (CIs). Latina GDM Study, 2000-2004.

	Meets Fruit and Vegetable Guidelines-All[a] OR (95% CI)	Meets Fruit and Vegetable Guidelines-Subset[b] OR (95% CI)
Meets physical activity guidelines		
No	Ref	Ref
Yes	1.9 (0.8-4.2)	*3.7 (1.2-11.3)
Current smoker		
No	Ref	Ref
Yes	*0.5 (0.3-0.9)	0.4 (0.1-1.4)
Education		
Less than high school	Ref	Ref
High school/trade or tech school	1.3 (0.8-2.1)	0.5 (0.2-1.7)
>=Some college	*2.2 (1.1-4.3)	2.5 (0.9-7.1)
p-trend	0.02	0.17
History of GDM		
No	Ref	Ref
Yes	1.9 (0.8-4.6)	2.9 (0.7-11.6)
Illicit drug use		
No	Ref	Ref
Yes	*3.8 (1.7-8.5)	*3.9 (1.1-14.3)
Pre-pregnancy BMI (kg/m^2)		
20-<25 (Normal)	Ref	Ref
<20 (Underweight)	1.1 (0.6-2.2)	0.9 (0.3-3.1)
25-<30 (Overweight)	0.6 (0.3-1.0)	0.5 (0.2-1.5)
>=30 (Obese)	0.5 (0.3-1.0)	0.3 (0.1-1.1)
p-trend	0.01	0.05

All ORs adjusted for other variables in the table and maternal age.
*= P<0.05
a = Meets fruit/vegetable guidelines including all fruits and vegetables.
b = Meets fruit/vegetable guidelines excluding starchy vegetables – plantains, root crops, potatoes, and legumes.

Table 1.8. Multivariable associations between socioeconomic characteristics and meeting physical activity guidelines in early and mid-pregnancy: odds ratios (ORs) and 95% confidence intervals (CIs). Latina GDM Study, 2000-2004.

	Meets Physical Activity Recommendations in Early Pregnancy: OR (95% CI)	Meets Physical Activity Recommendations in Mid Pregnancy OR (95% CI)
History of adverse pregnancy outcome		
No	Ref	Ref
Yes	*4.8 (2.3-10.2)	3.3 (1.0-10.6)
Illicit drug use		
No	Ref	Ref
Yes	2.1 (1.0-4.4)	2.6 (1.0-6.8)
Preferred language		
English	Ref	Ref
Spanish/both	0.6 (0.3-1.0)	0.5 (0.2-1.2)
Age (years)		
16-19	Ref	Ref
20-24	1.3 (0.8-2.2)	0.7 (0.3-1.5)
25-29	*0.2 (0.1-0.6)	0.3 (0.1-1.0)
30-40	0.8 (0.3-1.9)	0.2 (0.01-1.3)
P-trend	0.07	0.06
Education		
Less than high school	Ref	Ref
High school/trade or tech school	0.6 (0.4-1.1)	0.8 (0.4-1.7)
>=Some college	0.5 (0.2-1.2)	*2.8 (1.1-7.1)
P-trend	0.04	0.17

All ORs adjusted for other variables in the table.
*= P<0.05

Table 1.9. Multivariable odds ratios between socioeconomic characteristics and cigarette smoking in early and mid-pregnancy: odds ratios (ORs) and 95% confidence intervals (CIs). Latina GDM Study, 2000-2004.

	Smoking in Early Pregnancy: OR (95% CI)	Smoking in Mid Pregnancy: OR (95% CI)
Alcohol use		
No	Ref	Ref
Yes	*4.4 (1.3-14.7)	*3.9 (1.1-13.8)
Illicit drug use		
No	Ref	Ref
Yes	*8.2 (4.6-14.6)	*6.4 (3.3-12.2)
Parous		
Nulliparous	Ref	Ref
Parous	*2.1 (1.4-3.2)	*2.6 (1.6-4.3)
Language preference		
English	Ref	Ref
Spanish/both	*0.6 (0.4-0.8)	0.7 (0.4-1.1)
Education		
Less than high school	Ref	Ref
High school/trade or tech school	*0.5 (0.4-0.8)	0.7 (0.5-1.1)
>=Some college	*0.2 (0.1-0.4)	0.6 (0.3-1.3)
P-trend	<0.0001	0.09

All ORs adjusted for other variables in the table and maternal age.
*= P<0.05

CHAPTER 2

SEDENTARY BEHAVIORS AND RISK OF GLUCOSE INTOLERANCE AMONG PREGNANT LATINA WOMEN

2.1 Introduction

Gestational diabetes mellitus (GDM), defined as glucose intolerance of varying degree with first onset during pregnancy, is a common maternal complication that affects 2-6% of pregnancies (62). A less severe form of glucose intolerance, termed abnormal glucose tolerance (AGT), affects even more pregnancies with reported incidence ranging from 17% (63) to 27% (64) depending on diagnostic criteria and population. Both GDM and AGT are associated with poor perinatal outcomes and pregnancy complications including macrosomia, preeclampsia, hypertension, cesarean section, preterm labor and neonatal adiposity (65-73). In fact, even mild maternal hyperglycemia (abnormally high glucose concentration in the blood) has been associated with large-for-gestational age, macrosomia, premature rupture of membranes, and cesarean section (64, 65, 67, 70, 74-77). Maternal hyperglycemia has been positively associated with childhood obesity at 5-7 years of age (78) and increased risk of subsequent type II diabetes mellitus (DM) in mother (79-81) and offspring (82).

Identified risk factors for GDM and AGT are similar, including marked obesity, diabetes in first-degree relatives, older maternal age, current glycosuria (excess sugar in the urine), previous delivery of a macrosomic infant, and nonwhite ethnicity (62, 83). Latina women have 2-4 times the risk of developing GDM as compared to non-Latina white women (84, 85). Indeed, few modifiable risk factors for glucose intolerance have been identified, marking the importance of research on behavioral factors, such as sedentary activities, that may affect risk of developing glucose intolerance in pregnancy.

Sedentary lifestyles have become more prevalent in recent decades as reflected by the increasing number of television sets, VCRs, and remote controls per household and the time spent watching TV in the past decade (86). The average adult female spends 34 hours per week watching television. Increasing evidence suggests that physical activity may be protective against GDM (87-89), obesity (90, 91), type II DM (92, 93) and other chronic diseases, meanwhile, sedentary behaviors are becoming more widespread (94).

The role of sedentary behaviors in the development of glucose intolerance and GDM is not well understood. It is known that normal pregnancy involves progressive insulin resistance that begins in mid-pregnancy and continues through the third trimester to levels similar to that observed in type II diabetics (83). However, individuals with high levels of sedentary behaviors, such as TV viewing, characterized by prolonged absence of muscle contraction, may be more susceptible to insulin resistance and hyperglycemia. Indeed, there are three potential mechanisms by which sedentary behaviors may affect risk of AGT and GDM. Specifically, sedentary behaviors may directly alter glucose metabolism, indirectly influence risk of AGT and GDM through obesity (95), or displace healthier physical activities thus lowering total energy expenditure and favoring an insulin resistant state (96).

Sparse data exists on the association between sedentary behaviors and abnormal glucose tolerance and GDM in pregnancy, but several studies have been conducted in non-pregnant populations in relation to type II diabetes (96-98). Time spent TV watching has been associated with an increased risk of type II diabetes in women (96-98), GDM (89), and obesity (90, 98-101), an important cause of glucose intolerance in pregnant and non-pregnant individuals. Conversely, increasing amounts of physical activity have been associated with a decreased risk of type II diabetes (92, 96-98), AGT(63), and GDM (87-89, 102, 103). Moreover, no studies have been conducted among Latina women, a population more likely to lead sedentary lives than non-Latina women (85, 104, 105).

This study was conducted in a Latina population and assessed sedentary behaviors before and during pregnancy and risk of AGT and GDM using a validated questionnaire administered in early and mid pregnancy.

2.2 Review of the Literature

2.2.1 Physiology of Sedentary Behaviors and Glucose Intolerance

Behavioral and epidemiologic studies have shown that physical activity and sedentary behaviors are largely independent behaviors and may exhibit independent effects on risk of disease (89, 96-99, 101, 106, 107). The biologic mechanism linking sedentary behaviors to the development of glucose intolerance and GDM in pregnancy is not well understood. However, there are three potential mechanisms by which sedentary behaviors may affect risk of AGT and GDM. Specifically, sedentary behaviors may directly alter glucose metabolism, indirectly influence risk of AGT and GDM through obesity (95), or displace healthier physical activities thus lowering total energy expenditure and favoring an insulin resistant state (96).

In terms of the first mechanism, the third trimester of pregnancy is characterized by metabolic stress on maternal lipid and glucose metabolism including insulin resistance and hyperinsulemia, thus favoring transfer of nutrients to the fetus (83). Glucose tolerance remains in the normal range for most women, but reaches diabetic levels in 2-6% of women. Physical activity has independent effects on glucose disposal by increasing both insulin mediated and non-insulin mediated glucose disposal (108, 109). Skeletal muscle contraction triggers glucose uptake and promotes insulin sensitivity (110), so that individuals who engage in regular physical activity may ward off development of GDM and AGT. Conversely, individuals with high levels of sedentary behavior, characterized by the prolonged absence of muscle contraction, may be more susceptible to insulin resistance and hyperglycemia. As skeletal muscle is an important site for glucose disposal, the cumulative absence of skeletal contraction characterized by sedentary behavior may explain, in part, its association with hyperglycemia.

In terms of the second mechanism, high levels of TV viewing have been positively associated with obesity, an important cause of insulin resistance and glucose intolerance (90, 95, 99, 106, 111, 112). Postulations regarding the connection between obesity and insulin resistance have suggested an inflammatory mechanism (113-115). Inflammatory molecules released by adipose tissue, termed adipokines, including leptin, adiponectin, resistin and visfatin, as well as cytokines and chemokines may be responsible for creating a chronic subinflammatory state leading to insulin resistance (113-115). Therefore, the relation between sedentary behaviors, such as TV viewing, and risk of AGT and GDM may be mediated through obesity (116, 117). Individuals with high levels of TV viewing tend to follow an unhealthy eating pattern including high-fat snacking behaviors, possibly triggered by food cues and commercial advertisements

(111, 118-120). The unhealthy diet may lead to overweight or obesity which in turn increases risk of AGT and GDM (90, 99, 106, 111, 112).

In terms of the third mechanism, TV watching results in lower energy expenditure compared to other sedentary activities, such as sewing, writing, reading, and driving an automobile (121). Time spent TV watching may also displace physical activity throughout the day, thus reducing total physical activity (90, 122). The high levels of inactivity during TV watching may contribute to increased risk of glucose intolerance by directly altering glucose metabolism and/or indirectly through obesity.

In summary, although the exact mechanism by which sedentary behaviors may affect glucose metabolism is not clear, such a modifiable factor represents an important link to glucose intolerance that warrants investigating. A reduction in TV watching may result in greater physical activity and less snacking, thus improving insulin resistance and reducing risk of obesity, an important cause of glucose intolerance.

2.2.2 Epidemiology of Sedentary Behaviors and Glucose Intolerance

Only two studies have investigated the impact of sedentary behaviors on risk of maternal glucose intolerance and GDM (63, 89). However, there is largely consistent evidence from epidemiologic studies that physical activity reduces risk of type II DM and suggestive evidence for GDM (123-125), two conditions shown to be pathophysiologically similar (126). Furthermore, no studies have been conducted exclusively among Latina women, a group known to be at high-risk for glucose intolerance during and outside of pregnancy and sedentary lifestyles.

In one of only two studies to examine sedentary behaviors and risk of GDM, Zhang et al. conducted a prospective cohort study using Nurses' Health Study II data collected from 21,765 predominantly white women with at least 1 pregnancy between 1990 and 1998 (89). Pregravid physical activity and sedentary behaviors were assessed through mailed questionnaires in 1989, 1991, and 1997 using a validated questionnaire. Diagnosis of GDM was self-reported in the biennial questionnaire and was previously validated in this cohort based on medical record review. Sedentary behaviors included TV/video watching, sitting at work or away from home or while driving, and other sitting at home (reading, meal times, or at a desk). After adjustment for age and time spent on other sedentary behaviors (sitting at work or away from home, driving/riding in a vehicle, sitting at home at a desk, reading, or at meals), greater time spent TV watching was associated with higher GDM risk. Women who spent ≥20 hrs/week watching TV in the year prior to pregnancy had a 70% increased risk of GDM (95% C.I. 1.29-2.34; p-trend=0.001) compared to those who watched less than 2 hrs/week. This association was attenuated, but remained statistically significant, after adjusting for physical activity and dietary factors (RR=1.47, 95% C.I. 1.09-1.99; p-trend=0.03). The association was no longer significant after controlling for BMI, suggesting the association may be mediated through obesity (89). In a combined analysis of sedentary behavior and physical activity controlling for BMI and other covariates, women who spent ≥20 hrs/week watching TV and who performed no vigorous activity had more than a 2-fold greater risk of GDM compared to those who spent <2 hrs/week watching TV and were in the highest quintile of vigorous activity (RR=2.30, 95% C.I. 1.06-4.97).

Using data from Project Viva, Oken et al. were the first group to investigate sedentary behaviors and risk of maternal AGT as well as GDM (63). Participants (n=1,805) were recruited at prenatal care visits (mean=10.2 weeks gestation) in one of eight obstetric offices in eastern Massachusetts from 1999-2002. Participants underwent routine GDM screening at 26-28 weeks gestation with a nonfasting 50-g oral glucose challenge test. If the 1-hr glucose result was ≥140 mg/dl the participant was classified as AGT and referred for a 3-hr OGTT. GDM was diagnosed using ADA criteria (62). Sedentary behaviors and physical activity during and before pregnancy were assessed via a modified version of the Physical Activity Scale for the Elderly (PASE) at the recruitment visit and at a second time in mid-pregnancy at 26-28 weeks gestation. Sedentary behaviors included watching TV or videos, and light, moderate, and vigorous forms of physical activity were assessed. After adjusting for multiple confounders, watching 14 or more hours of TV/week before pregnancy or during pregnancy, respectively, was not associated with GDM (OR=1.28, 95% C.I. 0.75-2.18; OR=1.03, 95% C.I.0.59-1.78) or AGT (OR=0.99, 95% C.I. 0.74-1.32; OR=1.01, 95% C.I. 0.75-1.35) compared to watching 13 or fewer hours/week of TV. However, vigorous activity during the year before pregnancy was associated with a reduced risk of GDM (OR=0.56, 95% C.I. 0.33-0.95) and AGT (OR=0.76, 95% C.I. 0.57-1.00) compared to not engaging in any vigorous activity, though vigorous activity during pregnancy was associated with a weaker effect.

The study by Zhang et al. had the advantage of a large sample size and prospective design (89). However, the authors did not collect information on physical activity and sedentary behaviors during pregnancy, a time period that may be more relevant for GDM and AGT risk as compared to pre-pregnancy behaviors. This problem is confounded by the fact that pregnant women generally decrease their physical activity and may increase their sedentary behaviors with the onset of pregnancy. In addition, the study population consisted of registered nurses, 92% of whom were White, a population that may not represent a high risk group.

Similarly, the study by Oken et al. was conducted among predominantly white, affluent women. As opposed to Zhang, information was collected on physical activity and TV watching both during and before pregnancy via questionnaire. While the authors observed an association between vigorous activity and decreased risk of GDM and AGT, they did not find an association between TV watching and risk of GDM and AGT. The absence of association with TV watching contradicts the findings of Zhang et al. (89) and several studies of type II DM (96-98). This may be due to differences in the choice of referent group for the TV watching analysis conducted by Oken et al. (≤13 hrs/week) as compared to that of Zhang et al. (<2 hrs/week). Finally, Oken et al. did not have information on sedentary behaviors other than TV watching, such as sitting at work, which could result in nondifferential misclassification, thus weakening the strength of findings.

Three studies have investigated the association between sedentary behaviors and risk of type II DM (96-98), a condition shown to be similar in pathogenesis and risk profile to GDM. After adjusting for physical activity and other confounders, all three studies demonstrated an increasing risk of DM with increasing time spent watching TV. For example, using data from the Health Professionals Follow-up Study, Hu et al. observed an almost 2-fold increased risk for those watching 21-<40 hrs/week of TV (RR=1.8, 95% C.I. 1.2-2.7) and a further increased risk for those watching 40 or more hrs/week of TV (RR=2.3, 95% C.I. 1.2-4.5) compared to those watching <2hrs/week (p-trend <0.001) (96). In addition, those watching >15hrs/week of TV and who were in the lowest quartile of physical activity had an even greater risk of DM (RR=2.92, 95% C.I. 1.87-4.55) as compared to those in the lowest quartile of TV watching and the highest quartile of physical activity. In another study using the Nurses' Health Study II population, Hu et al. found that each 2 hr/day increment in TV time resulted in a 23% (95% C.I. 17-30%) increased risk of DM after adjustment for age, exercise, diet and other covariates (98).

Two prior studies examined the relation between sedentary behaviors and serum glucose (97, 127). Specifically, in a population-based cross-sectional study in Australia including 8,299 men and women, Dunstan et al. found that >14hrs/week TV time was associated with increased risk of abnormal glucose metabolism compared to watching ≤7hrs/week (OR=1.49, 95% C.I. 1.12-1.99) (97). Increasing TV time was also associated with incident type II DM and impaired glucose tolerance. In a similar study, Dunstan et al. cross-sectionally examined the association between TV watching and glucose levels in the same Australian population (127). After adjusting for known confounders, time spent TV watching was positively associated with 2-hr post challenge plasma glucose, fasting insulin levels, and homeostasis model assessment of insulin sensitivity (HOMA) in women (127).

In summary, the current epidemiologic research is lacking data on sedentary behaviors and risk of glucose intolerance in pregnancy. Given that Latina ethnicity is a strong risk factor for type II DM, GDM and AGT, research is urgently needed to determine how sedentary lifestyle affects the development of GDM and AGT in Latina populations. Prior evidence that TV watching may be associated with abnormal glucose metabolism in non-pregnant individuals suggests that this association warrants further investigation during pregnancy. The fact that few modifiable risk factors for maternal glucose intolerance have been identified further highlights the importance of research on lifestyle factors.

2.3 Summary

Abnormal glucose tolerance and GDM are common complications of pregnancy that are associated with increased risk of adverse maternal and fetal outcomes during both pregnancy and thereafter. The majority of known risk factors for glucose intolerance are not modifiable, including non-white ethnicity, family history of DM, older maternal age, and obesity. Therefore, research on modifiable risk factors for AGT and GDM is urgently needed.

Sedentary behaviors may increase the risk of GDM through a number of mechanisms. The prolonged lack of muscle contraction characterizing sedentary activities may predispose skeletal muscles to a hyperglycemic state. Additionally, sedentary behavior may impact risk of GDM through increasing the risk of overweight and obesity. Sedentary behavior is also associated with unhealthy snacking and poor diet, factors that may contribute to development of glucose intolerance. Numerous studies have demonstrated that physical activity and sedentary behaviors, such as TV viewing, are largely independent and likely exert independent effects on health outcomes. However, existing epidemiologic studies on modifiable factors for glucose intolerance have predominantly focused on physical activities rather than sedentary activities. Moreover, epidemiologic studies on sedentary behaviors and risk of glucose intolerance have been largely limited to non-pregnant populations, with only two studies conducted among pregnant women. Furthermore, no studies have been conducted among Latina women, a group that is largely understudied despite their high risk for GDM and likelihood of leading a sedentary lifestyle.

In conclusion, this study fills several research gaps. We examined sedentary behaviors at three time points (pre, early and mid pregnancy) in relation to risk of AGT and GDM in pregnant Latina women.

2.4 Study Aims

Overall goal: To evaluate the relationship between sedentary behavior and risk of AGT.

1) To evaluate the relationship between time spent TV watching in pre, early, and mid pregnancy and risk of abnormal glucose tolerance (AGT).

2) To evaluate the relationship between frequency of sitting at work in pre, early, and mid pregnancy and risk of AGT.

3) To evaluate the association between low levels of sports/exercise activity and risk of AGT.

Secondary aim: To evaluate the relationship between sedentary behavior and risk of GDM.

2.5 Methods

2.5.1 Study Design and Population

Participants were self-identified Latinas enrolled in prenatal care in the public obstetrics and gynecology (OB/GYN) and midwifery practice of Baystate Medical Center, a large tertiary care facility in Western Massachusetts. Briefly, participants were recruited by bilingual interviewers at prenatal care visits up to 24 weeks of gestation (mean = 15 weeks gestation) from September 2000 to December 2003. Eligibility criteria included Latina ethnicity, age 16-40 years, <24 weeks gestational age at first interview, singleton pregnancy, no prior diagnosis of hypertension, chronic renal disease, or type 2 diabetes, and no prior participation in the study. Interviewers obtained informed consent from participants approved by the Institutional Review Boards of the University of Massachusetts-Amherst and Baystate Medical Center.

Interviewers collected information on substance use, medical and obstetric history, physical activity, and sociodemographic factors at the time of recruitment. Participants were interviewed a second time in mid-pregnancy to update information on substance use and physical activity (mean = 28 weeks gestation). Information on additional medical factors was collected from medical records by trained medical abstractors.

2.5.2 AGT and GDM Assessment

Baystate Obstetrical Practices routinely screens all prenatal care patients for GDM at 26-28 weeks of gestation. The screening test consists of a non-fasting 50-g glucose load and a plasma glucose determination 1 hour later (1-hr oral glucose tolerance test [OGTT]). If the plasma glucose value is $\geq$135 mg/dL, a 3-hour glucose tolerance test is performed. Diagnosis of GDM was defined as meeting any one of the following three criteria: 1) 2 or more elevated values at fasting, and 1, 2, and 3 hours, based on the American Diabetes Association criteria of 95, 180, 155, and 140 mg/dL, respectively (62); 2) a 1-hr OGTT greater than 180 mg/dL (128);

or 3) elevated fasting (greater than 105 mg/dL) or elevated 2-hr postprandial blood sugar (greater than 120 mg/dL) in patients unwilling or unable to tolerate the OGTT (129). Diagnosis of GDM was confirmed by an obstetrician who reviewed the medical records of each suspected case. We categorized participants with a normal value on the 1-hr OGTT screen (<135 mg/dL) as having normal glucose tolerance (NGT) and those who failed the test (≥135 mg/dL) as having abnormal glucose tolerance (AGT).

2.5.3 Sedentary Behavior Assessment

Physical activity and sedentary behaviors in pre, early, and mid-pregnancy were measured using a modified version of the Kaiser Physical Activity Survey (KPAS) (130). Sedentary behaviors are measured in the KPAS as hours spent TV watching per day and the frequency of sitting at work with responses ranging from “never” to “always”. Additionally, the KPAS measures activity on a 5-point Likert scale in 4 domains: sports/exercise, occupational, household/care giving, and active living (transportation). Of particular interest for the current analysis are TV watching, sitting at work, and low levels of sports/exercise. TV watching was categorized as an ordinal variable with the following responses: <1 hr/day, 1-<2 hrs/day, 2-<4 hrs/day, 4+ hrs/day. Sitting at work was categorized as: never/rarely, sometimes, often, always, and not employed. The KPAS assesses sports/exercise participation by allowing women to report the 3 most common sports/exercise activities followed by frequency and duration for each. Participation in sports/exercise was categorized in quartiles with the most active as the referent group.

Additionally, to be consistent with previous studies (89, 96, 98) we created two composite sedentary behavior variables hereafter we refer to as Composite I and Composite II. For Composite I, 2 categories of TV watching (high 4+ hrs/day and low <4 hrs/day) and 2 categories of sports/exercise (high 4th quartile and low 1st-3rd quartiles) were cross-tabulated to create a 4-level variable with the highest sedentary group composed of those with high TV watching and low sports/exercise, and the lowest sedentary group composed of those with low TV watching and high sports/exercise. The two intermediate categories are composed of the remaining combinations of high and low TV watching and sports/exercise. Those with missing information on either TV watching or sports/exercise were excluded from this analysis.

For Composite II, we summed the values for frequency of sitting at work (values = 0-3 corresponding to each increasing level), TV watching (values = 0-3 corresponding to each increasing level), and sports/exercise (values = 0-3 corresponding to each decreasing quartile; i.e. reverse scored) to create a total sedentary score ranging from 0 to 9. The summary score was categorized in tertiles with the most sedentary group having the highest total score. Only those with complete information on sitting at work, TV watching, and sports/exercise were included. Both composite variables were created separately for pre, early and mid pregnancy time periods, with early and mid pregnancy having the same tertile cutpoints for Composite II.

2.5.4 Validity of Sedentary Behavior Assessment

The modified KPAS was validated among a sample of 54 pregnant women at Baystate Medical Center using 7-days of accelerometer measurements (130). Spearman correlation coefficients between the KPAS and three published cut points used to classify accelerometer data ranged from 0.25 to 0.33 for occupational activity and from 0.34 to 0.51 for sports/exercise activity.

2.5.5 Covariate Assessment

Interviewers collected information on substance use, medical and obstetric history, and sociodemographic factors at the time of recruitment. Information collected on substance use included cigarette use, alcohol use, and illicit drug use before and during pregnancy. Substance use was updated again at a second interview at a mean of 28 weeks gestation. Information abstracted from medical records included history of GDM, reproductive history, family history of diabetes mellitus, pre-pregnancy BMI, parity and pregnancy weight gain. Sociodemographic information included age, birth place, length of time in the United States, educational attainment, income, and employment.

Diet was assessed using a modified NCI/Block food frequency questionnaire administered in mid pregnancy (mean=23 weeks gestation) over the phone or in person among a subset of the study population (62%) who could be located for this interview.

2.5.6 Statistical Analysis

All analyses were performed using SAS 9.1 (SAS Campus Drive, Cary, North Carolina 27513, USA).

Using chi-square tests for independence, we assessed covariates as potential confounders by cross-tabulating them with both the outcome and exposure. For 2x2 tables with small cell frequencies, we used Fisher's Exact test. We then used the 2-sample t-test to compare continuous variables across 2 categories. Using logistic regression, unadjusted relative risks and 95% confidence intervals were calculated to estimate the association between sedentary behaviors (time spent TV watching, frequency of sitting at work, low participation in sports/exercise, composite of TV watching/sports exercise, and total sedentary score) and risk of AGT and GDM in pre, early and mid pregnancy.

Multivariable logistic regression was used to model the relation between sedentary behaviors and risk of AGT while accounting for multiple confounding variables. Those covariates which caused a 15% change in the coefficient for the exposure were considered confounders and were included in the final model. We calculated relative risks and 95% confidence intervals for this association in pre, early and mid pregnancy. Tests for trend were evaluated by entering the categorical variable for TV watching, sitting at work, and sports/exercise (reverse scored) as an ordinal variable composed of the midpoints of each category and evaluating statistical significance with the Wald chi-square test (p-value <0.05). For the analysis of risk of GDM, we limited adjustment to maternal age and pre-pregnancy BMI due to limited statistical power.

We considered pre-pregnancy BMI, parity, family history of type II diabetes, caloric intake, and pregnancy weight gain at GDM screen as potential effect modifiers in AGT analyses, as previous studies have suggested these variables to be important predictors of AGT (89). Assessment of effect modification involved the evaluation of multiplicative interaction terms with sedentary behaviors multiplied by the following factors: pre-pregnancy BMI (<25 vs. ≥25 kg/m^2), parity (multiparous vs. nulliparous), family history of type II diabetes mellitus (yes vs. no), caloric intake (<50th percentile vs. ≥50th percentile), and weight gain (at or below vs. above weight gain recommendations at GDM screen). We did not assess effect modification for risk of GDM due to the sparse number of cases and limited statistical power.

Because dietary information was only collected among a subgroup of the population, we conducted a sub-analysis among those for which dietary data was available. Specifically, we included each dietary component (dietary fat [in grams], total calories, and dietary fiber [in grams]) in continuous form in the logistic model to assess the amount of change in the estimate for each sedentary behavior on risk of AGT. If the exposure estimate changed >15% after inclusion of a dietary factor in the model, the estimates adjusted for dietary factors were presented.

We utilized least squares linear regression to model the impact of sedentary behaviors on the 1-hr OGTT value. We first examined the 1-hr OGTT values for normality and determined that a log-transformation was necessary to achieve normality for linear regression. Using multivariable linear regression, we modeled the adjusted association of sedentary behaviors on the 1-hr OGTT values while accounting for confounding variables. Those covariates which caused a 15% change in the coefficient for the exposure were considered confounders and included in the final model. We report adjusted beta coefficients and p-values for each level of the exposure variables. Among the 1,232 participants in the Latina GDM Study, 1,006 were screened for AGT and GDM. For the analysis, the sample was restricted to those with AGT/GDM outcome information.

2.6 Results

Briefly, participants ranged from ages 16 to 39 years with 72% below age 25 years. Fifty-six percent of the sample had not completed high school at enrollment while 50% were employed or in school at some point during pregnancy. With respect to acculturation factors, 45% were born outside the Continental U.S., 33% were bilingual (Spanish and English) or preferred to speak only Spanish, and 85% were of Puerto Rican descent. Regarding medical factors, 60% were multiparous, 60% had a family history of type II diabetes mellitus, 5% had been diagnosed with GDM in a previous pregnancy, and >40% were overweight or obese in pre-pregnancy.

Patterns of sedentary behaviors differed from pre-pregnancy to the early and mid pregnancy time periods. For example, 25% of participants reported watching 4 or more hours of TV per day in the year before pregnancy, whereas this percentage increased to 35% in early pregnancy and 29% in mid-pregnancy (Table 2.10). Similarly, the frequency of sitting at work increased from pre pregnancy through mid pregnancy (Table 2.11). The percentage of women who often or always sat at work increased from 30% in pre-pregnancy to 48% in early and 42% in mid pregnancy. In addition, the number of employed women decreased from 75% in the year prior to pregnancy to 50% and 42%, in early and mid pregnancy, respectively.

Quartile median values of sports/exercise score were greater for pre-pregnancy indicating a wider distribution and higher values (4.0, 2.8, 1.5, 1.3) as compared to both early and mid pregnancy (2.5, 1.5, 1.3, 1.0) (Table 2.12).

We created two composite sedentary behavior variables: Composite I, a composite of TV watching and sports/exercise (reversed scored), and Composite II, a total sedentary behavior score which was a composite of total sitting (TV watching and sitting at work) and sports/exercise reverse scored (Table 2.13). For Composite II, the median values for the sedentary score in each tertile were lower for pre-pregnancy (1, 2, and 3, respectively) as compared to early and mid pregnancy (1, 3, and 4, respectively) (Table 2.13).

Of the total sample screened (N=1,009), 11% (N=119) of women were classified as having AGT and 3% (N=33) were diagnosed with GDM (Table 2.14). With regard to maternal characteristics, increasing age, educational attainment, income, parity, and pre-pregnancy BMI were associated with an increase in the risk of AGT, whereas cigarette smoking in pregnancy was associated with a decrease in risk of AGT (Table 2.15). Having a family history of type II diabetes mellitus, personal history of GDM, and a history of adverse pregnancy outcome were statistically significantly associated with an increased risk of AGT ($p<0.05$). Associations were similar in terms of risk of GDM, with the exception of parity and cigarette smoking, which were not significantly associated with GDM risk (Table 2.15).

We then evaluated participant characteristics in relation to sedentary behaviors and observed several consistent associations (Tables 2.16-2.18). Maternal age, employment, education, pre-pregnancy BMI, history of GDM, illicit drug use and total physical activity were negatively associated with time spent TV watching in pregnancy, whereas history of GDM was positively associated with time spent TV watching (Table 2.16). These same factors, with the exception of age, BMI and drug use, were positively associated with frequency of sitting at work (Table 2.17). In addition, income and cigarette use were positively associated with sitting at work, whereas Spanish/bilingual language preference (vs. English only) and total physical activity were negatively associated with sitting at work. Finally, a similar grouping of characteristics (i.e., employment, income, parity and total physical activity) was negatively associated with low participation in sports/exercise in pregnancy.

In unadjusted analyses, time spent TV watching and frequency of sitting at work were not significantly associated with risk of AGT in pre, early or mid pregnancy (Table 2.19). Low participation in sports/exercise in mid pregnancy was associated with increased risk of AGT, with those in the lowest quartile having a 2-fold increased risk for AGT compared to those in the highest quartile (OR=2.06, 95% CI 1.06-4.01) with a significant linear trend (P_{trend}=0.03). Regarding the composite sedentary behavior variables, Composite I was not associated with increased risk for AGT in any pregnancy period. However, Composite II was associated with significantly increased risk of AGT in mid pregnancy with significant linear trend (P_{trend}=0.005). Odds ratios for the top two tertiles of Composite II were 4.9 (95% CI 1.10-21.88) and 8.0 (95% CI 1.7-37.54), respectively as compared to the lowest tertile although confidence intervals were wide and the referent category had only 2 AGT cases in mid pregnancy (Table 2.19).

Similar to the unadjusted analyses, after adjustment for maternal age, smoking, pre-pregnancy BMI and history of GDM, time spent TV watching and frequency of sitting at work were not statistically significantly associated with risk of AGT and the direction or magnitude of results remained comparable (Table 2.20). After adjusting for maternal age, education, cigarette smoking, parity, and pre-pregnancy BMI, the relative risk for low participation in sports/exercise in mid pregnancy remained similar at 2.01 (95% CI 1.01-4.02). Again, sports/exercise in pre or early pregnancy was not associated with AGT risk. Similar to the unadjusted results, Composite I was not associated with AGT risk; however, increase in total sedentary behavior as assessed by

Composite II in mid pregnancy was associated with significantly elevated AGT risk after adjustment for multiple confounders, although again confidence intervals were wide.

We evaluated several dietary components, total caloric intake, dietary fiber, and dietary fat, as potential confounders in a sub-sample for which dietary information was available. We ran each model including these variables singly in addition to the other final model covariates. The estimates were virtually unchanged after adjustment.

With regard to the secondary aim of evaluating sedentary behaviors as risk factors for GDM, time spent TV watching and frequency of sitting at work in pre, early and mid pregnancy were not associated with risk of GDM in unadjusted analyses (Table 2.21). However this analysis was limited by sparse numbers of GDM cases within strata and wide confidence intervals. As observed for AGT, low participation in sports/exercise in mid pregnancy was associated with a significantly elevated risk of GDM (P_{trend}=0.05). Due to the small total number of GDM cases (N=33) in our cohort, we limited adjustment in multivariable analyses to maternal age and pre-pregnancy BMI, the two strongest risk factors for GDM in our population. Similar to unadjusted results, lower mid pregnancy sports/exercise (P_{trend} = 0.04) and higher Composite II score (P_{trend} = 0.05) were positively associated with GDM risk (Table 2.22).

We also evaluated sedentary behaviors as predictors of glucose values on the non-fasting 1-hour 50-gram OGTT (Table 2.23). Time spent TV watching, sitting at work, and sports/exercise in pre, early and mid pregnancy were not associated with glucose values. However, higher total sedentary behavior as assessed by Composite II score in mid pregnancy was significantly associated with elevated glucose values (highest vs. lowest tertile: β=0.081, p-value=0.04), though the linear trend was not statistically significant.

Finally, we evaluated several factors as effect modifiers of the association between sedentary behaviors and risk of AGT. Family history of diabetes, parity (parous vs. nulliparous), BMI (<25 and ≥25 kg/m^2), total caloric intake (<50th percentile and ≥50th percentile) and pregnancy weight gain at GDM screen (at/or below vs. above weight gain recommendations) were not statistically significant effect modifiers (data not shown).

2.7 Discussion

In this prospective cohort of pregnant Latina women, we found that time spent TV watching and frequency of sitting at work were not associated with risk of AGT and GDM. We also found that low levels of sports and exercise and a composite measure of high levels of total sedentary behavior in mid pregnancy were associated with abnormal glucose tolerance, but this finding was based on small numbers of AGT cases and must be interpreted with caution. Despite these limitations, this is the first study to investigate sedentary behaviors at multiple time points in relation to risk of AGT and GDM in a pregnant Latina population, an ethnic group at higher risk for glucose abnormalities both during and outside of pregnancy as compared to non-Latina white women.

2.7.1 Comparison with Prior Literature

Only two prior studies have examined perinatal sedentary behaviors in relation to risk of AGT or GDM. In the first study by Oken et al., the authors investigated both time spent TV watching and physical activity independently in relation to risk of AGT and GDM among 1600 predominantly white (80%) women (63). The authors found that TV watching in pregnancy (2+ hrs/day vs. <2 hrs/day) was not associated with AGT (OR=1.0, 95% CI 0.6-1.8) or GDM (OR=1.0, 95% CI 0.8-1.4). Similarly, we found no association between TV watching before or during pregnancy and risk of AGT (early pregnancy: OR= 0.9, 95% CI 0.5, 1.7) or GDM (OR=1.25, 95% CI 0.4-3.9). Oken et al. also observed a reduced risk of GDM (OR=0.6, 95% CI 0.3-0.9) and AGT (OR=0.8, 95% CI 0.6-1.0) associated with any vigorous activity before pregnancy, though the association was weaker during pregnancy (GDM: OR= 0.9, 95% CI 0.5-1.7; AGT: OR=0.7, 95% CI 0.5-1.0). Similarly, we observed an increased risk of AGT for those in the lowest quartile of sports and exercise as compared to those in the highest quartile in mid pregnancy (OR= 2.0, 95% CI 1.0-4.0), but not in pre (OR= 1.0, 95% CI 0.5, 2.0) or early pregnancy (OR= 1.2, 95% CI 0.6-2.2) and in mid pregnancy for GDM (OR= 5.8, 95% CI 1.1-30.8).

In the second prospective cohort study examining pre-pregnancy sedentary behaviors and risk of GDM among 21,765 predominantly white nurses, Zhang et al. found an increased risk for GDM associated with high levels of TV watching during the year prior to pregnancy (≥20 hrs/week vs. <1 hr/week: RR= 1.7, 95% CI 1.3-2.3) (89). Although we did not find an independent effect of TV watching on GDM or AGT in pre, early or mid pregnancy, we did find that low sports/exercise and high total sedentary behavior in mid pregnancy was associated with AGT and GDM. As in the current study, Zhang et al. analyzed the joint effect of time spent TV watching and in physical activity on GDM risk. They observed a further increased risk (RR= 2.3, 95% CI 1.1-5.0) for those who watched ≥20 hrs/week of TV and did not perform vigorous physical activity as compared to those who watched <2 hrs/week of TV and were in the highest quintile of physical activity. Similarly, we found that women in the highest tertile for total sedentary score (Composite II) compared to the lowest tertile in mid pregnancy had an increased OR for AGT (OR=11.8, 95% CI 2.25-61.86, $P_{trend} = 0.002$) and GDM ($P_{trend} = 0.048$). However, we had limited statistical power to detect a similar association using GDM as the outcome.

Differences in findings for the relation between TV watching and risk of AGT/GDM between the current study and those of the prior literature may be due to a number of different factors. The participants in the current study reported TV watching with less overall variability than in previous studies, thus limiting the contrast between comparison groups. For example, the majority (60%) of women in our sample reported watching 2+ hours of TV per day in early pregnancy suggesting that our population may be overall more sedentary than those of others. Though the distribution of TV watching was not reported by Zhang et al., Oken et al. reported that 34% of their pregnant population watched 2+ hours of TV/day. Moreover, the nurses in the study by Zhang et al. may be more physically active than our population, as Latina women tend to be less active than non-Latina white women (131, 132). Furthermore, the nurses were not pregnant during physical activity assessment, and their total activity score assessed a broader range of activities (a total of 9 aerobic activities) providing a higher range of total activity scores (89). Furthermore, 6.5% of women in the nurses' cohort and 5% in Oken et al. developed GDM, compared to 3.3% in the current study, thus limiting statistical power in our sample. Finally, substantial differences in population characteristics exist between the current study and that of Zhang et al., such as ethnicity (100% Latina vs. 92% white), education (70% less than High

School vs. 100% professional nursing degree), and age (mean age =24 years vs. mean age=30 years) that may have contributed to differences in findings.

Several studies have found an increased risk for abnormal glucose metabolism and type II diabetes associated with high levels of TV watching in non-pregnant populations (96-98, 127, 133). These studies have consistently found relative risks of 2 to 3-fold for those watching TV for >40 hrs/week as compared to <1 hr/week for type II diabetes (96, 98) and 1.5-fold for those watching >14 hrs/week of TV compared to <7 hrs/week for abnormal glucose metabolism (97). Our highest category of TV watching was 4+ hours/day as compared to <1 hour/day. Furthermore, Healy et al. demonstrated that time spent TV watching disrupts normal glucose metabolism in a linear fashion even among those who are meeting Centers for Disease Control's physical activity recommendations (133).

2.8 Study Limitations

Our study faces several limitations. To limit error due to difficulty in recalling past behaviors, we prospectively collected information on sedentary behaviors at two study visits in early and mid pregnancy. However, participant reporting is still prone to error, which would likely bias our results toward the null. In addition, time spent TV watching may not always represent a sedentary behavior if a participant reports watching TV while engaging in other activities simultaneously, e.g. light housework. The KPAS question on TV watching did not distinguish between sitting or reclining while watching TV and watching TV while doing other activities; as a result, question interpretation may result in bias toward the null. Reporting of sedentary behaviors occurred before screening for AGT/GDM, therefore biased exposure reporting based on knowledge of disease status is unlikely. Another limitation is the lack of information on other types of sedentary behaviors such as riding in vehicles, reading, talking on the phone, and computer use while sitting, which could further bias our results toward the null. However, TV watching is known to be a marker of broader sedentary patterns, especially in women (134) and has been associated with important health outcomes in prior literature (98, 106, 107, 111, 122, 127).

Fewer study participants had fully completed the sedentary behavior assessment at mid pregnancy (70%), as compared to pre (90%) and early pregnancy (89%). Women missing mid pregnancy sedentary behavior and physical activity information did not differ from those with such information in terms of the majority of factors and risk of AGT or GDM, though they tended to be older, less educated, Spanish/bilingual speakers and parous. If these women missing sedentary behavior information at mid pregnancy differ in terms of both sedentary behavior and risk profile for GDM/AGT as compared to those with complete information, bias may ensue. However, the magnitude of bias is likely to be low given that few overall cases of GDM and AGT developed in this cohort. Moreover, this type of bias pertains mainly to the mid pregnancy assessment as there is fewer missing data for pre and early pregnancy, thus there is less likely to be substantial bias in those time periods.

The use of self-reported exposure information on TV watching and physical activity may be subject to information bias if reporting is related to disease status. We sought to minimize this type of bias in two ways: the use of a prospective design and a validated exposure assessment instrument. By reporting exposure information before disease status is known, it is unlikely that exposure reporting was influenced by disease status. In addition, the exposure assessment tool has been previously validated in this population. However, it is possible for women with a history of gestational glucose intolerance, who are more likely to develop glucose intolerance during the index pregnancy, to underreport TV watching and/or over-report physical activity. Reasons for such biased reporting may be social desirability or their knowledge of exercise recommendations for those with a GDM history. If this situation occurred, this may bias our results toward the null value. Moreover, we expect this type of bias to be minimal given that few women are aware of the underlying hypothesis that sedentary behavior may increase risk of AGT or GDM.

The classification criteria for both AGT and GDM used in this study has been recommended by the American Diabetes Association. However, researchers have not agreed on a global gold standard for this testing. The sensitivity for detecting GDM is 86-90% using the ADA criteria for diagnosis (84, 135), indicating there may be some degree of false positives in GDM detection. If misclassification of GDM status were to occur, it unlikely would be related to exposure status and/or other covariates making this type of misclassification nondifferential. We expect this type of misclassification to bias our results toward the null value. Similarly, misclassification may occur in AGT diagnosis as standard definitions have not yet been established. Such misclassification is expected to bias our results toward the null.

In all, 1006 (82%) participants were screened for GDM/AGT out of 1231 cohort participants. Of those not screened, N=48 had a spontaneous or therapeutic abortion or delivered preterm <=28 weeks, N=54 delivered at the study hospital but did not receive the screening, and N=123 were lost to follow-up (i.e. did not keep prenatal care appointments and did not return phone calls from study staff). Women who did not receive GDM/AGT screening did not differ from the remaining cohort in terms of sedentary behaviors (TV watching, sitting at work, low sports/exercise, composite I and composite II), therefore we suspect this type of bias to be minimal.

To assess potential factors that may bias the association between sedentary behavior and risk of AGT, we collected information on a large number of established risk factors for glucose intolerance and other behavioral, obstetrical, and sociodemographic factors. We assessed the potential for confounding using multivariable regression. Our population is restricted to Latina women which accounts for confounding by ethnicity to a large extent. In addition our population is restricted to women 16-40 years of age, thus limiting confounding by extreme age in the reproductive span.

Our study was further limited by small numbers of GDM cases precluding full adjustment for potential confounding factors for the analysis with GDM as the outcome. However, we adjusted for pre-pregnancy BMI and maternal age, the two strongest risk factors for GDM in our population. Other factors that were associated with GDM in our population were income, maternal education, history of adverse pregnancy outcome, history of GDM and family history of type II diabetes, though the latter 3 factors were not related to frequency of sitting at work and sports/exercise. To the extent that income and education were not accounted for by adjusting for age and pre-pregnancy BMI, the associations may be impacted by these factors.

Approximately 45% of women were missing dietary information, thus limiting full adjustment for dietary factors that may have confounded the association between sedentary behaviors and AGT/GDM. However, we assessed the potential for confounding by total calories, dietary fat and dietary fiber among the sub-sample for whom dietary information was available.

Participants missing dietary information did not differ significantly from those who had complete dietary information, although they were more likely to be parous. Adjustment for dietary factors did not substantially impact the observed findings. Consistent with this finding, recent literature has found that dietary factors have not been strongly associated with glucose intolerance in pregnancy (63, 136).

2.9 Generalizability

The participants in this study were pregnant Latina women recruited from an inner city population. The biologic rational supporting the association between sedentary behaviors and risk of AGT and GDM is unlikely to vary among different populations of pregnant women. Given a true biologic association between sedentary behavior and risk of AGT and GDM, findings from this study will generalize to all pregnant women.

2.10 Conclusion

In summary, we found that time spent TV watching and sitting at work in pre, early, and mid pregnancy were not associated with AGT or GDM. Future studies should further assess other types of sedentary behaviors such as other types of sitting in and outside the home at multiple time points during pregnancy. Findings represent the first study of sedentary behaviors and risk of glucose intolerance conducted exclusively amongst pregnant Latina women.

Table 2.10. Distribution of participants according to time spent TV watching in pre, early and mid pregnancy. Latina GDM Study, 2000-2004.

Time spent TV watching	Pre pregnancy	Early pregnancy	Mid pregnancy
	N (%)	N (%)	N (%)
TV watching			
0-<1 hr/day	162 (17.7)	135 (15.1)	102 (14.5)
1-<2 hrs/day	265 (29.0)	211 (23.5)	165 (23.4)
2-<4 hrs/day	257 (28.1)	238 (26.5)	232 (33.0)
4+ hrs/day	230 (25.2)	313 (34.9)	205 (29.1)
Total	914	897	704

Table 2.11. Distribution of participants according to frequency of sitting at work in pre, early and mid pregnancy. Latina GDM Study, 2000-2004.

Frequency of sitting at work	Pre pregnancy	Early pregnancy	Mid pregnancy
	N (%)	N (%)	N (%)
Never/rarely	330 (48.1)	134 (30.8)	83 (30.5)
Sometimes	152 (22.2)	93 (21.4)	74 (27.2)
Often	129 (18.8)	135 (31.0)	85 (31.3)
Always	75 (10.9)	73 (16.8)	30 (11.0)
Employed	686 (74.9)	435 (50.0)	272 (42.4)
Not employed	230 (25.1)	435 (50.0)	370 (57.6)
Total	916	870	642

Table 2.12. Distribution of participants according to participation in sports/exercise activity in pre, early and mid pregnancy periods. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
Low sports/exercise activity	N (%)	Median score	N (%)	Median score	N (%)	Median Score
Quartiles of sports/exercise						
1 (highest)	225 (24.8)	4.0	243 (27.2)	2.5	188 (26.7)	2.5
2	207 (22.8)	2.8	193 (21.6)	1.5	196 (27.9)	1.5
3	260 (28.6)	1.5	251 (28.1)	1.3	178 (25.3)	1.3
4 (lowest)	217 (23.9)	1.3	206 (23.1)	1.0	141 (20.1)	1.0
Total	909		893		703	

Table 2.13. Distribution of subjects according to composite sedentary behaviors in pre, early and mid pregnancy periods. Latina GDM Study, 2000-2004.

Composite Sedentary Behavior	Pre pregnancy			Early pregnancy			Mid pregnancy		
	N (%)	Cutpoint		N (%)	Cutpoint		N (%)	Cutpoint	
Sedentary behavior[a]									
1 (lowest)	182 (20.3)	>=75th sports; <4hrs TV		176 (19.8)	>=75th sports; <4hrs TV		139 (19.9)	>=75th sports; <4hrs TV	
2	489 (54.5)	<75th sports; <4 hrs TV		402 (45.3)	<75th sports; <4 hrs TV		357 (51.0)	<75th sports; <4 hrs TV	
3	39 (4.3)	>=75th sports; >=4hrs TV		66 (7.4)	>=75th sports; >=4hrs TV		49 (7.0)	>=75th sports; >=4hrs TV	
4 (highest)	188 (20.9)	<75th sports; >=4 hrs TV		243 (27.4)	<75th sports; >=4 hrs TV		155 (22.1)	<75th sports; >=4 hrs TV	
Total	898			887			700		
Sedentary behavior[b]									
[Range 0-5]			Median			Median			Median
1 (lowest)	218 (32.8)	0-1	1	90 (22.3)	0-1	1	62 (25.1)	0-1	1
2	204 (30.7)	2-2	2	206 (51.1)	2-3	3	128 (51.8)	2-3	3
3 (highest)	243 (36.5)	3-5	3	107 (26.6)	4-5	4	57 (23.1)	4-5	4
Total	665			403			247		

a=Composite of TV watching and sports/exercise reversed scored.

b=Composite score of total sitting (TV watching + sitting at work) + sports/exercise reverse scored.

Table 2.14. Distribution of participants according to AGT and GDM classification. Latina GDM Study, 2000-2004.

Diagnosis	AGT	GDM
	n (%)	n (%)
Yes	119 (11.83)	33 (3.28)
No	887 (88.17)	973 (96.72)
Total	1006	1006

Table 2.15. Distibution of participants according to glucose tolerance and characteristics. Latina GDM Study, 2000-2004.

Characteristics	NGT[a]	AGT	p-value[b]	Non-GDM	GDM	p-value[c]
Age categories (years)						
16-19	317 (35.74)	23 (19.33)	<0.0001	337 (34.64)	3 (9.09)	<0.0001
20-24	342 (38.56)	39 (32.77)		372 (38.23)	9 (27.27)	
25-29	151 (17.02)	26 (21.85)		170 (17.47)	7 (21.21)	
30-40	77 (8.68)	31 (26.05)		94 (9.66)	14 (42.42)	
Employed (work or student)						
No	388 (50.59)	47 (45.63)	0.35	423 (50.18)	12 (44.44)	0.56
Yes	379 (49.41)	56 (54.37)		420 (49.82)	15 (55.56)	
Education level						
Less than high school	455 (56.52)	47 (45.19)	0.005	492 (55.97)	10 (33.33)	0.048
High school/tech school	259 (32.17)	34 (32.69)		279 (31.74)	14 (46.67)	
>=Some college	91 (11.30)	23 (22.12)		108 (12.29)	6 (20.00)	
Income ($)						
<15 k	289 (36.58)	44 (43.14)	<0.001	322 (37.35)	11 (36.67)	0.016
15-30 k	153 (19.37)	18 (17.65)		167 (19.37)	4 (13.33)	
>30 k	42 (5.32)	14 (13.73)		50 (5.80)	6 (20.00)	
Don't know	306 (38.73)	26 (24.19)		323 (37.47)	9 (30.00)	
Birth place						
U.S. (Continental)	436 (53.96)	36 (30.51)	0.39	477 (54.02)	11 (36.67)	0.061
Other	372 (46.04)	82 (69.49)		406 (45.98)	19 (63.33)	
Preferred language						
English only	586 (67.2)	69 (58.47)	0.06	635 (66.28)	20 (62.50)	0.66
Spanish/Both	286 (32.8)	49 (41.53)		323 (33.72)	12 (37.50)	
Parity						
Nulliparous	357 (40.34)	36 (30.51)	0.04	383 (39.48)	10 (30.30)	0.29
Parous	528 (59.66)	82 (69.49)		587 (60.52)	23 (69.70)	
Pre-pregnancy BMI						
Underweight (<20 kg/m^2)	118 (13.55)	10 (8.70)	<0.0001	128 (13.42)	0 (0)	<0.0001
Normal (20-<25 kg/m^2)	345 (39.61)	26 (22.61)		365 (38.26)	6 (18.75)	
Overweight (25-<30 kg/m^2)	213 (24.45)	32 (27.83)		240 (25.16)	5 (15.63)	
Obese (>=30 kg/m^2)	195 (22.39)	47 (40.87)		221 (23.17)	21 (65.63)	
Weight gain at GDM screen[d]						
Below target weight range	168 (23.50)	19 (22.09)	0.27	185 (23.66)	2 (10.53)	0.28
Within target weight range	252 (35.24)	24 (27.91)		270 (34.53)	6 (31.58)	
Above target weight range	295 (41.26)	43 (50.0)		327 (41.82)	11 (57.89)	
Family history of DM						
No	314 (37.47)	25 (22.73)	0.002	334 (36.38)	5 (16.67)	0.027
Yes	524 (62.53)	85 (77.27)		584 (63.62)	25 (83.33)	
History of GDM						
No	849 (96.48)	107 (91.45)	0.01	928 (96.27)	28 (84.85)	0.001
Yes	31 (3.52)	10 (8.55)		36 (3.73)	5 (15.15)	
History of adverse pregnancy outcome						
No	836 (94.25)	103 (88.03)	0.01	914 (93.94)	25 (80.65)	0.003
Yes	51 (5.75)	14 (11.97)		59 (6.06)	6 (19.35)	
Cigarette use						
No	632 (77.17)	98 (89.09)	0.004	703 (78.37)	27 (84.38)	0.42
Yes	187 (22.83)	12 (10.91)		194 (21.63)	5 (15.63)	

Table 2.15 continued.

Characteristics	NGT[a]	AGT	p-value[b]	Non-GDM	GDM	p-value[c]
Illicit drug use						
No	777 (94.18)	106 (95.50)	0.57	852 (94.35)	31 (96.97)	0.71
Yes	48 (5.82)	5 (4.50)		51 (5.65)	2 (6.06)	
Total physical activity (quartiles)[e]						
1	212 (25.39)	28 (25.23)	0.10	230 (25.19)	10 (30.30)	0.64
2	219 (26.23	22 (19.82)		234 (25.63)	7 (21.21)	
3	210 (25.15)	24 (21.62)		228 (24.97)	6 (18.18)	
4	194 (23.23)	37 (33.33)		221 (24.21)	10 (30.30)	

P-values derived from chi square tests for categorical variables.

a =NGT denotes normal glucose tolerant

b=P-value comparing AGT and NGT

c=P-value comparing GDM and non-GDM cases

d=Exceeds target weight >3% target weight, below target weight <-3%, at target weight (between -3 and 3% of target weight)

e=Quartiles of total activity weighted based on contribution of each activity type to total activity

Table 2.16. Distribution of subjects according to time spent TV watching and characteristics. Latina GDM Study, 2000-2004.

Characteristics	0-<1hr/day	1-<2 hrs/day	2-<4 hrs/day	4+ hrs/day	p-value
Age categories (years)					
16-19	62 (37.80)	75 (29.53)	92 (31.29)	154 (40.10)	0.03
20-24	54 (32.93)	93 (36.61)	122 (41.50)	133 (34.64)	
25-29	28 (17.07)	48 (18.90)	55 (18.71)	67 (17.45)	
30-40	20 (12.20)	38 (14.96)	25 (8.50)	30 (7.81)	
Employed (work or student)					
No	60 (40.99)	102 (41.46)	129 (45.74)	230 (63.89)	<0.0001
Yes	95 (59.01)	144 (58.54)	153 (54.26)	130 (36.11)	
Education level					
Less than high school	90 (58.06)	114 (48.72)	150 (55.15)	214 (60.11)	0.05
High school/tech school	41 (26.45)	80 (34.19)	92 (33.82)	105 (29.49)	
>=Some college	24 (15.48)	40 (17.09)	30 (11.03)	37 (10.39)	
Income ($)					
<15 k	52 (34.21)	76 (33.19)	100 (37.59)	138 (39.32)	0.27
15-30 k	29 (19.08)	48 (20.96)	66 (24.81)	62 (17.66)	
>30 k	16 (10.53)	16 (6.99)	16 (6.02)	22 (6.27)	
Don't know	55 (36.18)	89 (38.86)	84 (31.58)	129 (36.75)	
Birth place					
U.S. (Continental)	91 (58.71)	123 (51.68)	154 (56.41)	195 (54.17)	0.53
Other	64 (41.29)	115 (48.32)	119 (43.59)	165 (45.83)	
Preferred language					
English only	119 (72.56)	175 (70.00)	187 (64.71)	247 (64.49)	0.17
Spanish/Both	45 (27.44)	75 (30.00)	102 (35.29)	136 (35.51)	
Parity					
Nulliparous	66 (40.74)	90 (35.57)	108 (37.37)	162 (43.09)	0.23
Parous	96 (59.26)	163 (64.43)	181 (62.63)	214 (56.91)	
Pre-pregnancy BMI					
Underweight (<20 kg/m^2)	12 (7.45)	27 (10.84)	48 (16.78)	55 (14.82)	0.02
Normal (20-<25 kg/m^2)	62 (38.51)	85 (34.14)	100 (34.97)	156 (42.05)	
Overweight (25-<30 kg/m^2)	42 (26.09)	78 (31.33)	65 (22.73)	82 (22.10)	
Obese (>=30 kg/m^2)	45 (27.95)	59 (23.69)	73 (25.52)	78 (21.02)	
Weight gain at GDM screen[d]					
Below target weight range	18 (18.18)	34 (20.99)	54 (27.14)	66 (25.00)	0.13
Within target weight range	37 (37.37)	67 (41.36)	63 (31.66)	77 (29.17)	
Above target weight range	44 (44.44)	61 (37.65)	82 (41.21)	121 (45.83)	
Family history of DM					
No	57 (35.85)	89 (36.33)	99 (35.61)	129 (35.34)	0.99
Yes	102 (64.15)	156 (63.67)	179 (64.39)	236 (64.66)	
History of GDM					
No	161 (98.17)	243 (96.05)	266 (92.68)	372 (97.89)	0.003
Yes	3 (1.83)	10 (3.95)	21 (7.32)	8 (2.11)	
History of adverse pregnancy outcome					
No	145 (92.36)	235 (95.14)	265 (93.97)	352 (94.62)	0.67
Yes	12 (7.64)	12 (4.86)	17 (6.03)	20 (5.38)	
Cigarette use					
No	134 (82.21)	200 (81.63)	226 (79.86)	274 (74.05)	0.06
Yes	29 (17.79)	45 (18.37)	57 (20.14)	96 (25.95)	
Illicit drug use					
No	158 (96.93)	235 (95.14)	274 (95.80)	342 (91.69)	0.04
Yes	5 (3.07)	12 (4.86)	12 (4.20)	31 (8.31)	
Total Physical Activity (quartiles)					
1	21 (12.88)	48 (19.12)	59 (20.27)	142 (37.47)	<0.0001
2	30 (18.4)	50 (19.92)	68 (23.37)	123 (32.45)	
3	40 (24.54)	74 (29.48)	87 (29.90)	75 (19.79)	
4	72 (44.17)	79 (31.47)	77 (26.46)	39 (10.29)	

P-values derived from chi square tests for categorical variables.
DM denotes diabetes mellitus, GDM denotes gestational diabete mellitus.

Table 2.17. Distribution of subjects according to frequency of sitting at work and characteristics. Latina GDM Study, 2000-2004.

Characteristics	Never/rarely	Sometimes	Often	Always	Not employed	p-value
Age categories (years)						
16-19	58 (36.02)	27 (22.31)	55 (34.59)	37 (41.57)	198 (36.73)	0.17
20-24	58 (36.02)	55 (45.45)	59 (37.11)	30 (33.71)	188 (34.88)	
25-29	24 (14.91)	23 (19.01)	28 (17.61)	17 (19.10)	103 (19.11)	
30-40	21 (13.04)	16 (13.22)	17 (10.69)	5 (5.62)	50 (9.28)	
Education level						
Less than high school	80 (53.33)	38 (35.19)	60 (40.0)	39 (48.15)	334 (67.20)	<0.0001
High school/tech school	51 (34.0)	50 (46.30)	56 (37.33)	32 (39.51)	121 (24.35)	
>=Some college	19 (12.67)	20 (18.52)	34 (22.67)	10 (12.35)	42 (8.45)	
Income ($)						
<15 k	53 (36.55)	31 (29.25)	44 (29.53)	21 (25.93)	206 (42.39)	<0.0001
15-30 k	35 (24.14)	30 (28.30)	42 (28.19)	23 (28.40)	69 (14.20)	
>30 k	9 (6.21)	13 (12.26)	17 (11.41)	8 (9.88)	22 (4.53)	
Don't know	48 (33.10)	32 (30.19)	46 (30.87)	29 (35.80)	189 (38.89)	
Birth place						
U.S. (Continental)	81 (53.64)	65 (60.19)	86 (56.58)	48 (60.0)	267 (53.29)	0.59
Other	70 (46.36)	43 (63.87)	66 (43.42)	32 (40.0)	234 (46.71)	
Preferred language						
English only	105 (65.63)	84 (71.19)	117 (74.52)	66 (75.0)	341 (63.62)	0.034
Spanish/Both	55 (34.38)	34 (28.81)	40 (25.48)	22 (25.0)	195 (36.38)	
Parity						
Nulliparous	75 (50.0)	43 (36.13)	63 (39.87)	39 (44.83)	188 (35.54)	0.015
Parous	79 (50.0)	76 (63.87)	95 (60.13)	48 (55.17)	341 (64.46)	
Pre-pregnancy BMI						
Underweight (<20 kg/m^2)	23 (14.65)	14 (11.86)	18 (11.46)	10 (11.630	70 (13.46)	0.88
Normal (20-<25 kg/m^2)	60 (38.22)	39 (33.05)	61 (38.85)	38 (44.19)	196 (37.69)	
Overweight (25-<30 kg/m^2)	36 (22.93)	29 (24.58)	41 (26.11)	23 (26.74)	129 (24.81)	
Obese (>=30 kg/m^2)	38 (24.20)	36 (30.51)	37 (23.57)	15 (17.44)	125 (24.04)	
Weight gain at GDM screen[d]						
Below target weight range	14 (13.46)	18 (25.00)	24 (21.43)	19 (30.16)	91 (25.71)	0.27
Within target weight range	40 (38.46)	25 (34.72)	39 (34.82)	23 (36.51)	113 (31.92)	
Above target weight range	50 (48.08)	29 (40.28)	49 (43.75)	21 (33.33)	150 (42.37)	
Family history of DM						
No	48 (31.37)	36 (32.43)	57 (36.54)	27 (31.76)	192 (37.43)	0.56
Yes	105 (68.63)	75 (67.57)	99 (63.46)	58 (68.24)	321 (62.57)	
History of GDM						
No	154 (96.86)	115 (96.64)	150 (94.94)	82 (96.47)	515 (96.26)	0.92
Yes	5 (3.14)	4 (3.36)	8 (5.06)	3 (3.53)	20 (3.74)	
History of adverse pregnancy outcome						
No	148 (94.27)	107 (91.45)	147 (94.84)	83 (97.65)	489 (94.77)	0.43
Yes	9 (5.73)	10 (8.55)	8 (5.16)	2 (2.35)	27 (5.23)	
Cigarette use						
No	135 (87.66)	93 (80.17)	136 (87.18)	68 (82.93)	381 (73.41)	<0.0001
Yes	19 (12.34)	23 (19.83)	20 (12.82)	14 (17.07)	138 (26.59)	
Illicit drug use						
No	147 (94.84)	114 (97.44)	147 (93.63)	83 (100.0)	487 (93.12)	0.062
Yes	8 (5.16)	3 (2.56)	10 (6.37)	0 (0)	36 (6.88)	
Total Physical Activity (quartiles)						
1	14 (8/75)	9 (7.50)	22 (13.92)	24 (28.24)	197 (37.17)	<0.0001
2	26 (16.25)	19 (15.83)	42 (26.58)	20 (23.53)	160 (30.19)	
3	44 (27.50)	36 (30.0)	46 (29.11)	26 (30.59)	112 (21.13)	
4	76 (47.50)	56 (46.67)	48 (30.38)	15 (17.65)	61 (11.51)	

P-values derived from chi square tests for categorical variables.

DM denotes diabetes mellitus, GDM denotes gestational diabete mellitus.

Table 2.18. Distribution of participants according to participation in sports/exercise and characteristics. Latina GDM Study, 2000-2004.

	Sports/exercise participation				
Characteristics	4th quartile (highest)	3rd quartile	2nd quartile	1st quartile (lowest)	p-value
Age categories (years)					
16-19	111 (36.75)	71 (30.60)	116 (37.91)	84 (33.73)	0.28
20-24	113 (37.42)	83 (35.78)	109 (35.62)	96 (38.55)	
25-29	45 (14.90)	57 (24.57)	50 (16.34)	45 (18.07)	
30-40	33 (10.93)	21 (9.05)	31 (10.13)	24 (9.64)	
Employed (work or student)					
No	144 (49.83)	109 (47.39)	128 (45.23)	143 (59.83)	0.01
Yes	145 (50.17)	121 (52.61)	155 (54.77)	96 (40.17)	
Education level					
Less than high school	163 (58.42)	118 (55.66)	139 (49.29)	146 (60.58)	0.22
High school/tech school	84 (30.11)	65 (30.66)	104 (36.88)	67 (27.80)	
>=Some college	32 (11.47)	29 (13.68)	39 (13.83)	28 (11.62)	
Income ($)					
<15 k	96 (35.04)	71 (33.33)	90 (32.61)	110 (47.41)	0.01
15-30 k	59 (21.53)	34 (15.96)	66 (23.91)	45 (19.40)	
>30 k	23 (8.39)	15 (7.04)	18 (6.52)	12 (5.17)	
Don't know	96 (35.04)	93 (43.66)	102 (36.96)	65 (28.02)	
Birth place					
U.S. (Continental)	152 (54.09)	127 (58.80)	155 (54.77)	125 (51.44)	0.47
Other	128 (45.91)	89 (41.20)	128 (45.23)	118 (48.56)	
Preferred language					
English only	208 (69.33)	153 (66.81)	205 (67.88)	156 (62.65)	0.40
Spanish/Both	92 (30.67)	76 (33.19)	97 (32.12)	93 (37.35)	
Parity					
Nulliparous	125 (42.52)	72 (31.58)	132 (43.56)	95 (38.31)	0.03
Parous	169 (57.48)	156 (68.42)	171 (56.44)	153 (61.69)	
Pre-pregnancy BMI					
Underweight (<20 kg/m^2)	38 (13.15)	26 (11.35)	39 (13.04)	41 (16.87)	0.31
Normal (20-<25 kg/m^2)	120 (41.52)	90 (39.30)	102 (34.11)	88 (36.21)	
Overweight (25-<30 kg/m^2)	67 (23.18)	53 (23.14)	89 (29.77)	54 (22.22)	
Obese (>=30 kg/m^2)	64 (22.15)	60 (26.20)	69 (23.08)	60 (24.69)	
Weight gain at GDM screen[d]					
Below target weight range	47 (22.93)	32 (20.78)	45 (23.44)	49 (28.99)	0.46
Within target weight range	62 (30.24)	55 (35.71)	69 (35.94)	56 (33.14)	
Above target weight range	96 (46.83)	67 (43.51)	78 (40.63)	64 (37.87)	
Family history of DM					
No	115 (39.93)	88 (40.00)	92 (31.72)	81 (33.20)	0.09
Yes	173 (60.07)	132 (60.00)	198 (68.28)	163 (66.80)	
History of GDM					
No	285 (95.64)	226 (97.84)	288 (95.36)	237 (96.34)	0.47
Yes	13 (4.36)	5 (2.16)	14 (4.64)	9 (3.66)	
History of adverse pregnancy outcome					
No	266 (93.01)	211 (94.20)	286 (95.02)	229 (95.02)	0.70
Yes	20 (6.99)	13 (5.80)	15 (4.98)	12 (4.98)	
Cigarette use					
No	231 (78.84)	185 (81.50)	238 (80.68)	178 (72.36)	0.06
Yes	62 (21.26)	42 (18.50)	57 (19.32)	68 (27.64)	
Illicit drug use					
No	274 (92.57)	219 (96.05)	281 (94.93)	232 (93.93)	0.36
Yes	22 (7.43)	9 (3.95)	15 (5.07)	15 (6.07)	
Total physical activity (quartiles)					
1	47 (15.72)	50 (21.55)	76 (25.09)	98 (39.36)	<0.0001
2	59 (19.73)	59 (25.43)	91 (30.03)	62 (24.90)	
3	80 (26.76)	64 (27.59)	77 (25.41)	53 (21.29)	
4	113 (37.79)	59 (25.43)	59 (19.47)	36 (14.46)	

P-values derived from chi square tests for categorical variables.

DM denotes diabetes mellitus, GDM denotes gestational diabete mellitus.

Table 2.19. Unadjusted relative risk and 95% C.I. for AGT by type of sedentary behavior. Latina GDM Study, 2000-2004.

	N	Cases	Pre pregnancy	N	Cases	Early pregnancy	N	Cases	Mid pregnancy
	N=914		Odds Ratio (95% C.I.)	N=897		Odds Ratio (95% C.I.)	N=704		Odds Ratio (95% C.I.)
TV watching									
0-<1 hr/day	162	23	Ref	135	19	Ref	102	11	Ref
1-<2 hrs/day	265	33	0.86 (0.49, 1.52)	211	29	0.97 (0.52, 1.82)	165	26	1.55 (0.73, 3.29)
2-<4 hrs/day	257	30	0.80 (0.45, 1.43)	238	27	0.78 (0.42, 1.47)	232	28	1.14 (0.54, 2.38)
4+ hrs/day	230	22	0.64 (0.34, 1.19)	313	31	0.67 (0.36, 1.24)	205	16	0.70 (0.36, 1.24)
p-trend			0.15			0.12			0.13
Sitting at work	N=916			N=703			N=642		
Never/rarely	330	41	Ref	134	14	Ref	83	7	Ref
Sometimes	152	26	1.46 (0.85, 2.48)	93	17	1.92 (0.89, 4.1)	74	14	2.53 (0.96, 6.67)
Often	129	11	0.66 (0.33, 1.32)	135	19	1.40 (0.67, 2.93)	85	8	1.13 (0.39, 3.27)
Always	75	8	0.84 (0.38, 1.88)	73	6	0.77 (0.28, 2.09)	30	6	2.71 (0.83, 8.86)
Not employed	230	21	0.71 (0.41, 1.23)	435	47	1.04 (0.55, 1.95)	370	37	1.21 (0.52, 2.81)
P-trend[£]			0.4			0.8			0.37
Sports/exercise	N=909			N=893			N=703		
1 (highest quartile)	225	25	Ref	243	23	Ref	188	17	Ref
2 (25th-75th percentile)	467	59	1.06 (0.70, 1.90)	444	60	1.49 (0.90, 2.49)	374	40	1.21 (0.66, 2.19)
3 (lowest quartile)	217	21	0.86 (0.47, 1.58)	206	21	1.09 (0.58, 2.02)	141	24	2.06 (1.06, 4.01)
p-trend			0.65			0.73			0.03
Sedentary behavior[a]	N=898			N=887			N=700		
1 (least sedentary)	182	19	Ref	176	19	Ref	139	13	Ref
2	489	63	1.27 (0.74, 2.19)	402	55	1.31 (0.75, 2.28)	357	52	1.65 (0.87, 3.14)
3	39	6	1.56 (0.58, 4.20)	66	4	0.53 (0.17, 1.63)	49	4	0.86 (0.27, 2.78)
4 (most sedentary)	188	16	0.80 (0.40, 1.61)	243	26	0.99 (0.53, 1.85)	155	12	0.81 (0.36, 1.85)
p-trend			0.83			0.87			0.41
Sedentary behavior[b]	N=665			N=403			N=247		
1 (least sedentary)	218	24	Ref	90	9	Ref	62	2	Ref
2	204	37	1.79 (1.03, 3.12)	206	32	1.67 (0.78, 3.63)	128	18	4.91 (1.10, 21.88)
3 (most sedentary)	243	21	0.77 (0.41, 1.42)	107	9	0.83 (0.31, 2.18)	57	12	8.00 (1.71, 37.54)
p-trend			0.18			0.48			0.005

a=Composite of TV watching and sports/exercise reversed scored.

b=Composite score of TV watching + sitting at work + sports/exercise (reverse scored).

Table 2.20. Multivariate relative risk and 95% C.I. for AGT by type of sedentary behavior. Latina GDM Study, 2000-2004.

	Pre pregnancy	Early pregnancy	Mid pregnancy
	Odds Ratio (95% C.I.)	Odds Ratio (95% C.I.)	Odds Ratio (95% C.I.)
TV watching[a]	N=869	N=863	N=699
0-<1 hr/day	Ref	Ref	Ref
1-<2 hrs/day	0.88 (0.47, 1.62)	1.02 (0.53, 1.98)	1.45 (0.65, 3.22)
2-<4 hrs/day	0.83 (0.44, 1.54)	0.90 (0.46, 1.77)	1.27 (0.58, 2.77)
4+ hrs/day	0.87 (0.45, 1.69)	0.88 (0.46, 1.70)	0.83 (0.36, 1.94)
p-trend	0.65	0.61	0.42
Sitting at work[b]	N=841	N=801	N=610
Never/rarely	Ref	Ref	Ref
Sometimes	1.17 (0.64, 2.13)	2.08 (0.91, 4.77)	2.78 (1.02, 7.59)
Often	0.51 (0.23, 1.14)	1.33 (0.59, 2.97)	1.11 (0.37, 3.37)
Always	0.77 (0.32, 1.87)	0.86 (0.29, 2.59)	2.45 (0.68, 8.85)
Not employed	0.78 (0.43, 1.42)	1.21 (0.61, 2.40)	1.33 (0.55, 3.22)
p-trend[c]	0.26	0.88	0.53
Sports/exercise[d]	N=847	N=831	N=670
1 (highest quartile)	Ref	Ref	Ref
2 (25th-75th percentile)	1.31 (0.77, 2.25)	1.42 (0.83, 2.45)	1.07 (0.57, 1.99)
3 (lowest quartile)	1.00 (0.51, 1.96)	1.16 (0.60, 2.24)	2.01 (1.01, 4.02)
p-trend	0.95	0.62	0.048
Composite sedentary behavior[d,e]	N=837	N=827	N=670
1 (least sedentary)	Ref	Ref	Ref
2	1.44 (0.80, 2.58)	1.20 (0.67, 2.15)	1.55 (0.80, 3.02)
3	2.18 (0.71, 6.74)	0.50 (0.14, 1.79)	0.98 (0.30, 3.28)
4 (most sedentary)	1.20 (0.57, 2.55)	1.12 (0.58, 2.17)	0.84 (0.36, 1.99)
p-trend	0.96	0.69	0.37
Composite sedentary behavior[d,f]	N=627	N=376	N=237
1 (least sedentary)	Ref	Ref	Ref
2	2.14 (1.18-3.89)	1.68 (0.73-3.88)	6.10 (1.26-29.9)
3 (most sedentary)	0.72 (0.37-1.41)	0.85 (0.30-2.42)	11.8 (2.25-61.86)
p-trend	0.34	0.75	0.002

a=Adjusted for maternal age, smoking, pre-pregnancy body mass index, history of GDM
b=Adjusted for maternal age, smoking, pre-pregnancy body mass index, maternal education
c=P-trend excluding "not employed" category
d=Adjusted for maternal age, smoking, pre-pregnancy BMI, parity, maternal education
e=Composite of TV watching and sports/exercise reversed scored.
f=Composite score of TV watching + sitting at work + sports/exercise reverse scored.

Table 2.21. Unadjusted relative risk and 95% C.I. for GDM by type of sedentary behavior. Latina GDM Study, 2000-2004.

.

	N	Cases	Pre pregnancy	N	Cases	Early pregnancy	N	Cases	Mid pregnancy
	N=914		OR (95% C.I.)	N=897		OR (95% C.I.)	N=704		OR (95% C.I.)
TV watching									
0-<1 hr/day	162	8	Ref	135	5	Ref	102	3	Ref
1-<2 hrs/day	265	8	0.60 (0.22, 1.63)	211	8	1.03 (0.33, 3.20)	165	10	2.13 (0.57, 7.93)
2-<4 hrs/day	257	7	0.54 (0.19, 1.52)	238	5	0.56 (0.16, 1.96)	237	7	1.03 (0.26, 4.05)
4+ hrs/day	230	7	0.60 (0.22, 1.70)	313	10	0.86 (0.29, 2.56)	205	6	1.00 (0.24, 4.06)
p-trend			0.36			0.62			0.44
Sitting at work									
Never/rarely	330	12	Ref	134	4	Ref	83	3	Ref
Sometimes	152	9	1.67 (0.69, 4.05)	93	3	1.08 (0.24, 4.96)	74	4	1.52 (0.33, 7.04)
Often	129	2	0.42 (0.09, 1.89)	135	7	1.78 (0.51, 6.22)	85	4	1.32 (0.29, 6.07)
Always	75	2	0.73 (0.16, 3.31)	73	1	0.45 (0.05, 4.12)	30	2	1.91 (0.30, 12.0)
Not employed	230	5	0.59 (0.21, 1.70)	435	12	0.92 (0.29, 2.91)	370	12	0.89 (0.25, 3.24)
P-trend[a]			0.42			0.99			0.56
Sports/exercise	N=909			N=893			N=703		
1 (highest quartile)	225	10	Ref	243	16	Ref	188	1	Ref
2 (25th-75th percentile)	467	16	0.76 (0.34, 1.71)	444	16	1.48 (0.57, 3.82)	374	17	8.91 (1.18, 67.43)
3 (lowest quartile)	217	4	0.40 (0.13, 1.31)	206	6	1.18 (0.38, 3.73)	141	8	11.25 (1.39, 91.0)
p-trend			0.13			0.75			0.01
Composite sedentary behavior[b]									
1 (least sedentary)	182	8	Ref	176	5	Ref	139	0	Ref
2	489	14	0.64 (0.26, 1.56)	402	13	1.14 (0.40, 3.26)	357	20	NC
3	39	2	1.18 (0.24, 5.76)	66	1	0.53 (0.06, 4.59)	49	1	NC
4 (most sedentary)	188	5	0.59 (0.19, 1.85)	243	9	1.32 (0.43, 4.00)	155	5	NC
p-trend			0.93			0.89			NC
Composite sedentary behavior[c]									
1 (least sedentary)	218	11	Ref	90	4	Ref	62	1	Ref
2	204	9	0.87 (0.35-2.14)	206	7	0.76 (0.22-2.65)	128	8	4.07 (0.50-33.26)
3 (most sedentary)	243	6	0.48 (0.17-1.31)	107	5	1.05 (0.27-4.05)	57	5	5.87 (0.66-51.82)
p-trend			0.15			0.95			0.10

NC denotes not calculable
a=P-trend excluding "not employed" category
b=Composite of TV watching and sports/exercise reversed scored.
c=Composite score of TV watching + sitting at work + sports/exercise reverse scored.

Table 2.22. Multivariate relative risk and 95% C.I. for GDM by type of sedentary behavior. Latina GDM Study, 2000-2004.

	Pre pregnancy	Early pregnancy	Mid pregnancy
	Odds Ratio (95% C.I.)	Odds Ratio (95% C.I.)	Odds Ratio (95% C.I.)
TV watching[a]	N=905	N=887	N=699
0-<1 hr/day	Ref	Ref	Ref
1-<2 hrs/day	0.59 (0.22-1.58)	1.15 (0.36-3.71)	3.18 (0.71-14.17)
2-<4 hrs/day	0.34 (0.11-1.04)	0.87 (0.25-3.0)	2.24 (0.48-10.39)
4+ hrs/day	0.70 (0.24-2.01)	1.25 (0.40-3.90)	1.73 (0.36-8.44)
p-trend	0.32	0.78	0.96
Sitting at work[a]	N=680	N=431	N=269
Never/rarely	Ref	Ref	Ref
Sometimes	1.38 (0.56-3.37)	1.26 (0.30-5.44)	2.34 (0.50-11.02)
Often	0.27 (0.05-1.37)	1.81 (0.50-6.52)	1.54 (0.31-7.74)
Always	0.36 (0.05-2.89)	0.58 (0.06-5.51)	1.05 (0.10-11.55)
p-trend	0.13	0.84	0.85
Sports/exercise[a]	N=901	N=883	N=698
1 (highest quartile)	Ref	Ref	Ref
2 (25th-75th percentile)	0.76 (0.33-1.75)	1.84 (0.69-4.89)	4.91 (1.02-23.7)
3 (lowest quartile)	0.42 (0.13-1.41)	1.33 (0.40-4.34)	5.80 (1.09-30.76)
p-trend	0.16	0.61	0.04
Composite sedentary behavior[a,b]	N=890	N=877	N=695
1 (least sedentary)	Ref	Ref	Ref
2	0.65 (0.25-1.70)	1.34 (0.45-4.01)	NC
3	1.59 (0.29-8.75)	1.02 (0.11-9.36)	NC
4 (most sedentary)	0.92 90.28-3.05)	1.92 (0.60-6.18)	NC
p-trend	0.89	0.28	0.37
Composite sedentary behavior[a,c]	N=661	N=400	N=244
1 (least sedentary)	Ref	Ref	Ref
2	0.99 (0.38-2.570	0.85 (0.23-3.19)	6.36 (0.53-75.78)
3 (most sedentary)	0.35 (0.11-1.10)	1.26 (0.31-5.22)	11.22 (0.87-144.85)
p-trend	0.11	0.73	0.048

a=Adjusted for maternal age and pre-pregnancy BMI.

b=Composite of TV watching and sports/exercise reversed scored.

c=Composite score of TV watching + sitting at work + sports/exercise reverse scored.

Table 2.23. Linear regression estimates (log scale) of 1-hr 50-g OGTT results by type of sedentary behavior. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
TV watching[a]	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)
0-<1 hr/day	Ref	Ref	Ref	Ref	Ref	Ref
1-<2 hrs/day	0.0006 (0.98)	0.006 (0.80)	-0.004 (0.88)	-0.008 (0.76)	-0.008 (0.79)	-0.027 (0.34)
2-<4 hrs/day	0.002 (0.94)	0.013 (0.57)	-0.008 (0.75)	-0.003 (0.90)	-0.021 (0.44)	-0.021 (0.43)
4+ hrs/day	-0.003 (0.89)	0.024 (0.30)	-0.020 (0.40)	-0.004 (0.86)	-0.037 (0.18)	-0.039 (0.16)
p-trend	0.90	0.26	0.33	0.96	0.13	0.22
Sitting at work[b]						
Never/rarely	Ref	Ref	Ref	Ref	Ref	Ref
Sometimes	0.009 (0.69)	-0.001 (0.96)	0.017 (0.58)	-0.0004 (0.99)	0.043 (0.24)	0.038 (0.29)
Often	0.018 (0.45)	0.016 (0.49)	0.016 (0.56)	0.0019 (0.95)	-0.024 (0.49)	-0.019 (0.59)
Always	-0.0004 (0.98)	0.002 (0.95)	0.025 (0.46)	0.026 (0.43)	0.036 (0.46)	0.017 (0.73)
Not employed	-0.008 (0.70)	0.012 (0.55)	-0.004 (0.86)	0.0026 (0.91)	-0.050 (0.07)	-0.041 (0.13)
p-trend	0.69	0.61	0.47	0.53	0.93	0.70
Sports/exercise[c]						
1 (highest quartile)	Ref	Ref	Ref	Ref	Ref	Ref
2 (25th-75th percentile)	0.019 (0.31)	0.025 (0.17)	0.013 (0.46)	0.009 (0.63)	0.004 (0.85)	0.000 (0.99)
3 (lowest quartile)	0.0002 (0.99)	0.011 90.58)	-0.0056(0.79)	-0.002 (0.91)	0.039 (0.13)	0.036 (0.16)
p-trend	0.98	0.56	0.84	0.94	0.15	0.19
Composite sedentary behavior[c]						
Low sedentary score	Ref	Ref	Ref	Ref	Ref	Ref
Medium sedentary score	0.012 (0.59)	0.013 (0.57)	0.044 (0.14)	0.038 (0.19)	0.067 (0.05)	0.057 (0.10)
High sedentary score	0.024 (0.28)	0.024 (0.27)	-0.011 (0.74)	-0.011 (0.75)	0.077 (0.06)	0.081 (0.04)
p-trend	0.66	0.43	0.43	0.44	0.21	0.17

a=Adjusted for maternal age, smoking, pre-pregnancy BMI, history of GDM

b=Adjusted for maternal age, smoking, pre-pregnancy BMI, maternal education

c=Adjusted for maternal age, smoking, pre-pregnancy BMI, parity, maternal education

CHAPTER 3

MATERNAL PHYSICAL ACTIVITY AND RISK OF ADVERSE BIRTH OUTCOMES IN A PREDOMINANTY LATINA POPULATION

3.1 Introduction

Preterm birth (PTB) (<37 weeks gestation) and low birth weight (LBW) (<2500 grams) rates have steadily increased in recent years in developed countries (137, 138). According to the Centers for Disease Control and Prevention, over the past 15 years, the national preterm birth rate increased from 10.6% in 1990 to 12.5% in 2004 with more than 500,000 infants born prematurely, whereas the LBW rate increased from 7.0% to 8.2% (138, 139). Preterm infants are at increased risk of perinatal mortality and morbidity as well as developmental delay and disability (137). LBW infants face higher risk of perinatal morbidity and mortality and chronic disease later in life, such as type II diabetes mellitus (DM) and obesity (140-142). Another abnormal growth classification, small-for-gestational-age (SGA), is defined as those below the 10^{th} percentile of standardized birth weight distributions for respective gestational age groups (143). Rates for SGA have been reported as 6-9% in recent years (144-146). From 1985-1986 to 1997-1998, rates of SGA have declined 11% among Whites and 12% among Blacks, while rates of preterm SGA births have increased by 3% overall (144). Moreover, the mean birth weight has increased over time, indicating that infants may be getting heavier on average (144). Like preterm birth and low birthweight, SGA infants are at risk of growth and developmental abnormalities and chronic disease as adults (139).

Among Latina women, those of Puerto Rican descent have the highest rates of adverse birth outcomes as compared to those of Mexican and Cuban descent, and other Latina groups (147-149). Several studies have also noted that Puerto Rican women have have higher infant mortality than other Latina subgroups (147-150). In addition, the preterm-related infant mortality rate is 75% higher for mainland and island Puerto Rican mothers than for non-Latina white mothers (151).

Given the increasing rates of adverse birth outcomes and the associated public health impact, understanding the relationship between modifiable lifestyle factors and adverse birth outcomes is of public health importance. Approximately 50-60% of reproductive-aged women engage in regular leisure time physical activity (152), while only approximately 30% of pregnant women are estimated to exercise regularly at some point during gestation (153, 154). Latina women report lower rates of physical activity and are half as likely to meet physical activity guidelines set by the Centers for Disease Control and Prevention as compared to non-Latina white women (153, 154). Although recent American College of Obstetricians and Gynecologists' guidelines now recommend regular physical activity during pregnancy for women without medical or obstetrical complications, the appropriate dose of physical activity that is safe for both mother and developing fetus has not been identified (155).

Earlier studies had suggested that physical activity during pregnancy could pose a threat to the developing fetus through deprivation of oxygenated blood to the fetus during and after exercise, increased caloric output, maternal hyperthermia, and ergonomic stress (156-158). However, physiological compensatory mechanisms such as the redistribution of blood flow toward the placenta, increased maternal blood volume, and improved heat dissipation likely protect the fetus from these factors during maternal physical activity (157, 159).

The association between physical activity and adverse birth outcomes has been investigated in over 30 epidemiologic studies in a number of populations over the last 2 decades with conflicting results (160). The study designs, participants, and physical activity assessments varied widely across studies. Moreover, a recent meta-analysis of 8 intervention studies of physical activity in pregnancy concluded that there was insufficient evidence to infer a significant benefit or risk to mother or infant (161).

Few studies of physical activity during pregnancy and adverse birth outcomes have included women of Latina ethnicity, women who may have differing patterns of physical activity as compared to Whites (162). Prior epidemiologic studies in this area have been limited by: 1) measurement of only leisure time activity (sports/exercise), 2) only one assessment of activity throughout pregnancy, 3) study populations of predominantly affluent women, 4) physical activity assessments without known validity or reliability in pregnant populations, and 5) lack of information on frequency, intensity, and duration of activity. No study to date has simultaneously assessed all domains of activity (sports/exercise, household/caregiving, occupation and active transportation) relevant to reproductive-aged women.

This study sought to investigate the association between sports/exercise, household/caregiving, occupational, and active transportation physical activity in pre, early, and mid pregnancy and risk of adverse birth outcomes. The participants represent an inner city Latina population of predominantly Puerto Rican descent, a largely understudied group of high-risk pregnant women.

3.2 Review of the Literature

3.2.1 Physiology of Physical Activity and Adverse Birth Outcomes

The physiological association between physical activity and adverse birth outcomes is complex and not completely understood. Earlier studies had suggested potential harm to the fetus associated with prenatal physical activity, however there may be a number of compensatory mechanisms to protect both the mother and the developing fetus (159). In fact, some evidence suggests that physical activity may be beneficial in a number of ways to maternal and fetal health (163-165).

The first mechanism by which physical activity may affect birth weight and risk of abnormal fetal growth, such as SGA, is through a redistribution of oxygenated blood away from the uterus toward working skeletal muscles (159). This redistribution of blood could deprive the fetus of sufficient oxygenated blood and necessary nutrients potentially compromising fetal nutrition and growth. However, during exercise the blood flow is preferentially shifted away from the myometrium and toward the placenta and is accompanied by increased oxygen extraction by uteroplacental tissues (166, 167). Moreover, Clapp et al. demonstrated that regular, sustained, strenuous maternal exercise is not associated with fetal hypoxemia (168). Evidence from animal studies has shown that even when pregnant ewes are exercised to full exhaustion there was no evidence of acidosis or anaerobic metabolism in placental or fetal tissues (166). Recent evidence suggests that regular maternal physical activity may actually be beneficial for fetoplacental growth. In addition to delivering heavier babies, Clapp et al. showed that women who began an exercise program had increased mid-trimester placental growth rates and vascularization compared to women who did not exercise in pregnancy (163).

Another mechanism by which physical activity may impact fetal growth restriction and risk of SGA is through increased caloric output or an energy deficit. Exercise increases daily energy expenditure; this energy output must be balanced against the nutritional needs of both mother and developing fetus. It has been theorized that associations between high intensity exercise and reduced birth weight may result from inadequate nutrition accompanying strenuous exercise, rather than the exercise itself (159, 169, 170). Dietary intake must be addressed in studies of physical activity and birth weight as inadequate nutrition is a known determinant of birth weight (169-171).

Concern has also been raised about maternal hyperthermia associated with physical activity and its effect on the fetus (172). It was thought that hyperthermia may result in fetal distress subsequently leading to preterm labor (159, 172). Strenuous physical activity has been shown to mildly raise core maternal body temperature; however studies have shown that moderate-intensity exercise lasting up to 60 minutes raises the body temperature only about 0.6 degrees Celsius (173). There are a number of compensatory mechanisms in place to protect the fetus from increased body temperatures. For example, the increase in blood volume associated with pregnancy helps to increase heat release (174). The larger body mass associated with pregnancy also requires more heat to raise the core body temperature (172, 174). In addition, the temperature required to induce sweating drops by the 7th week of gestation and continues to fall throughout pregnancy providing another mechanism of enhanced heat dissipation (174).

Several mechanisms have been proposed to suggest that exercise may result in fetal distress, in turn, leading to preterm birth (175). For example, ergonomic stress associated with physical activity has been postulated as a mechanism leading to preterm birth (163, 175). Several studies have reported uterine vasoconstriction and increased uterine contractions during and after physical activity (176-178). However, these studies were small and results were inconsistent with certain types of activity. For instance, in the study by Grisso et al., uterine contractions increased with climbing stairs and walking, but not with formal exercise or lifting heavy objects (176).

In summary, there are several potential concerns associated with physical activity in pregnancy on birth weight, SGA and timing of delivery such as decreased uterine blood flow, increased energy expenditure, and ergonomic stress. However, for each of these concerns, there may be a number of compensatory mechanisms accompanying the pregnant state to protect both mother and fetus.

3.2.2 Epidemiology of Physical Activity and Adverse Birth Outcomes

The association between physical activity and adverse birth outcomes has been widely investigated in a number of populations over the last two decades with conflicting results (160). The study designs, participants, and physical activity assessments varied widely across studies. Two recent meta-analyses concluded that there is insufficient evidence to infer a significant risk or benefit to mother or infant associated with physical activity in pregnancy (161, 179). The majority of studies (n=16) found no association between physical activity and preterm birth (161, 163, 179-192), with 7 studies suggesting a protective effect (193-199), and still others (n=5) indicating an increased risk associated with occupational activity (200-204). However, in the latter studies, it is unclear whether the increased risk of preterm birth was related to working long hours, work-related stress, work-related physical activity, or a combination of these factors.

With respect to birth weight and risk of LBW, approximately 20 studies, including 3 meta-analyses, have reported no association between physical activity and birth weight or risk of LBW (161, 167, 179-182, 185-188, 192, 205-212), while 7 studies reported a positive association between physical activity and birth weight (163, 189, 213-217), and still others (n=11) reported an inverse association with birth weight and/or increased risk of LBW (156, 168, 200, 214, 218-224). Studies on the association between physical activity and risk of SGA (n=8) are few in number and results are mixed (183, 208, 225-230).

In one of the few studies to assess both occupational and non-occupational related physical activity, Klebanoff et al. utilized data from the Vaginal Infections and Prematurity (VIP) Study, a prospective study of 7,101 pregnant women of whom 35% were Latina, to analyze the association between physical activity and risk of preterm delivery and birth weight distribution (188). Participants were recruited at prenatal clinics at one of five centers (Columbia University, NY; University of Washington, Seattle; University of Oklahoma, Oklahoma City; University of Texas, San Antonio; Louisiana State University, New Orleans) from 1984 to 1987. The authors measured physical activity at 23-26 weeks gestational age via interviewer-administered questionnaire with the question, “In a typical day during the first 5 months of pregnancy, about how many hours did you spend doing the following?” Activities included standing for long periods of time, heavy work/exercise and light work/exercise. Time periods of PA were a priori classified as 0, 1-3, 4-7, and 8+ hours per day. Type of occupation was also assessed. Gestational age at delivery was based on the obstetrician's best estimate utilizing the last menstrual period, ultrasonograms, uterine measurements, and detection of fetal heart tones.

After adjusting for study site, ethnicity, maternal age, education, marital status, medical insurance, income, current smoking, alcohol use, parity, and employment, heavy work or exercise ≥4 hrs/day was not associated with preterm birth (OR=1.04, 95% CI 0.76-1.42) as compared to 0 hrs/day, though prolonged standing for ≥8 hrs/day was associated with a modestly increased risk of preterm birth (OR=1.31, 95% CI 1.01-1.71; $P_{trend} = 0.06$) compared to 0 hrs of standing throughout the day (188). In contrast, light work or exercise was associated with a protective effect on preterm birth (≥8 hrs/day OR=0.59, 95% CI 0.38-0.93; P_{trend}=0.0019) compared to not engaging in any light activity. With regard to fetal growth, increasing time spent in light physical activity was associated with increased gestational age-adjusted birth weight in unadjusted analyses; however, after controlling for confounders, physical activity was not associated with birth weight (P_{trend} heavy work=0.29; P_{trend} light work=0.25; P_{trend} standing=0.12) (188).

One of the first studies to examine both frequency and intensity of physical activity, Evenson et al. utilized the prospective Pregnancy, Infection and Nutrition Study (PIN) to examine the association between vigorous activity and risk of preterm birth (194). Participants (N=1,699), of which 6% were of 'Other' race/ethnicity (non-White and non-African American; % Latina was not reported) were recruited at 24-29 weeks' gestation from four prenatal clinics in North Carolina from August 1995 to June 1998. In a telephone interview two weeks after recruitment (26-31 weeks' gestation), women were asked, “Thinking back to three months before you got pregnant until now, have there been times when you have done any regular exercise or strenuous activity, like aerobic exercise or jogging, at least twice a week?” If the response was affirmative, the woman was asked about participation in selected activities at 3 time periods (3 months before pregnancy, the first 3 months of pregnancy, and the second 3 months of pregnancy) and how many hours of participation per week in each time period. Activity choices were selected from the National Maternal and Infant Health Survey and included swimming laps, jogging at a moderate to fast pace, aerobics or aerobic dance, other fast dancing, and moderate to fast bicycling with at least six metabolic equivalents (METs). Participants could also report other kinds of exercise or strenuous activity. Vigorous leisure time activity was also based on total duration per week: 0, 0.1-2.9, or 3+ hours per week. Pregnancy outcome information was obtained from hospital delivery logs. Gestational age at delivery was determined based on an algorithm combining last menstrual period (LMP) and ultrasound dating.

After adjusting for smoking, maternal age, pre-pregnancy body mass index (BMI), marital status, maternal education, race, parity, quartiles of energy intake, and bed rest, vigorous activity in the first trimester (OR=0.80; 95% CI 0.48-1.35) and in the second trimester (OR=0.52; 95% CI 0.24-1.11) was associated with a non-significant reduced risk of preterm birth (194). There were no differences in risk of preterm birth associated with number of hours per week of vigorous activity in the first or second trimester. Specifically, those with three or more hours of vigorous activity in the first trimester (OR=0.85; 95% CI 0.44-1.66) and second trimester (OR=0.61, 95% CI 0.23-1.57) did not have an increased risk as compared to those who did not participate in vigorous activity (p-trends not reported).

Another study examined the relationship between intensity of physical activity and risk of SGA using a cross-sectional design (225). Alderman et al. studied participants (n=291) recruited previously as controls for a case-control study of risk factors for craniosynostosis (231). Physical activity, other prenatal health behaviors and demographics were obtained from a 1-hour standardized telephone interview after delivery. The physical activity questions were adapted from the CARDIA Physical Activity History (PAH) (232), which classifies activities into 13 groups based on intensity and determines a frequency for each group (at least 1 hour per month, one hour per week, or two hours per week). Vigorous activities were described to participants as those which "…increase your heart rate or make you sweat when doing them or make you breathe hard or raise your body temperature." Gestational age and birth weight were abstracted from medical records.

After adjusting for prenatal cigarette and alcohol use, moderate or vigorous activity performed for at least two hours per week in any month of the second or third trimester was not associated with SGA (OR=0.8; 95% CI 0.3-2.3) as compared to those engaging in moderate or vigorous activity for <2 hrs/week. Adjustment for other demographic, obstetrical or anthropomorphic factors did not affect the estimates. With regard to specific activities, jogging for ≥2 hrs/week in any month showed a non-significant increase in risk of SGA (OR=2.6; 95% CI not reported).

The study by Alderman et al. was one of the first studies to examine intensity and frequency of physical activity on risk of SGA, whereas most prior studies have focused only on occupational activity in relation to this outcome (225). The authors utilized a physical activity assessment tool with known reliability and validity in a non-pregnant population, which may not be applicable to pregnant women. Limitations of this study are a small sample size and the use of a cross-sectional design. The assessment of physical activity information post-delivery may be affected by differential recall by women who delivered an infant with adverse birth outcomes and those who did not and the inaccurate recall of physical activity retrospectively.

There are a number of limitations associated with existing epidemiologic studies of physical activity in pregnancy and adverse birth outcomes. First, the majority of studies have focused solely on leisure time physical activity (i.e. sports and exercise), which tends to represent a <40% of a pregnant woman's daily energy expenditure (233). Other physical activities, such as occupational, household/caregiving, and active transportation, should also be measured to accurately assess risks associated with total activity and different types of activity. Furthermore, two large studies indicate that Latinas spend a substantial portion of their physical activity time in occupational, active transportation, and household type activities (162, 234). Second, many studies were limited by one assessment of physical activity throughout pregnancy, in spite of the observation that physical activity patterns vary across the gestational period. Third, the majority of studies were conducted amongst populations of white, generally high socioeconomic status women, whose activity patterns may differ from those of Latina women. Studies conducted among high-risk minority women, who are known to have higher rates of sedentary behavior and adverse birth outcomes are urgently needed. Fourth, the majority of studies utilized questionnaires which have not been validated among populations of pregnant women. The association between physical activity and birth outcomes is likely to be modest, therefore the assessment tools must be highly specific to the population, valid, and reliable to accurately assess risk (160, 165).

3.3 Summary

Rates of adverse birth outcome rates have steadily increased in recent years in developed countries, yet research is inconclusive as to the cause. LBW and preterm infants face increased risk for perinatal morbidity and mortality as well as growth and developmental disorders (139). The public health burden of adverse birth outcomes underscores the importance of identifying modifiable risk factors associated with birth weight and length of gestation. Latina women have higher risk of adverse pregnancy outcomes and are more likely to report leading sedentary lives than non-Latina white women. Therefore, studies of adverse birth outcomes conducted among high-risk minority women are urgently warranted.

Physical activity in pregnancy has been implicated as a lifestyle factor associated with adverse birth outcomes, yet evidence remains inconclusive. While exercise may lead to uterine vasoconstriction, reduced uterine blood flow, and hyperthermia, compensatory mechanisms may serve to protect the fetus. Consistent with this finding, the majority of epidemiologic evidence does not support a harmful effect of physical activity on birth weight or preterm birth. However, these studies have, in general, relied on physical activity assessments without known reliability and validity and no study to date has been conducted exclusively among Latina women, a group at high-risk for adverse pregnancy outcomes.

Therefore, this study fills several gaps in existing research with the inclusion of a minority population, multiple physical activity assessments across pregnancy, a physical activity measurement tool with known validity and reliability, and the measurement of multiple domains of activity (household/caregiving, occupational, sports/exercise, and active transportation).

3.4 Study Aims

1) To investigate the association between total (sports/exercise, household/caregiving, occupational, active transportation combined) physical activity in pre, early and mid pregnancy and risk of preterm birth.

2) To investigate the association between total (sports/exercise, household/caregiving, occupational, active transportation combined) physical activity in pre, early and mid pregnancy and risk of delivering a small-for-gestational-age infant (SGA).

3) To investigate the association between total (sports/exercise, household/caregiving, occupational, active transportation combined) physical activity in pre, early and mid pregnancy) and gestational age.

4) To investigate the association between total (sports/exercise, household/caregiving, occupational, active transportation combined) physical activity in pre, early and mid pregnancy and birth weight.

3.5 Methods

3.5.1 Study Design and Population

Participants were self-identified Latinas enrolled in prenatal care in the public obstetrics and gynecology (OB/GYN) and midwifery practice of a large tertiary care facility in Western Massachusetts, Baystate Medical Center. Participants were recruited by bilingual interviewers at prenatal care visits up to 24 weeks of gestation (mean = 15 weeks gestation) from September 2000 to December 2003. Eligibility criteria included Latina ethnicity, age 16-40 years, <24 weeks gestational age at first interview, singleton pregnancy, no prior diagnosis of hypertension, chronic renal disease, or type 2 diabetes, and no prior participation in the study. Interviewers obtained informed consent from participants approved by the Institutional Review Boards of the University of Massachusetts-Amherst and Baystate Medical Center.

Interviewers collected information on substance use, medical and obstetric history, physical activity, and sociodemographic factors at the time of recruitment. Participants were interviewed a second time in mid-pregnancy to update information on substance use and physical activity (mean = 28 weeks gestation). Additional medical factors were collected from medical records by trained medical abstractors.

3.5.2 Outcome Assessment

Gestational age at birth was derived from the clinician's "best obstetric estimate". This estimate was based on sonograms, date of last menstrual period (LMP), date the first fetal heart beat was heard with a stethoscope, and fundal height abstracted from medical records. If the best obstetric estimate was not available (n=2), gestational age was based on ultrasound. Preterm birth will be defined as birth prior to the 37th completed week of gestation.

Birth weights were abstracted from medical records at Baystate Medical Center by trained medical abstractors. SGA was defined as below the 10th percentile of birth weight for gestational age based on Oken et al.'s continuous distribution of standardized birth weights in the United States (143). The birth weight distribution as reported by Oken et al. has been recommended for research purposes because it represents a larger sample and is more comprehensive than previous reports (143). Moreover, a birth weight distribution specific to the Puerto Rican population is not currently available. Hispanic birth weight distributions are available (235), however the infants included in such samples are mainly of Mexican descent and represent a different population from Puerto Rican infants.

3.5.3 Validity of Outcome Assessment

Currently there is no gold standard for pregnancy dating (i.e. estimating gestational age). While the most widely used tool for assessing gestational age is maternal recall of the last menstrual period (LMP), this method is subject to bias in that: 1) the normal cycle length can vary considerably between women; 3) women with irregular cycles or anovulation may not adhere to the presumed 28-day cycle; 3) irregular bleeding may reflect a miscarriage rather than menstrual period; and 4) errors in recall of the LMP may render the estimate unreliable (145, 236). For these reasons, a clinical method of assessing gestational age using ultrasound technology is becoming more widely used in developed nations where pregnant women routinely receive early ultrasounds. Several studies have shown the ultrasound method to be superior to the LMP method in predicting actual delivery dates (237-241); however, the ultrasound estimate may also be biased for women carrying unusually large or small babies as the clinical estimate is based on size (236). Furthermore, several researchers have recommended the use of a hybrid combination of the menstrual and clinical estimate of gestational age as used in this study (145, 242, 243).

With regard to birth weight, the data for the proposed study was collected directly from the medical record. Information collected from the medical record is generally accepted to be the gold standard level of information for medical characteristics, such as birth weight.

Our classification of SGA utilizes information from both the birth weight and gestational age assessment, thus validity information discussed previously for these outcomes also applies to SGA. While there is no gold standard universally accepted for classification of these outcomes, we used the most current and comprehensive birth weight distribution available for United States' infants and standard definitions for SGA in epidemiologic research (143).

3.5.4 Physical Activity Assessment

Physical activity in pre, early and mid-pregnancy was measured using a modified version of the Kaiser Physical Activity Survey (KPAS) (244). The KPAS was interviewer-administered at two time points: at recruitment (mean = 15 weeks gestation) and at mid-pregnancy (mean = 28 weeks gestation). Pre pregnancy and early pregnancy physical activities were assessed at recruitment and mid pregnancy activity at the follow-up interview. The KPAS measures activity on a 5-point Likert scale ranging from “never” to “always” in 4 domains: sports/exercise, occupational, household/caregiving, and active living (transportation). For sports/exercise, the participants may list up to 3 activities and the corresponding weekly frequency and duration of participation. In addition, total activity was calculated as the sum of the 4 domains of activity with weights based on the time spent in each activity from a previous study (233). Each domain of activity will be categorized in quartiles, except for occupational activity, which includes “not employed” women in group I and divides working women into two (early and mid pregnancy) or three (pre pregnancy) groups based on the distribution of occupational activity.

3.5.5 Validity of Physical Activity Assessment

The modified KPAS was validated among a sample of 54 pregnant women at Baystate Medical Center using 7-days of accelerometer measurements (244). Correlation coefficients used to measure the reproducibility of the KPAS ranged from r=0.76-0.86 and Spearman correlation coefficients between the KPAS and three published cut points used to classify accelerometer data ranged from r=0.49-0.59. Correlation coefficients ranged from 0.25-0.33 for occupational activity, 0.31-0.36 for active living, 0.34-0.51 for sports/exercise, and 0.12-0.36 for household/caregiving.

3.5.6 Covariate Assessment

Interviewers collected information on substance use, medical and obstetric history, and sociodemographic factors at the time of recruitment. Information collected on substance use included cigarette use, alcohol use, and illicit drug use before and during pregnancy. Substance use was updated at a second interview in mid pregnancy (mean=28 weeks gestation). Information abstracted from medical records included history of GDM, reproductive history, family history of diabetes mellitus, pre pregnancy BMI, parity and pregnancy weight gain. Sociodemographic information collected at recruitment included age, birth place, length of time in the United States, educational attainment, income and employment. Psychosocial stress was assessed at both the early and mid pregnancy interview using the 4-item Perceived Stress Scale (245) and the Modified Life Events Inventory (246, 247).

Pregnancy diet was assessed using a food frequency questionnaire (FFQ) adapted from the National Cancer Institute (NCI/Block) FFQ designed for Latinos in Northeastern United States (of mainly Puerto Rican and Dominican heritage) (248). This questionnaire, adapted from the Block FFQ designed for non-Latino whites, was validated in a population of Latinos and non-Latino whites using 24 hour recalls (248). The FFQ was administered in mid pregnancy (mean=23 weeks gestation) on a subset of the study population (62%). Total caloric intake (quartiles) was considered as a covariate.

3.5.7 Statistical Analysis

All analyses were performed using SAS 9.1 (SAS Campus Drive, Cary, North Carolina 27513, USA).

Using chi-square tests for independence, we assessed covariates as potential confounders by cross-tabulating them with both the outcome and physical activity variables. Using logistic regression, unadjusted odds ratios and 95% confidence intervals

(C.I.) were calculated to estimate the unadjusted association between physical activity in pre, early and mid pregnancy and risk of preterm birth and SGA using the bottom quartile as the referent group. For the analyses with respect to occupational activity, we reported results in the tables using group I (not employed) as the referent category, but we also examined the results using group II (low activity, employed) as the referent category.

We also analyzed the association between % change in physical activity from pre to early pregnancy and risk of these birth outcomes. We calculated the % change in each physical activity domain by subtracting the pre pregnancy score from the early pregnancy score. Because most participants decreased their physical activity from pre to early pregnancy, the referent group was composed of those who reduced their activity by >25%, and the three other comparison groups were those who decreased activity from 5-25%, maintained activity levels between -5 and 5% and those who increased by >5%.

Multivariable logistic regression was used to model the relation between different types of physical activity and risk of preterm birth and SGA while accounting for confounding variables. Those covariates which caused a 15% change in the coefficient for physical activity were considered confounders and included in the final model. We also included confounding variables identified in previous studies of this association. Tests for trend were evaluated by entering the categorical variable for physical activity as an ordinal variable using the category midpoint and using the Wald chi-square test for statistical significance (p-value <0.05).

A sub-analysis was conducted to determine the extent of potential confounding by lack of information on history of preterm birth or SGA by restricting the sample to nulliparous women and comparing the results to that of the entire sample. Furthermore, we considered BMI and parity as effect modifiers of the association between physical activity and risk of preterm birth. Assessment of effect modifiers was accomplished by including multiplicative interaction terms of physical activity x BMI (<25 kg/m^2 and ≥ 25 mg/m^2) and physical activity x parity (nulliparous and parous) in the logistic regression model and assess statistical significance of the interaction term ($p<0.05$).

We also considered gestational age and birth weight as continuous outcomes. We first examined the distribution of both outcomes to assess normality. The distributions were sufficiently normal and did not require transformation. We utilized least squares linear regression to model the association between each physical activity domain and gestational age and birth weight. We reported unadjusted and adjusted beta coefficients and p-values for each level of the exposure variables. Multivariable linear regression was used to model the association between physical activity variables and both continuous outcomes while accounting for confounding variables.

The analysis for preterm birth was restricted to N=1041 women for whom gestational age information was available and the analysis for SGA was restricted to N=1040 for whom information on both birth weight and gestational age was available. Among those missing birth outcome information (N=191, 15%), N=35 had a spontaneous abortion or therapeutic abortion, N=155 were lost to follow-up, and N=1 was delivered at the study hospital but the birth weight was missing from the medical record.

3.6 Results

Participants ranged in ages from 16 to 39 years with 72% below age 25 years; fifty-six percent of the women had not completed high school at enrollment. With respect to acculturation factors, 45% were born outside the Continental U.S., 33% were bilingual (Spanish and English) or preferred only Spanish, and 85% were of Puerto Rican descent. Regarding medical factors, 60% were multiparous, 5% had a history of adverse pregnancy outcome (prior stillbirth, preterm birth, low birth weight, or infant with anomaly) and >40% were overweight or obese according to their pre-pregnancy BMI.

A total of 12% (N=123) of participants delivered preterm (<37 completed weeks) with 4% delivered before 34 weeks and 8% between 34 and 36 weeks gestation. A total of 14% (N=148) of participants delivered an SGA infant (Table 3.24). The mean birth weight was 3172 (SD=612) grams and the mean gestational age was 38 (SD=2.7) weeks. Lower maternal education, cigarette use, and increased number of stressful life events in mid pregnancy were statistically significantly associated with increased risk of preterm birth (Table 3.25). Mothers who delivered term babies gained on average more weight throughout the pregnancy; however, their length of pregnancy was longer, and therefore they had greater opportunity for weight gain. In terms of SGA, decreased maternal age, education and parity and increased mid pregnancy perceived stress were associated with increased risk for SGA. In addition, mothers who delivered SGA infants had lower pre-pregnancy BMI, and maternal weight gain compared to mothers who delivered non-SGA infants.

Overall, activity level in most domains decreased from pre to early pregnancy and remained stable from early to mid pregnancy (Table 3.26). Total activity and active transportation levels showed slight increases from early to mid pregnancy with slightly greater median and 75th percentile values in mid as compared to early pregnancy. A total of 75% of women were employed in the year prior to pregnancy whereas only 50% were employed during pregnancy.

In terms of factors associated with activity level in each domain, increasing perceived stress was significantly associated with decreased sports/exercise level, whereas employment and increasing income were borderline associated with increased sports/exercise level (Table 3.27). Several factors were associated with increased household/caregiving level, including increasing age, education, parity, perceived stress, and caloric intake (Table 3.28). Increased occupational activity was associated with increased education, decreased income, English language preference and increasing pregnancy weight gain; whereas cigarette use and high perceived stress were associated with decreased occupational activity (Table 3.29). For active transportation, increased pre-pregnancy BMI and stressful life events were associated with increased activity, whereas increased perceived stress was associated with decreased activity (Table 3.30). Finally, higher total physical activity was associated with increasing age, education, income, parity, stressful life events, and employment (Table 3.31).

The majority of women decreased their physical activity in all domains from pre to early pregnancy, while a small percentage of women increased their physical activity (13% in sports/exercise, 19% in household/caregiving, 20% in active transportation, 17% in occupational, and 12% for total activity). Incidence of adverse birth outcomes in women who increased their physical activity did not differ significantly from those who decreased their activity from pre to early pregnancy (12% preterm birth and 16% SGA for sports/exercise increase, 8.6% preterm birth and 18% SGA for household/caregiving increase, 8.4% preterm birth and 14% SGA for active transportation increase, 9% preterm birth and 15% SGA for occupational increase, and 9.8% preterm birith and 9.8% SGA in total activity increase; Table 3.33, 3.35).

In univariate analysis, there was no significant association between any domain of physical activity and risk of preterm birth in pre, early or mid pregnancy (Table 3.32). However, there was a suggestion of decreased risk for increasing occupational activity in pre pregnancy. There was also no association between change in physical activity from pre to early pregnancy in any domain and risk of preterm birth (Table 3.33). Further adjustment for confounding factors did not alter this association. However, a significant reduced risk for preterm birth was observed for those who slightly decreased their total activity (5-25% reduction) as compared to those who substantially decreased their total activity by greater than 25% (OR=0.53, 95% C.I. 0.31, 0.94) (Table 3.33).

With regard to risk of SGA in univariate analysis, there was no association between occupational activity and active transportation and SGA (Table 3.34). However, increasing household/caregiving activity in mid pregnancy (P_{trend}=0.004) and increasing total activity in pre and mid pregnancy (P_{trend}=0.0002) were associated with a significant decreased risk for SGA. For sports/exercise activity, increased levels in pre pregnancy were associated with decreased risk for SGA, whereas mid pregnancy activity was associated with an increased risk, though without significant linear trend. Regarding change in physical activity from pre to early pregnancy, there was no clear association between change in occupational, active transportation, sports/exercise, and total activity and risk of SGA (Table 3.35). However, there was a decreased risk of SGA associated with maintaining or slightly decreasing household activity levels as compared to those who substantially decreased their activity by greater than 25%.

After adjusting for age, education, pre-pregnancy BMI, and parity, results remained virtually unchanged in direction and magnitude for risk of preterm birth and the slight impact of occupational activity was attenuated (Table 3.36).

After adjustment for maternal age, parity, pre-pregnancy BMI, and maternal education, there was a significant reduction in risk of SGA for increasing levels of mid pregnancy total activity with a significant linear trend (p=0.003) (Table 3.37). Those in the 3^{rd} and 4^{th} quartile of total activity in mid pregnancy had significant decreased risk for SGA compared to those in the lowest quartile (OR=0.50, 95% C.I. 0.27, 0.92 and OR=0.44, 95% C.I. 0.22, 0.86, respectively). We also observed a reduction in risk with increasing mid pregnancy household/caregiving activity, pre pregnancy sports/exercise, and a trend toward decreasing risk with mid pregnancy active transportation (p-trend = 0.048). Conversely, we observed an increased risk for SGA for mid pregnancy sports/exercise, but without significant linear trend (p=0.22). No association was observed for occupational activity and SGA using either the "not employed" (group 1) as the referent group or the low activity (employed) (group 2) as the referent group. Furthermore, after adjustment for multiple confounders, change in physical activity from pre to early pregnancy in any domain was not associated with SGA (Table 3.35).

We further examined the effect of physical activity on length of gestation and birth weight as continuous variables. There was no clear association between increasing physical activity, or change in physical activity, and length of gestation (Table 3.38-3.39). However, we observed a significant association between increasing total activity and household/caregiving in mid pregnancy and increasing birth weight (Table 3.40). After adjustment, women in the 3^{rd} and 4^{th} quartile of total activity delivered infants that weighed approximately 155g (p=0.0007) and 91g (p=0.05) heavier, respectively, compared to women in the 1st quartile. Similarly, women in the 4th quartile of household/caregiving activity delivered babies weighing approximately 144.5g (p=0.006) more than those in the bottom quartile. Regarding change in physical activity from pre to early pregnancy, the majority of domains of activity were not associated with birth weight (Table 3.41). However, women who maintained their pre pregnancy household/caregiving activity within 5% delivered heavier babies (p=0.02) than those who decreased their activity by greater than 25%.

Finally, we examined whether the association between physical activity and preterm birth, SGA, gestational age and birth weight was modified by parity and pre-pregnancy BMI. We did not observe significant interaction (p<0.05) between these factors and physical activity. For the sub-analyses restricted to nulliparous women, results were similar in magnitude and direction for both SGA and preterm birth.

3.7 Discussion

In this prospective cohort of Latina prenatal care patients, we observed a neutral or somewhat protective effect of physical activity on birth outcomes. Specifically, we observed no apparent association between any type of physical activity and risk of preterm birth or length of gestation; however, there was evidence that increased total activity was associated with a significant decreased risk of SGA and the delivery of heavier infants in a dose-response fashion. Occupational and active transportation were not associated with SGA, whereas increased household/caregiving activity and total activity in mid pregnancy were associated with a statistically significant decreased risk of

SGA. Sports/exercise in mid pregnancy was associated with an increased risk of SGA, while pre and early pregnancy sports/exercise was not. These findings represent results from the first prospective study of physical activity and risk of adverse birth outcomes in a Latina population

3.7.1 Comparison with Prior Literature

Our overall findings of a null to protective effect of physical activity on preterm birth are consistent with the vast majority of prior literature on physical activity in pregnancy which was conducted using a variety of study designs, populations, and physical activity assessments (160). A recent review of such studies found that the majority of studies observed no association between physical activity and preterm birth or length of gestation (163, 179, 180, 182-192, 194, 249) with some reporting a decreased risk of preterm birth (193, 195-199, 250), and a small number of studies finding an increased risk associated with prolonged standing at work (188, 200, 228). Consistent with previous literature, we did not observe an increased risk of preterm birth or reduced length of gestation for any domain of physical activity in any pregnancy time point.

To our knowledge, only one study has examined change in physical activity level with the onset of pregnancy in relation to preterm birth. This study, a large prospective cohort of over 87,000 pregnancies in the Danish National Birth Cohort, found a slight decrease in risk for those who maintained (OR=0.81, 95% C.I. 0.72, 0.91) or increased (OR=0.83, 95% C.I. 0.73, 0.95) their physical activity over the course of pregnancy as compared to those who remained sedentary across pregnancy (250). Similarly, we observed a non-significant decrease in risk for those who increased their total physical activity from pre to early pregnancy (OR=0.74, 95% C.I. 0.32, 1.69).

Physical activity has been less often studied in relation to SGA and results are similarly conflicting (225, 226). Only two studies, both using a case-control design, have examined sports/exercise in relation to SGA. Alderman et al. found no association (OR=0.80, 95% C.I. 0.3, 2.3) (225), while Campbell et al. in a case-control design study of n=529, predominantly married and highly educated women (race or ethnicity not reported), found an increased risk for both high (>5 times per week: OR=4.6, 95% C.I. 1.7, 12.3) and low (<3 times per week: OR=2.6, 95% C.I. 1.3, 5.4) exercise in late pregnancy (3^{rd} trimester) as compared to moderate exercise (3-5 times a week) (226). Studies of recreational activity and risk of low birth weight have overall found a null to protective effect (189, 210, 217) with a significant decreased risk for very low birth weight (<1500g) (189, 210). We found that sports/exercise in mid pregnancy (4^{th} quartile vs. 1^{st}: OR= 2.01, 95% C.I. 1.01, 4.33) was positively associated with risk of SGA. However this observation conflicted with our findings for pre pregnancy sports/exercise (4^{th} vs. 1^{st} quartile: OR = 0.69, 95% C.I. 0.41, 1.15; P_{trend}=0.11) and early pregnancy sports exercise (OR=0.80, 95% C.I. 0.47, 1.36) which were suggestive of a protective or null association. In addition, sports/exercise in any time period was not statistically significantly associated with decreased birth weight.

We found a decreased risk of SGA for increased mid pregnancy household/caregiving activity (4^{th} quartile vs. 1^{st}: OR=0.69, 95% C.I. 0.34, 1.39 and 3^{rd} quartile vs. 1^{st}: OR=0.53, 95% C.I. 0.23, 1.00; P_{trend}=0.10) and mid pregnancy total activity (4^{th} quartile vs. 1^{st}: OR=0.44, 95% C.I. 0.22, 0.86; P_{trend} = 0.002). Prior studies have not directly assessed household/caregiving activity level or total activity in relation to SGA. However, Launer et al. in an prospective study of n=15,786 low to middle class Guatemalan women, found a 2-fold increased risk of SGA for women with three or more children in the home and no household help compared to those with hired help, but actual activity level was not assessed and gestational age was determined at birth (95% CI 1.16, 3.33) (228). Schramm et al. in a population-based case-control study among n=2,828 predominantly white women, found no association between strenuous household activity and risk of LBW but found a decreased risk for caring for preschool children on a daily basis (OR=0.81, $p<0.05$, 95% C.I. not reported) (210). Another two studies found no difference in adjusted mean birth weight or risk of LBW between those active in the home and those who were not, but results suggested a trend toward increased birth weight with increased energy expenditure ($p<0.05$) (209, 251).

Overall conflicting results across studies are likely due to the differing methods and timing of physical activity assessments ranging from retrospective recall at or after delivery to only one measurement during pregnancy. In addition, a number of studies utilized questionnaires without known validity or reliability.

3.8 Limitations

Our study has several limitations. We did not have complete information on mid pregnancy physical activity for all participants. Women missing mid pregnancy physical activity information did not differ from those without such information in terms of the majority of sociodemographic and behavioral factors, levels of pre and early pregnancy physical activity, or risk of preterm birth or SGA. However, they tended to be older, less educated, Spanish/bilingual speakers and parous. To the extent that these factors were associated with our study outcomes, this would result in biasing our observed findings for mid pregnancy activity.

Due to the social desirability of physical activity, it is possible that participants overestimated their physical activity level. We suspect this misclassification to be minimal because the KPAS tool utilized in this study has been validated previously in this population of pregnant women. The use of bilingual interviewers and limited period of recall (1 month prior to the interview) may further reduce the magnitude of misclassification. Furthermore, the prospective nature of the study design precluded the knowledge of study outcomes (i.e., preterm birth and SGA) from biasing reported physical activity levels. Therefore, such misclassification would likely bias our results toward the null value. Another limitation of the KPAS is the Likert-type scoring system which precludes the calculation of a physical activity dose that may be relevant to maternal and fetal health and compared to measurements in other studies.

Misclassification of SGA status may occur through random error in weighing the infant; however this type of error is expected to be minimal due to the objective nature of birth weight measurement. Preterm birth status (<37 completed weeks gestation) as well as SGA may be misclassified through inaccurate recall of LMP and/or inaccuracies associated with ultrasound estimation. However, the majority of gestational ages were calculated using the obstetrician's best estimate taking into account multiple sources including LMP, ultrasound technology, first date of hearing the fetal heart beat, and fundal height, thus limiting misclassification. Such misclassification is expected to bias our results toward the null.

The use of a specific birth weight distribution to classify SGA may lead to nondifferential misclassification of outcome. Currently, birth weight distributions for Puerto Rican infants are not yet available; therefore, we chose a recently derived, nationally representative continuous birth weight standard that represents almost 7 million singleton births between 1999 and 2000 (143). This birth weight distribution has been recommended for research purposes because it is larger and more comprehensive than previous standards (143). Recently published United States national birth weight distributions are largely similar so the expected misclassification by choice of distribution is expected to be minimal (143, 146, 235). Potential limitations to using birth weight standards for classifying infants as SGA are the risk of classifying infants who are not growth restricted but who are genetically small and the somewhat arbitrary cutoff of the 10^{th} percentile (252). However, if misclassification occurs due to the choice of birth weight standard, this would most likely bias our results toward the null (253).

Due to the prospective nature of this study, selection bias may occur through loss to follow-up of cohort participants. However, those lost to follow-up must differ in terms of both disease and exposure status as compared to those remaining in the cohort to produce such a bias. In our study, those lost to follow-up did not differ from those remaining in the cohort in terms of pre, early or mid pregnancy physical activity level, suggesting that selection bias is likely to be minimal.

A second type of possible bias relates to biased surveillance or assessment of the outcome. However, medical record abstractors were not aware of the physical activity levels of participants, thus knowledge of the exposure would not influence outcome ascertainment.

To assess potential factors that may bias the association between sedentary behavior and risk of adverse birth outcomes, we collected information on a large number of established risk factors for SGA and preterm birth and other behavioral, obstetrical, and sociodemographic factors that may be associated with physical activity. One factor that was not collected was a prior history of preterm birth or SGA infant. We assessed prior adverse pregnancy outcome, which includes a prior preterm birth, low birth weight infant, stillbirth, or infant with anomaly as part of the multivariate analysis. Adjustment for this factor did not substantially alter results and was not included in the final models. In addition, we performed a secondary analysis restricted to nulliparous women. Results were similar in magnitude and direction to that of the entire sample for both SGA and preterm birth, providing some justification that prior pregnancy history was not a strong confounding factor.

We cannot rule out the possibility that active women were in general healthier, and therefore delivered heavier infants as compared to less active women; however, this is more likely a possibility for voluntary activity, such as sports/exercise as compared to non-voluntary activity in occupational or household/caregiving domains. Women less often have a choice whether to participate in active occupations or caring for children/elderly family members. Therefore, this limitation would be most relevant to associations between sports/exercise and birth outcome. Finally, we had limited ability to fully adjust for confounding by dietary factors, as only 62% of our population had dietary information. When total caloric intake was adjusted for in the subset for whom it was available, results did not change substantially for any analysis. Finally, overall results should be interpreted with caution given the limitation of multiple comparisons and thus, increased likelihood of significant results due to chance.

There is biologic plausibility to support findings that physical activity is safe and possibly beneficial during pregnancy. Numerous compensatory mechanisms exist that protect the fetus from hyperthermia (172, 174), decreased uterine blood flow during activity (166, 167), and potentially limited fetal oxygen availability (168). In fact, activity may exert a protective effect on the release of inflammatory factors, such as catecholamines, that may improve fetal growth and placentation (163, 254). Physical fitness and pregnancy activity have been shown to increase cardiac output, increase 24-hour nutrient delivery to the placenta, and improve placental function (163, 254, 255), which may in turn increase fetal growth. However, if insufficient calories are consumed to offset the energy expenditure associated with vigorous physical activity, the fetus may be smaller at delivery, largely from decreased fat mass (170, 254, 255). Furthermore, the physiologic association between physical activity and birth outcomes may differ by activity type, in that sports/exercise may be more vigorous than other forms of activity, such as household/caregiving activities and walking for transportation.

3.9 Generalizability

The participants in this study were pregnant Latina women recruited from an inner city population. The biologic rational supporting the association between physical activity and risk of adverse birth outcomes is likely to be similar among different populations of pregnant women. Given a true biologic association between physical activity and risk of

SGA and preterm birth and birth weight and gestational age, findings from this study will generalize to all pregnant women.

3.10 Conclusion

In summary, in this prospective study of pregnant Latina women, we found that physical activity was not associated with increased risk of preterm delivery. We found that increased household and total activity in mid pregnancy were associated with a decreased risk of SGA while mid pregnancy sports/exercise was associated with an increased risk. Overall, findings are reassuring and provide justification for the CDC's physical activity guidelines that encourage healthy pregnant women to engage in regular, moderate-level activity.

Table 3.24. Distribution of study participants according to birth outcome. Latina GDM Study, 2000-2004.

Birth outcome	Preterm birth	Small-for-gestational-age	
	N (%)	N (%)	
No	918 (88.2)	892 (85.8)	
Yes	123 (11.8)	148 (14.2)	
Total	1041	1040	
	Mean (SD)	Minimum	Maximum
Birth weight (g)	3172.4 (611.8)	214	5131
Gestational age (wks)	38.4 (2.7)	20	42

SD denotes standard deviation; g denotes grams; wks denotes weeks.

Table 3.25. Distribution of study participants according to characteristics and birth outcomes. Latina GDM Study, 2000-2004.

	Preterm birth			SGA		
	No	Yes	P	No	Yes	P
Age (years)						
16-19	305 (33.3)	47 (38.2)	0.28	293 (32.9)	59 (39.9)	0.05
20-24	348 (37.9)	38 (30.9)		329 (36.9)	57 (38.5)	
25-29	166 (18.1)	20 (16.3)		171 (19.2)	15 (10.1)	
30-40	99 (10.8)	18 (14.6)		99 (11.1)	17 (11.5)	
Employed (work or student)						
No	428 (49.2)	62 (53.0)	0.44	410 (48.5)	79 (56.4)	0.08
Yes	442 (50.8)	55 (47.0)		436 (41.5)	61 (43.6)	
Maternal education						
Less than high school	453 (54.5)	71 (66.4)	0.04	433 (53.9)	90 (67.7)	0.005
High school/tech school	270 (32.5)	29 (27.1)		272 (33.8)	27 (20.3)	
Undergrad/grad college	108 (13.0)	7 (6.5)		99 (12.3)	16 (12.0)	
Income ($)						
<15k	302 (59.2)	40 (53.3)	0.48	295 (58.0)	46 (61.3)	0.54
15-30k	155 (30.4)	28 (37.3)		159 (31.2)	24 (32.0)	
>30k	53 (10.4)	7 (9.3)		55 (10.8)	5 (6.7)	
Birthplace						
US	446 (53.5)	59 (54.6)	0.83	433 (53.7)	71 (53.4)	0.95
Puerto Rico/other	387 (46.5)	49 (45.4)		374 (46.3)	62 (46.6)	
Language preference						
English	596 (65.9)	72 (60.0)	0.20	571 (65.0)	97 (67.4)	0.57
Spanish/both	308 (34.1)	48 (40.0)		308 (35.0)	47 (32.6)	
Parous						
No	357 (38.9)	46 (37.7)	0.80	326 (36.6)	77 (52.0)	0.004
Yes	561 (61.1)	76 (62.3)		565 (63.4)	71 (48.0)	
Pre-pregnancy BMI (kg/m^2)						
Underweight (<20)	118 (13.1)	15 (12.4)	0.19	106 (12.1)	27 (18.5)	0.04
Normal (20-24.99)	327 (36.3)	56 (46.3)		332 (37.9)	51 (34.9)	
Overweight (25-29.99)	232 (25.7)	26 (21.5)		215 (24.5)	42 (28.8)	
Obese (>=30)	225 (24.9)	24 (19.8)		223 (25.5)	26 (17.8)	
Pregnancy weight gain (lb)	31.2 (15.8)	27.4 (14.5)	0.03	31.5 (15.8)	27.1 (14.3)	0.003
History adverse pregnancy outcome[a]						
No	495 (88.4)	71 (94.7)	0.12	497 (88.1)	68 (97.1)	0.02
Yes	65 (11.6)	4 (5.3)		67 (11.9)	2 (2.9)	
Cigarette use						
No	678 (80.2)	81 (72.3)	0.05	651 (79.6)	107 (77.5)	0.58
Yes	167 (19.8)	31 (27.7)		167 (20.4)	31 (22.5)	
Alcohol use						
No	838 (98.5)	111 (97.4)	0.42	811 (98.3)	137 (98.6)	1.00
Yes	13 (1.5)	3 (2.6)		14 (1.7)	2 (1.4)	
Illicit drug use						
No	805 (94.6)	107 (93.9)	0.75	782 (94.8)	129 (92.8)	0.34
Yes	46 (5.4)	7 (6.1)		43 (5.2)	10 (7.2)	
Perceived stress-early pregnancy						
Low	543 (68.7)	71 (67.6)	0.83	572 (68.4)	86 (68.8)	0.94
High	248 (31.4)	34 (32.4)		243 (31.6)	39 (31.2)	
Perceived stress-mid pregnancy						
Low	466 (72.7)	48 (70.6)	0.71	450 (74.4)	64 (61.5)	0.007
High	175 (27.3)	20 (29.4)		155 (25.6)	40 (38.5)	

Table 3.25 continued.

	Preterm birth			SGA		
	No	Yes	P	No	Yes	P
Life events-early pregnancy						
<3 life events	515 (67.0)	66 (64.7)	0.65	494 (66.0)	87 (71.9)	0.20
3+ life events	254 (33.0)	36 (35.3)		255 (34.0)	34 (28.1)	
Life events-mid pregnancy						
<3 life events	484 (76.0)	45 (66.2)	0.07	452 (75.2)	77 (74.0)	0.80
3+ life events	153 (24.0)	23 (33.8)		149 (24.8)	27 (26.0)	
Total caloric intake						
1st quartile	149 (25.6)	17 (27.0)	0.60	139 (25.2)	27 (28.7)	0.91
2nd quartile	147 (25.3)	16 (25.4)		140 (25.4)	23 (24.5)	
3rd quartile	142 (24.4)	11 (17.5)		132 (24.0)	21 (22.3)	
4th quartile	144 (24.7)	19 (30.2)		140 (25.4)	23 (24.5)	

SGA denotes small-for-gestational-age
a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women.
P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated using Chi-square test.

Table 3.26. Distribution of participants according to KPAS physical activity score in pre, early and mid pregnancy. Latina GDM Study, 2000-2004.

Type of physical activity	N	Mean (SD)	25th percentile	50th percentile	75th percentile
Sports/exercise activity					
Pre pregnancy	933	2.36 (1.2)	1.50	2.00	3.25
Early pregnancy	920	1.61 (0.7)	1.25	1.25	1.75
Mid pregnancy	716	1.61 (0.7)	1.25	1.50	1.75
Household/caregiving activity					
Pre pregnancy	965	2.50 (0.6)	2.11	2.44	2.89
Early pregnancy	954	2.28 (0.6)	1.88	2.33	2.67
Mid pregnancy	720	2.27 (0.6)	1.88	2.33	2.67
Occupational activity					
Pre pregnancy	938	2.44 (1.1)	1.00	2.57	3.29
Early pregnancy	930	1.87 (1.0)	1.00	1.00	2.71
Mid pregnancy	706	1.73 (1.0)	1.00	1.00	2.57
Active transportation					
Pre pregnancy	942	2.70 (0.8)	2.25	2.75	3.25
Early pregnancy	925	2.29 (0.8)	1.75	2.25	3.00
Mid pregnancy	720	2.43 (0.7)	1.75	2.50	3.00
Total activity[b]					
Pre pregnancy	910	10.10 (1.9)	8.82	10.10	11.39
Early pregnancy	903	8.69 (1.7)	7.52	8.56	9.79
Mid pregnancy	700	8.66 (1.7)	7.50	8.61	9.85

a=KPAS scores range from 1-5, with 5 being the highest amount of activity.
b=Total activity was weighted by the contribution of each activity toward the total.
SD denotes standard deviation.

Table 3.27. Distribution of participants according to characteristics and sports/exercise participation. Latina GDM Study, 2000-2004.

	Sports/exercise participation				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Age (years)					
16-19	75 (35.6)	95 (37.0)	58 (29.4)	93 (36.5)	0.38
20-24	79 (37.4)	95 (37.0)	72 (36.6)	97 (38.0)	
25-29	36 (17.1)	40 (15.6)	48 (24.4)	37 (14.5)	
30-40	21 (10.0)	27 (10.5)	19 (9.6)	28 (11.0)	
Employed (work, volunteer, student)					
No	118 (55.9)	115 (45.1)	96 (48.7)	121 (47.6)	0.12
Yes	93 (44.1)	140 (54.9)	101 (51.3)	133 (52.4)	
Maternal education					
Less than high school	124 (60.2)	118 (49.2)	106 (57.3)	141 (58.8)	0.30
High school/tech school	59 (28.6)	89 (37.1)	55 (29.7)	72 (30.0)	
Undergrad/grad college	23 (11.2)	33 (13.8)	24 (13.0)	27 (11.3)	
Income ($)					
<15k	96 (68.1)	80 (53.0)	64 (62.1)	81 (54.0)	0.11
15-30k	35 (24.8)	56 (37.1)	27 (26.2)	51 (34.0)	
>30k	10 (7.1)	15 (9.9)	12 (11.7)	18 (12.0)	
Birthplace					
US	105 (50.7)	126 (52.5)	109 (58.3)	130 (53.9)	0.48
Puerto Rico/other	102 (49.3)	114 (47.5)	78 (41.7)	111 (46.1)	
Language preference					
English	131 (62.1)	167 (66.0)	127 (65.1)	173 (68.1)	0.59
Spanish/both	80 (37.9)	86 (34.0)	68 (34.9)	81 (31.9)	
Parous					
No	85 (40.3)	109 (42.6)	63 (32.0)	109 (42.8)	0.08
Yes	126 (59.7)	147 (57.4)	134 (68.0)	146 (57.2)	
Pre-pregnancy BMI (kg/m^2)					
Underweight (<20)	37 (17.7)	32 (12.6)	20 (10.2)	33 (13.2)	0.32
Normal (20-24.99)	74 (35.4)	89 (35.0)	77 (39.1)	101 (40.4)	
Overweight (25-29.99)	46 (22.0)	74 (29.1)	45 (22.8)	57 (22.8)	
Obese (>=30)	52 (24.9)	59 (23.2)	55 (27.9)	59 (23.6)	
Pregnancy weight gain (lb)	29.8 (15.3)	30.3 (14.7)	30.6 (16.0)	32.3 (16.8)	0.40
History adverse pregnancy outcome[a]					
No	136 (91.9)	152 (91.0)	136 (91.3)	140 (87.8)	0.55
Yes	12 (8.1)	15 (9.0)	13 (8.7)	20 (12.5)	
Cigarette use					
No	153 (73.6)	201 (80.7)	156 (80.4)	200 (80.3)	0.20
Yes	55 (26.4)	48 (19.3)	38 (19.6)	49 (19.7)	
Alcohol use					
No	203 (97.1)	248 (99.2)	191 (98.0)	248 (98.8)	0.31
Yes	6 (2.9)	2 (0.80)	4 (2.0)	3 (1.20)	
Illicit drug use					
No	197 (94.3)	236 (94.4)	187 (95.9)	233 (92.8)	0.59
Yes	12 (5.7)	14 (5.6)	8 (4.1)	18 (7.2)	
Perceived stress-early pregnancy					
Low	116 (56.9)	164 (66.7)	151 (77.8)	182 (72.8)	<0.0001
High	88 (43.1)	82 (33.3)	43 (22.2)	68 (27.2)	
Perceived stress-mid pregnancy					
Low	106 (69.3)	135 (71.8)	101 (76.5)	126 (71.6)	0.59
High	47 (30.7)	53 (28.2)	31 (23.5)	50 (28.40	

Table 3.27 continued.

	Sports/exercise participation				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Life events-early pregnancy					
<3 life events	126 (63.0)	169 (71.0)	127 (67.9)	159 (65.2)	0.31
3+ life events	74 (37.0)	69 (29.0)	60 (32.1)	85 (34.8)	
Life events-mid pregnancy					
<3 life events	113 (73.9)	141 (75.0)	103 (80.5)	130 (73.5)	0.50
3+ life events	40 (26.1)	47 (25.0)	25 (19.5)	47 (26.5)	
Total caloric intake					
1st quartile	36 (25.7)	47 (28.1)	37 (30.1)	33 (19.8)	0.28
2nd quartile	28 (20.0)	46 (27.5)	26 (21.1)	50 (29.9)	
3rd quartile	36 (25.7)	40 (24.0)	28 (22.8)	37 (22.2)	
4th quartile	40 (28.6)	34 (20.4)	32 (26.0)	47 (28.1)	

a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women.

P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated using Chi-square test.

Table 3.28. Distribution of participants according to characteristics and household/caregiving activity. Latina GDM Study, 2000-2004.

	Household/caregiving activity				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Age (years)					
16-19	155 (55.4)	76 (40.9)	66 (25.4)	35 (15.4)	<0.0001
20-24	76 (27.1)	67 (36.0)	115 (44.2)	93 (40.8)	
25-29	34 (12.1)	25 (13.4)	50 (19.2)	61 (26.7)	
30-40	15 (5.4)	18 (9.7)	29 (11.2)	39 (17.1)	
Employed (work, volunteer, student)					
No	138 (50.2)	86 (47.0)	124 (47.9)	115 (51.1)	0.81
Yes	137 (49.8)	97 (53.0)	135 (52.1)	110 (48.9)	
Maternal education					
Less than high school	170 (64.4)	106 (60.6)	122 (50.2)	100 (47.6)	0.002
High school/tech school	72 (27.3)	55 (31.4)	76 (31.3)	80 (38.1)	
Undergrad/grad college	22 (8.3)	14 (8.0)	45 (18.5)	30 (14.3)	
Income ($)					
<15k	94 (64.0)	58 (56.3)	93 (59.2)	81 (52.9)	0.28
15-30k	45 (30.6)	34 (33.0)	45 (28.7)	52 (34.0)	
>30k	8 (5.4)	11 (10.7)	19 (12.1)	20 (13.1)	
Birthplace					
US	150 (56.8)	102 (57.6)	115 (47.3)	118 (55.9)	0.09
Puerto Rico/other	114 (43.2)	75 (42.4)	128 (52.7)	93 (44.1)	
Language preference					
English	182 (65.7)	131 (70.4)	164 (63.6)	145 (64.7)	0.48
Spanish/both	95 (34.3)	55 (29.6)	94 (36.4)	79 (35.3)	
Parous					
No	191 (68.2)	86 (46.2)	75 (28.9)	26 (11.4)	<0.0001
Yes	89 (31.8)	100 (53.8)	185 (71.1)	201 (88.6)	
Pre-pregnancy BMI (kg/m^2)					
Underweight (<20)	44 (15.9)	18 (9.7)	35 (13.6)	28 (12.4)	0.10
Normal (20-24.99)	113 (40.9)	71 (38.4)	87 (33.9)	83 (36.9)	
Overweight (25-29.99)	72 (26.1)	47 (25.4)	64 (24.9)	51 (22.7)	
Obese (>=30)	47 (17.0)	49 (26.5)	71 (27.6)	63 (28.0)	
Pregnancy weight gain (lb)	32.7 (16.8)	31.7 (15.7)	29.7 (14.1)	29.3 (16.1)	0.08
History adverse pregnancy outcome					
No	89 (89.9)	100 (91.7)	197 (92.9)	200 (87.7)	0.29
Yes	10 (10.1)	9 (8.3)	15 (7.1)	28 (12.3)	
Cigarette use					
No	225 (84.0)	140 (78.7)	200 (80.0)	158 (72.5)	0.02
Yes	43 (16.0)	38 (21.3)	50 (20.0)	60 (27.5)	
Alcohol use					
No	270 (98.9)	176 (98.9)	246 (98.0)	215 (97.7)	0.71
Yes	3 (1.1)	2 (1.1)	5 (2.0)	5 (2.3)	
Illicit drug use					
No	256 (93.8)	166 (93.3)	239 (95.2)	209 (95.0)	0.78
Yes	17 (6.2)	12 (6.7)	12 (4.8)	11 (5.0)	
Perceived stress-early pregnancy					
Low	173 (65.8)	126 (71.2)	177 (72.2)	136 (65.4)	0.26
High	90 (34.2)	51 (28.8)	68 (27.8)	72 (34.6)	
Perceived stress-mid pregnancy					
Low	134 (67.0)	110 (82.7)	139 (75.5)	98 (66.2)	0.003
High	66 (33.0)	23 (17.3)	45 (24.5)	50 (33.8)	
Life events-early pregnancy					
<3 life events	167 (65.2)	119 (68.8)	162 (68.4)	131 (64.9)	0.76
3+ life events	89 (34.8)	54 (31.2)	75 (31.6)	71 (35.1)	

Table 3.28 continued.

	Household/caregiving activity				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Life events-mid pregnancy					
<3 life events	148 (74.4)	99 (75.0)	149 (81.0)	102 (69.4)	0.11
3+ life events	51 (25.6)	33 (25.0)	35 (19.0)	45 (30.6)	
Total caloric intake					
1st quartile	49 (27.8)	36 (28.8)	43 (25.0)	28 (20.4)	0.02
2nd quartile	34 (19.3)	38 (30.4)	50 (29.1)	31 (22.6)	
3rd quartile	43 (24.4)	20 (16.0)	50 (29.1)	35 (25.6)	
4th quartile	50 (28.4)	31 (24.8)	29 (16.9)	43 (31.4)	

a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women.
P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated using Chi-square test.

Table 3.29. Distribution of participants according to characteristics and occupational activity. Latina GDM Study, 2000-2004.

	Occupational activity			
	1st group	2nd group	3rd group	P
Age (years)				
16-19	177 (36.0)	75 (35.9)	75 (32.8)	0.47
20-24	180 (36.6)	70 (33.5)	91 (39.7)	
25-29	88 (17.9)	42 (20.1)	33 (14.4)	
30-40	47 (9.5)	22 (10.5)	30 (13.10	
Employed (work or student)				
No	458 (93.1)	0 (0)	0 (0)	<0.0001
Yes	34 (6.9)	209 (100)	229 (100)	
Maternal education				
Less than high school	314 (67.8)	85 (43.4)	93 (43.3)	<0.0001
High school/tech school	108 (23.3)	81 (41.3)	86 (40.0)	
Undergrad/grad college	41 (8.9)	30 (15.3)	36 (16.7)	
Income ($)				
<15k	199 (71.8)	50 (38.8)	73 (51.0)	<0.0001
15-30k	57 (20.6)	63 (48.8)	51 (35.7)	
>30k	21 (7.6)	16 (12.4)	19 (13.3)	
Birthplace				
US	241 (51.9)	119 (59.8)	113 (52.8)	0.16
Puerto Rico/other	223 (48.1)	80 (40.2)	101 (47.2)	
Language preference				
English	303 (62.0)	151 (73.0)	149 (66.0)	0.02
Spanish/both	186 (38.0)	56 (27.0)	77 (34.0)	
Parous				
No	179 (36.4)	89 (42.6)	102 (44.7)	0.07
Yes	313 (63.6)	120 (57.4)	126 (55.3)	
Pre-pregnancy BMI (kg/m^2)				
Underweight (<20)	62 (12.8)	25 (12.0)	33 (14.6)	0.85
Normal (20-24.99)	177 (36.4)	84 (40.4)	83 (36.7)	
Overweight (25-29.99)	120 (24.7)	54 (26.0)	54 (23.9)	
Obese (>=30)	127 (26.1)	45 (21.6)	56 (24.8)	
Pregnancy weight gain (lb)	29.6 (15.6)	31.5 (16.4)	32.6 (15.1)	0.05
History adverse pregnancy outcome[a]				
No	320 (91.2)	126 (94.0)	127 (86.4)	0.08
Yes	31 (8.8)	8 (6.0)	20 (13.6)	
Cigarette use				
No	351 (73.7)	165 (82.5)	194 (87.8)	<0.0001
Yes	125 (26.3)	35 (17.5)	27 (12.2)	
Alcohol use				
No	467 (97.5)	200 (99.0)	223 (99.6)	0.12
Yes	12 (2.5)	2 (1.0)	1 (0.4)	
Illicit drug use				
No	447 (93.3)	193 (95.5)	214 (95.5)	0.35
Yes	32 (6.7)	9 (4.5)	10 (4.5)	
Perceived stress-early pregnancy				
Low	302 (64.7)	147 (76.2)	156 (70.3)	0.01
High	165 (35.3)	46 (23.8)	66 (29.7)	
Perceived stress-mid pregnancy				
Low	237 (67.9)	115 (82.1)	115 (71.9)	0.007
High	112 (32.1)	25 (17.9)	45 (28.1)	
Life events-early pregnancy				
<3 life events	289 (63.7)	150 (78.1)	136 (64.10	0.001
3+ life events	165 (36.3)	42 (21.9)	76 (35.9)	

Table 3.29 continued.

	Occupational activity			
	1st group	2nd group	3rd group	P
Life events-mid pregnancy				
<3 life events	248 (71.3)	116 (83.5)	121 (76.1)	0.02
3+ life events	100 (28.7)	23 (16.5)	38 (23.9)	
Total caloric intake				
1st quartile	86 (27.7)	34 (27.0)	32 (20.0)	0.70
2nd quartile	73 (23.5)	33 (26.2)	43 (26.9)	
3rd quartile	74 (23.8)	29 (23.0)	41 (25.6)	
4th quartile	78 (25.1)	30 (23.8)	44 (27.5)	

a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women.

P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated calculated using Chi-square test.

Table 3.30. Distribution of participants according to characteristics and active transportation. Latina GDM Study, 2000-2004.

	Active living				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Age (years)					
16-19	76 (34.6)	90 (32.5)	73 (38.2)	85 (35.9)	0.69
20-24	80 (36.4)	102 (36.8)	65 (34.0)	95 (40.1)	
25-29	42 (19.1)	56 (20.2)	29 (15.2)	35 (14.8)	
30-40	22 (10.0)	29 (10.5)	24 (12.6)	22 (9.3)	
Employed (work or student)					
No	110 (50.2)	127 (46.2)	98 (51.3)	118 (49.8)	0.69
Yes	109 (49.8)	148 (53.8)	93 (48.7)	119 (50.2)	
Maternal education					
Less than high school	120 (58.2)	135 (51.5)	104 (58.8)	130 (56.8)	0.68
High school/tech school	65 (31.6)	90 (34.4)	51 (28.8)	70 (30.6)	
Undergrad/grad college	21 (10.2)	37 (14.1)	22 (12.4)	29 (12.7)	
Income ($)					
<15k	74 (57.8)	91 (54.2)	69 (66.4)	86 (58.5)	0.62
15-30k	40 (31.3)	57 (33.9)	28 (26.9)	46 (31.3)	
>30k	14 (10.9)	20 (11.9)	7 (6.7)	15 (10.2)	
Birthplace					
US	115 (55.3)	133 (50.4)	98 (55.4)	126 (55.0)	0.63
Puerto Rico/other	93 (44.7)	131 (49.6)	79 (44.6)	103 (45.0)	
Language preference					
English	139 (63.8)	171 (62.2)	129 (68.2)	162 (68.6)	0.35
Spanish/both	79 (36.2)	104 (37.8)	60 (31.8)	74 (31.4)	
Parous					
No	80 (36.5)	104 (37.6)	90 (47.1)	95 (40.1)	0.12
Yes	139 (63.5)	173 (62.4)	101 (52.9)	142 (59.9)	
Pre-pregnancy BMI (kg/m^2)					
Underweight (<20)	39 (17.8)	31 (11.3)	24 (12.8)	27 (11.5)	0.06
Normal (20-24.99)	77 (35.3)	100 (36.5)	80 (42.6)	86 (36.6)	
Overweight (25-29.99)	50 (22.9)	82 (29.9)	44 (23.4)	50 (21.3)	
Obese (>=30)	52 (23.9)	61 (22.3)	40 (21.3)	72 (30.6)	
Pregnancy weight gain (lb)	31.1 (15.8)	32.1 (16.3)	28.5 (14.6)	30.7 (15.6)	0.17
History adverse pregnancy outcome					
No	144 991/7)	170 (91.4)	110 (87.3)	143 (90.5)	0.59
Yes	13 (8.3)	16 (8.6)	16 (12.7)	15 (9.5)	
Cigarette use					
No	163 (76.9)	214 (80.2)	154 (82.3)	180 (76.9)	0.45
Yes	49 (23.1)	53 (19.8)	33 (17.7)	54 (23.1)	
Alcohol use					
No	21 (97.7)	267 (98.9)	184 (98.4)	230 (98.3)	0.79
Yes	5 (2.3)	3 (1.1)	3 (1.6)	4 (1.7)	
Illicit drug use					
No	205 (94.9)	257 (95.2)	178 (95.2)	215 (91.9)	0.34
Yes	11 (5.1)	13 (4.8)	9 (4.8)	19 (8.1)	
Perceived stress-early pregnancy					
Low	126 (60.3)	196 (73.4)	129 (70.9)	160 (68.4)	0.02
High	83 (39.7)	71 (26.6)	53 (29.1)	74 (31.6)	
Perceived stress-mid pregnancy					
Low	111 (71.1)	148 (75.5)	95 (73.6)	117 (68.8)	0.52
High	45 (28.9)	48 (24.5)	34 (26.4)	53 (31.2)	

Table 3.30 continued.

	Active living				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Life events-early pregnancy					
<3 life events	141 (68.4)	193 (73.7)	115 (65.3)	130 (58.3)	0.004
3+ life events	65 (31.6)	69 (26.3)	61 (34.7)	93 (41.7)	
Life events-mid pregnancy					
<3 life events	117 (74.5)	150 (76.9)	94 (74.6)	127 (74.7)	0.94
3+ life events	40 (25.5)	45 (32.1)	32 (25.4)	43 (25.3)	
Total caloric intake					
1st quartile	34 (24.8)	51 (27.8)	28 (23.3)	40 (25.5)	0.47
2nd quartile	36 (26.3)	48 (26.2)	37 (30.8)	29 (18.5)	
3rd quartile	35 (25.5)	42 (23.0)	23 (19.2)	42 (26.7)	
4th quartile	32 (23.4)	42 (23.0)	32 (26.7)	46 (29.3)	

a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women. P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated using Chi-square test.

Table 3.31. Distribution of participants according to characteristics and total activity. Latina GDM Study, 2000-2004.

	Total activity				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Age (years)					
16-19	124 (53.7)	80 (33.8)	65 (30.2)	46 (20.9)	<0.0001
20-24	60 (26.0)	101 (42.6)	81 (37.7)	92 (41.8)	
25-29	31 (13.4)	40 (16.9)	41 (19.1)	48 (21.8)	
30-40	16 (6.9)	16 (6.8)	28 (13.0)	34 (15.5)	
Employed (work, volunteer, student)					
No	174 (75.3)	134 (56.5)	84 (39.1)	50 (22.70	<0.0001
Yes	57 (24.7)	103 (43.5)	131 (60.9)	170 (77.3)	
Maternal education					
Less than high school	153 (69.2)	122 (55.5)	110 (53.7)	95 (45.5)	<0.0001
High school/tech school	55 (24.9)	72 (32.7)	73 (35.6)	71 (34.0)	
Undergrad/grad college	13 (5.9)	26 (11.8)	22 (10.7)	43 (20.6)	
Income ($)					
<15k	82 (70.1)	85 (60.3)	76 (57.6)	74 (50.0)	0.037
15-30k	25 (21.4)	46 (32.6)	43 (32.6)	53 (35.8)	
>30k	10 (8.6)	10 (7.1)	13 (9.9)	21 (14.2)	
Birthplace					
US	124 (55.9)	119 (54.1)	102 (49.0)	118 (56.5)	0.41
Puerto Rico/other	98 (44.1)	101 (45.9)	106 (51.0)	91 (43.5)	
Language preference					
English	140 (61.1)	164 (69.2)	138 (64.8)	144 (66.40	0.32
Spanish/both	89 (38.9)	73 (30.8)	75 (35.2)	73 (33.6)	
Parous					
No	131 (56.7)	99 (41.8)	79 (36.7)	51 (23.3)	<0.0001
Yes	100 (43.3)	138 (58.2)	136 (63.3)	168 (76.7)	
Pre-pregnancy BMI (kg/m^2)					
Underweight (<20)	36 (15.8)	35 (14.9)	19 (8.9)	27 (12.4)	0.36
Normal (20-24.99)	91 (39.9)	81 (34.5)	84 (39.4)	80 (36.9)	
Overweight (25-29.99)	55 (24.1)	62 (26.4)	50 (23.5)	51 (23.5)	
Obese (>=30)	46 (20.2)	57 (24.3)	60 (28.2)	59 (27.2)	
Pregnancy weight gain (lb)	32.0 (17.1)	30.3 (14.6)	30.6 (14.9)	30.5 (16.4)	0.67
History adverse pregnancy outcome[a]					
No	101 (92.7)	141 (91.6)	141 (90.4)	172 (88.7)	0.67
Yes	8 97.3)	13 (8.4)	15 (9.6)	22 (11.3)	
Cigarette use					
No	181 (79.0)	171 (75.3)	173 (82.4)	173 (79.7)	0.34
Yes	48 (21.0)	56 (24.7)	37 (17.6)	44 (20.30	
Alcohol use					
No	226 (98.3)	224 (97.4)	206 (98.1)	217 (99.5)	0.31
Yes	4 (1.7)	6 (2.6)	4 (1.9)	1 (0.5)	
Illicit drug use					
No	215 (93.5)	214 (93.0)	203 (96.7)	205 (94.0)	0.37
Yes	15 (6.5)	16 (7.0)	7 (3.3)	13 (6.0)	
Perceived stress-early pregnancy					
Low	144 (63.4)	157 (68.6)	139 (68.5)	160 (73.4)	0.16
High	83 (36.6)	72 (31.4)	64 (31.5)	58 (26.6)	
Perceived stress-mid pregnancy					
Low	116 (70.30	122 (70.1)	119 (75.3)	98 (71.5)	0.71
High	49 (29.7)	52 (29.9)	39 (24.7)	39 (28.5)	

Table 3.31 continued.

	Total activity				
	1st quartile	2nd quartile	3rd quartile	4th quartile	P
Life events-early pregnancy					
<3 life events	140 (63.9)	167 (74.6)	139 (67.8)	126 (61.5)	0.02
3+ life events	79 (36.1)	57 (25.5)	66 (32.3)	79 (38.5)	
Life events-mid pregnancy					
<3 life events	122 (73.9)	134 (77.5)	114 (74.0)	107 (77.0)	0.82
3+ life events	43 (26.1)	39 (22.5)	40 (26.0)	32 (23.0)	
Total caloric intake					
1st quartile	44 (28.8)	43 (28.1)	38 (28.2)	25 (17.4)	0.21
2nd quartile	32 (20.9)	35 (22.9)	41 (30.4)	36 (25.0)	
3rd quartile	36 (23.5)	38 (24.8)	26 (19.3)	40 (27.8)	
4th quartile	41 (26.8)	37 (24.2)	30 (22.2)	43 (29.9)	

a=Prior preterm, low birth weight, stillbirth, or infant with anomalies. Association restricted to parous women.
P-values for cells with N<5 were calculated using Fisher's exact test, all others calculated using Chi-square test.

Table 3.32. Risk of preterm birth by type and timing of physical activity: Unadjusted odds ratios and 95% confidence intervals. Latina GDM Study, 2000-2004.

	Pre pregnancy			Early pregnancy			Mid pregnancy		
	N	Cases	OR (95% C.I.)	N	Cases	OR (95% C.I.)	N	Cases	OR (95% C.I.)
Sports/exercise									
1st quartile	232	31	Ref	211	23	Ref	143	16	Ref
2nd quartile	261	31	0.87 (0.51, 1.49)	257	34	1.25 (0.71, 2.19)	180	12	0.57 (0.26, 1.24)
3rd quartile	213	18	0.60 (0.32, 1.11)	197	16	0.72 (0.37, 1.41)	201	20	0.89 (0.44, 1.76)
4th quartile	227	28	0.91 (0.53, 1.58)	255	35	1.30 (0.74, 2.28)	192	20	0.92 (0.46, 1.85)
P_{trend}			0.5			0.66			0.81
Household/ caregiving									
1st quartile	268	32	Ref	280	38	Ref	160	17	Ref
2nd quartile	215	23	0.88 (0.50, 1.56)	186	21	0.81 (0.46, 1.43)	192	20	0.98 (0.49, 1.94)
3rd quartile	267	27	0.83 (0.48, 1.43)	260	23	0.62 (0.36, 1.07)	200	18	0.83 (0.41, 1.67)
4th quartile	215	31	1.24 (0.73, 2.11)	228	29	0.93 (0.55, 1.56)	168	14	0.77 (0.36, 1.61)
P_{trend}			0.54			0.5			0.41
Occupational[a]									
1st group	257	34	Ref	492	61	Ref	421	41	Ref
2nd group	197	15	0.54 (0.29, 1.02)	209	22	0.83 (0.50, 1.39)	100	13	1.39 (0.71, 2.70)
3rd group	262	40	1.18 (0.72, 1.94)	229	28	0.98 (0.61, 1.59)	185	14	0.76 (0.40, 1.43)
4th group	222	21	0.69 (0.39, 1.22)						
P_{trend}			0.68			0.85			0.53
Active transportation									
1st quartile	235	30	Ref	220	31	Ref	184	20	Ref
2nd quartile	200	20	0.76 (0.42, 1.38)	277	26	0.63 (0.36, 1.10)	138	13	0.85 (0.41, 1.78)
3rd quartile	304	43	1.13 (0.68, 1.86)	191	21	0.75 (0.42, 1.36)	182	19	0.96 (0.49, 1.86)
4th quartile	203	18	0.67 (0.36, 1.23)	237	32	0.95 (0.56, 1.62)	216	17	0.70 (0.36, 1.38)
P_{trend}			0.52			0.92			0.37
Total activity									
1st quartile	236	26	Ref	231	30	Ref	177	19	Ref
2nd quartile	228	28	1.13 (0.64, 2.00)	237	31	1.01 (0.59, 1.73)	170	15	0.81 (0.40, 1.64)
3rd quartile	221	26	1.08 (0.60, 1.92)	215	21	0.73 (0.40, 1.31)	179	18	0.93 (0.47, 1.84)
4th quartile	225	27	1.10 (0.62, 1.95)	220	26	0.90 (0.51, 1.57)	174	15	0.79 (0.39, 1.60)
P_{trend}			0.41			0.75			0.96

a=Referent group is non-working women; only 3 groups were created for early and mid pregnancy because only 50% of women were working.

Table 3.33. Risk of preterm birth by change in physical activity from pre to early pregnancy: Unadjusted and adjusted odds ratios and 95% confidence intervals. Latina GDM Study, 2000-2004.

	N	Cases	OR	95% CI	OR[a]	95% CI
Sports/exercise change						
25% decrease or greater	394	43	Ref	Ref	Ref	Ref
5%-25% decrease	123	14	1.05	0.55, 1.99	1.07	0.53, 2.16
5% decrease to 5% increase	241	29	1.11	0.68, 1.84	1.24	0.62, 2.47
5% increase or greater	115	14	1.13	0.60, 2.15	1.43	0.67, 3.06
P_{trend}			0.62		0.35	
Household change						
25% decrease or greater	142	19	Ref	Ref	Ref	Ref
5%-25% decrease	320	43	1.00	0.56, 1.79	1.22	0.66, 2.26
5% decrease to 5% increase	278	27	0.70	0.37, 1.30	0.91	0.46, 1.78
5% increase or greater	174	15	0.61	0.30, 1.25	0.65	0.29, 1.45
P_{trend}			0.07		0.16	
Occupational change						
25% decrease or greater	308	35	Ref	Ref	Ref	Ref
5%-25% decrease	92	13	1.29	0.65, 2.55	1.40	0.68, 2.89
5% decrease to 5% increase	323	40	1.11	0.68, 1.79	1.18	0.64, 2.15
5% increase or greater	152	14	0.79	0.41, 1.53	0.93	0.44, 1.94
P_{trend}			0.71		0.94	
Active living change						
25% decrease or greater	277	29	Ref	Ref	Ref	Ref
5%-25% decrease	217	27	1.22	0.70, 2.13	1.39	0.78, 2.48
5% decrease to 5% increase	202	31	1.56	0.91, 2.68	1.51	0.83, 2.77
5% increase or greater	179	15	0.79	0.41, 1.51	0.70	0.33, 1.47
P_{trend}			0.94		0.64	
Total activity change						
25% decrease or greater	202	33	Ref	Ref	Ref	Ref
5%-25% decrease	357	32	0.50	0.30, 0.85	0.53	0.31, 0.94
5% decrease to 5% increase	178	24	0.80	0.45, 1.41	0.92	0.48, 1.77
5% increase or greater	102	10	0.56	0.26, 1.18	0.74	0.32, 1.69
P_{trend}			0.25		0.41	

a= Adjusted for maternal age, education, pre-pregnancy BMI, and pre-pregnancy activity level

Table 3.34. Risk of SGA by type and timing of physical activity: Unadjusted and adjusted odds ratios and 95% confidence intervals. Latina GDM Study, 2000-2004.

	Pre pregnancy			Early pregnancy			Mid pregnancy		
	N	Cases	OR (95% C.I.)	N	Cases	OR (95% C.I.)	N	Cases	OR (95% C.I.)
Sports/exercise									
1st quartile	232	45	Ref	211	33	Ref	143	12	Ref
2nd quartile	261	33	0.60 (0.37, 0.98)	257	39	0.97 (0.58, 1.60)	180	36	2.73 (1.36, 5.47)
3rd quartile	213	25	0.55 (0.33, 0.94)	197	24	0.75 (0.43, 1.32)	201	26	1.62 (0.79, 3.33)
4th quartile	227	30	0.64 (0.38, 1.05)	255	34	0.83 (0.49, 1.39)	192	32	2.18 (1.08, 4.41)
p-trend			0.07			0.35			0.22
Household/ caregiving									
1st quartile	268	43	Ref	280	43	Ref	160	33	Ref
2nd quartile	215	30	0.85 (0.51, 1.41)	186	28	0.98 (0.58, 1.64)	192	33	0.80 (0.47, 1.37)
3rd quartile	267	34	0.77 (0.47, 1.250	260	35	0.86 (0.53, 1.40)	200	21	0.45 (0.25, 0.82)
4th quartile	215	29	0.82 (0.49, 1.36)	228	25	0.68 (0.40, 1.15)	168	19	0.49 (0.27, 0.91)
p-trend			0.35			0.14			0.004
Occupational[a]									
1st group	257	42	Ref	492	77	Ref	421	68	Ref
2nd group	197	32	1.00 (0.60, 1.65)	209	24	0.70 (0.43, 1.14)	100	9	0.51 (0.25, 1.07)
3rd group	262	30	0.66 (0.40, 1.10)	229	28	0.75 (0.47, 1.19)	185	25	0.81 (0.49, 1.33)
4th group	222	29	0.77 (0.46, 1.28)						
p-trend			0.14			0.15			0.27
Active transportation									
1st quartile	235	39	Ref	220	33	Ref	184	31	Ref
2nd quartile	200	29	0.85 (0.51, 1.44)	277	30	0.69 (0.40, 1.16)	138	25	1.09 (0.61, 1.95)
3rd quartile	304	42	0.81 (0.50, 1.30)	191	35	1.27 (0.75, 2.13)	182	23	0.71 (0.40, 1.28)
4th quartile	203	25	0.71 (0.41, 1.21)	237	30	0.82 (0.48, 1.39)	216	27	0.71 (0.40, 1.23)
p-trend			0.20			0.99			0.12
Total activity									
1st quartile	236	47	Ref	231	36	Ref	177	37	Ref
2nd quartile	228	25	0.50 (0.29, 0.84)	237	38	1.03 (0.63, 1.70)	170	31	0.84 (0.50, 1.44)
3rd quartile	221	25	0.52 (0.31, 0.87)	215	22	0.62 (0.35, 1.09)	179	19	0.45 (0.25, 0.82)
4th quartile	225	32	0.67 (0.41, 1.09)	220	29	0.82 (0.49, 1.40)	174	15	0.36 (0.19, 0.68)
p-trend			0.10			0.21			0.0002

a=Referent group is non-working women; only 3 groups were created for early and mid pregnancy because only 50% of women were working.

Table 3.35. Risk of SGA by change in physical activity from pre to early pregnancy: Unadjusted and adjusted odds ratios and 95% confidence intervals. Latina GDM Study, 2000-2004.

	N	Cases	Unadjusted OR	95% CI	Adjusted OR[a]	95% CI
Sports/exercise change						
25% decrease or greater	394	53	1.00	Ref	1.00	Ref
5%-25% decrease	123	21	1.33	0.76, 2.30	1.09	0.59, 2.02
5% decrease to 5% increase	241	33	1.02	0.64, 1.63	0.67	0.35, 1.29
5% increase or greater	115	18	1.19	0.67, 2.13	0.75	0.36, 1.55
P_{trend}				0.67		0.30
Household change						
25% decrease or greater	142	27	1.00	Ref	1.00	Ref
5%-25% decrease	320	39	0.59	0.35, 1.01	0.63	0.36, 1.12
5% decrease to 5% increase	278	31	0.54	0.31, 0.94	0.67	0.36, 1.23
5% increase or greater	174	32	0.96	0.54, 1.69	1.04	0.84, 2.00
P_{trend}				0.98		0.76
Occupational change						
25% decrease or greater	308	44	1.00	Ref	1.00	Ref
5%-25% decrease	92	10	0.73	0.35, 1.52	0.70	0.32, 1.54
5% decrease to 5% increase	323	46	1.01	0.64, 1.56	0.84	0.48, 1.48
5% increase or greater	152	23	1.07	0.62, 1.85	1.04	0.55, 1.54
P_{trend}				0.79		0.92
Active living change						
25% decrease or greater	277	31	1.00	Ref	1.00	Ref
5%-25% decrease	217	32	1.37	0.81, 2.33	1.32	0.76, 2.27
5% decrease to 5% increase	202	36	1.72	1.02, 2.89	1.67	0.90, 2.93
5% increase or greater	179	25	1.29	0.73, 2.26	1.25	0.67, 2.32
P_{trend}				0.20		0.31
Total activity change						
25% decrease or greater	202	26	1.00	Ref	1.00	Ref
5%-25% decrease	357	53	1.18	0.71, 1.96	1.10	0.64, 1.89
5% decrease to 5% increase	178	28	1.26	0.71, 2.25	1.21	0.63, 2.33
5% increase or greater	102	10	0.74	0.34, 1.59	0.73	0.30, 1.75
P_{trend}				0.74		0.75

a = Adjusted for maternal age, pre-pregnancy BMI, parity, maternal education and pre-pregnancy activity level.

Table 3.36. Multivariable adjusted risk of preterm birth by type and timing of physical activity: Adjusted odds ratios and 95% C.I.s. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
	OR	95% CI	OR	95% CI	OR	95% CI
Sports/exercise activity[a]	N=889		N=865		N=689	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.86	0.49, 1.52	1.39	0.77, 2.51	0.51	0.23, 1.15
3rd quartile	0.62	0.33, 1.18	0.79	0.39, 1.58	0.74	0.36, 1.51
4th quartile	0.93	0.52, 1.66	1.37	0.76, 2.47	0.83	0.41, 1.68
P_{trend}		0.6		0.6		0.91
Household/caregiving activity[b]	N=903		N=886		N=693	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.92	0.50, 1.72	0.88	0.48, 1.61	0.84	0.40, 1.76
3rd quartile	0.95	0.51, 1.75	0.72	0.40, 1.32	0.84	0.40, 1.80
4th quartile	1.37	0.74, 2.55	0.94	0.50, 1.75	0.74	0.32, 1.73
P_{trend}		0.35		0.65		0.52
Occupational activity[a,c]	N=884		N=868		N=680	
1st group	1.00	Ref	1.00	Ref	1.00	Ref
2nd group	0.65	0.33, 1.29	1.02	0.59, 1.77	1.60	0.80, 3.17
3rd group	1.42	0.83, 2.42	1.24	0.74, 2.06	0.90	0.47, 1.72
4th group	0.89	0.48, 1.65				
P_{trend}		0.64		0.44		0.94
Active transportation activity[a]	N=892		N=868		N=693	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.81	0.42, 1.54	0.56	0.31, 1.02	0.98	0.46, 2.09
3rd quartile	1.25	0.73, 2.14	0.77	0.42, 1.43	0.92	0.46, 1.87
4th quartile	0.76	0.40, 1.46	0.97	0.56, 1.69	0.77	0.38, 1.55
		0.86		0.77		0.45
Total activity[b]	N=868		N=849		N=674	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	1.25	0.68, 2.28	1.05	0.59, 1.87	0.85	0.40, 1.81
3rd quartile	1.34	0.72, 2.50	0.79	0.43, 1.48	1.04	0.50, 2.13
4th quartile	1.29	0.69, 2.40	0.99	0.54, 1.83	0.96	0.45, 2.05
		0.41		0.75		0.96

a= Adjusted for age, education and pre-pregnancy BMI.
b= Adjusted for age, education, pre-pregnancy BMI, and parity.
c= 1st group (referent group) is composed of those who are not employed. Only three groups were created for early and mid pregnancy because 50% were not employed.

Table 3.37. Multivariable adjusted risk of SGA by type and timing of physical activity: Adjusted odds ratios and 95% confidence intervals. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
	OR	95% CI	OR	95% CI	OR	95% CI
Sports/exercise activity	N=925		N=910		N=712	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.66	0.40, 1.09	0.94	0.56, 1.59	2.90	1.42, 5.95
3rd quartile	0.56	0.36, 0.96	0.84	0.47, 1.50	1.58	0.75, 3.31
4th quartile	0.69	0.41, 1.15	0.80	0.47, 1.36	2.10	1.01, 4.33
P_{trend}		0.11		0.36		0.34
Household/caregiving activity	N=952		N=942		N=716	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	1.10	0.64, 1.89	1.18	0.69, 2.03	0.94	0.53, 1.66
3rd quartile	1.18	0.69, 2.03	1.10	0.65, 1.89	0.53	0.28, 1.00
4th quartile	1.38	0.77, 2.45	1.12	0.61, 2.06	0.69	0.34, 1.39
P_{trend}		0.28		0.72		0.10
Occupational activity	N=928		N=919		N=703	
1st group	1.00	Ref	1.00	Ref	1.00	Ref
2nd group	1.01	0.60, 1.73	0.71	0.42, 1.18	0.50	0.24, 1.06
3rd group	0.67	0.39, 1.13	0.76	0.47, 1.23	0.80	0.47, 1.35
4th group	0.82	0.48, 1.40				
P_{trend}		0.23		0.20		0.39
Active transportation activity	N=933		N=914		N=716	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.76	0.44, 1.31	0.69	0.40, 1.18	1.10	0.60, 1.99
3rd quartile	0.79	0.48, 1.28	1.11	0.64, 1.90	0.60	0.33, 1.11
4th quartile	0.66	0.38, 1.15	0.81	0.47, 1.40	0.64	0.36, 1.14
P_{trend}		0.16		0.87		0.048
Total activity	N=902		N=893		N=697	
1st quartile	1.00	Ref	1.00	Ref	1.00	Ref
2nd quartile	0.56	0.33, 0.96	1.13	0.67, 1.92	0.95	0.55, 1.65
3rd quartile	0.64	0.37, 1.11	0.65	0.35, 1.19	0.50	0.27, 0.92
4th quartile	0.91	0.54, 1.52	1.13	0.64, 2.00	0.44	0.22, 0.86
P_{trend}		0.68		0.84		0.003

Estimates adjusted for maternal age, pre-pregnancy BMI, parity, and maternal education.

Table 3.38. Linear regression of gestational age: Unadjusted and adjusted beta estimates and p-values by type and timing of physical activity. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
	Unadjusted	Adjusted*	Unadjusted	Adjusted*	Unadjusted	Adjusted*
	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)
Sports/exercise	N=933	N=870	N=920	N=854	N=716	N=684
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	0.31 (0.19)	0.27 (0.26)	0.31 (0.20)	0.30 (0.24)	0.12 (0.59)	0.14 (0.55)
3rd quartile	0.58 (0.02)	0.55 (0.03)	0.53 (0.04)	0.51 (0.06)	-0.03 (0.89)	0.076 (0.74)
4th quartile	0.10 (0.69)	0.091 (0.71)	0.32 (0.19)	0.32 (0.21)	0.10 (0.65)	0.18 (0.43)
Household/caregiving	N=965	N=881	N=954	N=868	N=720	N=688
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	-0.02 (0.93)	0.034 (0.89)	0.26 (0.28)	0.21 (0.43)	-0.15 (0.50)	-0.081 (0.72)
3rd quartile	0.25 (0.28)	0.36 (0.14)	0.50 (0.03)	0.44 (0.07)	0.04 (0.86)	0.011 (0.96)
4th quartile	-0.40 (0.10)	-0.35 (0.18)	0.12 (0.61)	0.12 (0.64)	0.07 (0.75)	0.087 (0.72)
Occupational activity	N=938	N=862	N=930	N=852	N=706	N=675
1st group	Ref	Ref	Ref	Ref	Ref	Ref
2nd group	0.26 (0.30)	0.048 (0.85)	0.20 (0.36)	0.10 (0.66)	-0.37 (0.10)	-0.49 (0.03)
3rd group	-0.27 (0.25)	-0.49 (0.04)	0.11 (0.59)	-0.009 (0.97)	0.21 (0.25)	0.09 (0.65)
4th group	0.38 (0.12)	0.16 (0.53)				
Active transportation	N=942	N=871	N=925	N=854	N=720	N=688
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	0.26 (0.30)	0.22 (0.40)	0.30 (0.21)	0.35 (0.16)	0.10 (0.66)	0.090 (0.70)
3rd quartile	0.27 (0.24)	0.23 (0.33)	0.05 (0.84)	0.009 (0.97)	0.12 (0.57)	0.18 (0.42)
4th quartile	0.28 (0.27)	0.25 (0.32)	0.16 (0.52)	0.14 (0.59)	0.32 (0.12)	0.34 (0.10)
Total activity	N=910	N=850	N=903	N=838	N=700	N=669
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	0.01 (0.95)	0.026 (0.92)	-0.11 (0.65)	-0.026 (0.92)	0.31 (0.16)	0.33 (0.14)
3rd quartile	0.11 (0.66)	0.074 (0.77)	0.20 (0.41)	0.16 (0.56)	-0.02 (0.92)	-0.089 (0.67)
4th quartile	0.002 (0.99)	-0.045 (0.86)	0.14 (0.57)	0.10 (0.71)	0.31 (0.15)	0.28 (0.23)

* Adjusted for maternal age, pre-pregnancy BMI, maternal education, and pregnancy smoking

Table 3.39. Linear regression estimates for gestational age by change in physical activity from pre to early pregnancy: Unadjusted and adjusted beta estimates and p-values. Latina GDM Study, 2000-2004.

	Unadjusted	Multivariable Adjusted*
	β (p-value)	β (p-value)
Sports/exercise change	N=873	N=837
25% decrease or greater	Ref	Ref
5%-25% decrease	0.29 (0.29)	0.21(0.46)
5% decrease to 5% increase	-0.13 (0.54)	-0.20 (0.49)
5% increase or greater	0.13 (0.64)	0.032 (0.92)
Household change	N=915	N=854
25% decrease or greater	Ref	Ref
5%-25% decrease	-0.014 (0.96)	-0.16 (0.56)
5% decrease to 5% increase	0.22 (0.42)	0.11 (0.71)
5% increase or greater	0.49 (0.09)	0.44 (0.17)
Occupational change	N=876	N=825
25% decrease or greater	Ref	Ref
5%-25% decrease	0.016 (0.96)	0.000 (1.00)
5% decrease to 5% increase	0.13 (0.54)	0.24 (0.34)
5% increase or greater	0.26 (0.32)	0.20 (0.49)
Active living change	N=876	N=833
25% decrease or greater	Ref	Ref
5%-25% decrease	-0.18 (0.45)	-0.26 (0.29)
5% decrease to 5% increase	-0.24 (0.30)	-0.17 (0.52)
5% increase or greater	-0.063 (0.80)	-0.002 (0.99)
Total activity change	N=839	N=805
25% decrease or greater	Ref	Ref
5%-25% decrease	0.27 (0.25)	0.33 (0.17)
5% decrease to 5% increase	0.10 (0.71)	0.087 (0.80)
5% increase or greater	0.58 (0.07)	0.50 (0.17)

* Adjusted for maternal age, pre-pregnancy BMI, maternal education, pregnancy smoking, and pre-pregnancy activity level.

Table 3.40. Linear regression of birth weight: Gestational age-adjusted and multivariable-adjusted beta estimates and p-values. Latina GDM Study, 2000-2004.

	Pre pregnancy		Early pregnancy		Mid pregnancy	
	GA Adjusted	Adjusted	GA Adjusted	Adjusted	GA Adjusted	Adjusted
	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)	β (p-value)
Sports/exercise	N=932	N=888	N=920	N=865	N=716	N=689
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	16.91 (0.66)	3.92 (0.92)	20.85 (0.60)	23.23 (0.56)	-31.68 (0.51)	-28.41 (0.55)
3rd quartile	49.89 (0.22)	64.39 (0.11)	17.52 (0.68)	-8.93 (0.93)	-23.56 (0.62)	-1.65 (0.97)
4th quartile	8.80 (0.82)	2.42 (0.95)	14.27 (0.72)	5.21 (0.89)	-50.37 (0.29)	-40.30 (0.39)
Household/caregiving	N=964	N=902	N=953	N=885	N=720	N=693
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	61.94 (0.11)	14.24 (0.72)	18.01 (0.65)	-13.83 (0.74)	91.62 (0.046)	79.03 (0.089)
3rd quartile	91.84 (0.012)	18.66 (0.64)	57.77 (0.11)	4.56 (0.91)	162.53 (0.0004)	136.93 (0.004)
4th quartile	100.21 (0.010)	0.012 (1.00)	91.64 (0.015)	17.87 (0.68)	190.61 (<0.0001)	144.49 (0.006)
Occupational activity	N=937	N=883	N=929	N=867	N=706	N=680
1st group	Ref	Ref	Ref	Ref	Ref	Ref
2nd group	-20.35 (0.61)	-14.97 (0.71)	92.71 (0.008)	92.59 (0.010)	133.3 (0.006)	126.65 (0.007)
3rd group	29.35 (0.43)	24.91 (0.52)	34.31 (0.31	41.89 (0.23)	30.11 (0.43)	16.24 (0.67)
4th group	27.33 (0.48)	8.32 (0.84)				
Active transportation	N=941	N=891	N=924	N=867	N=720	N=693
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	36.87 (0.37)	30.43 (0.46)	36.39 (0.34)	35.64 (0.36)	-26.41 (0.59)	-12.56 (0.79)
3rd quartile	29.17 (0.43)	1.28 (0.97)	-6.26 (0.88)	6.73 (0.87)	37.61 (0.41)	68.73 (0.13)
4th quartile	72.10 (0.077)	64.36 (0.12)	10.21 (0.80)	-9.76 (0.81)	16.16 (0.70)	36.22 (0.40)
Total activity	N=909	N=867	N=903	N=849	N=700	N=674
1st quartile	Ref	Ref	Ref	Ref	Ref	Ref
2nd quartile	49.19 (0.66)	29.46 (0.45)	23.40 (0.55)	13.29 (0.74)	97.97 (0.034)	86.92 (0.058)
3rd quartile	109.61 (0.006)	51.65 (0.20)	65.33 (0.10)	45.19 (0.27)	168.83 (0.0002)	154.97 (0.0007)
4th quartile	81.14 (0.039)	19.94 (0.62)	73.60 (0.065)	14.15 (0.74)	145.70 (0.0016)	91.22 (0.053)

GA denotes gestational age at birth; Ref denotes referent category.

Multivariable adjusted models included gestational age, height, pre-pregnancy BMI, maternal age, education and parity.

Table 3.41. Linear regression of birth weight by change in physical activity: Gestational-age adjusted and multivariable adjusted beta estimates and p-values. Latina GDM Study, 2000-2004.

	GA adjusted	Multivariable Adjusted*
	β (p-value)	β (p-value)
Sports/exercise change	N=873	N=837
25% decrease or greater	Ref	Ref
5%-25% decrease	-3.2 (0.94)	9.3 (0.84)
5% decrease to 5% increase	-3.0 (0.93)	13.9 (0.76)
5% increase or greater	-22.6 (0.62)	-29.6 (0.57)
Household change	N=914	N=853
25% decrease or greater	Ref	Ref
5%-25% decrease	65.5 (0.12)	50.7 (0.24)
5% decrease to 5% increase	116.2 (0.008)	103.4 (0.02)
5% increase or greater	-16.5 (0.73)	-1.7 (0.97)
Occupational change	N=875	N=824
25% decrease or greater	Ref	Ref
5%-25% decrease	30.6 (0.54)	55.2 (0.28)
5% decrease to 5% increase	16.7 (0.62)	54.8 (0.18)
5% increase or greater	-7.4 (0.86)	14.7 (0.75)
Active living change	N=875	N=832
25% decrease or greater	Ref	Ref
5%-25% decrease	-41.3 (0.29)	-42.0 (0.28)
5% decrease to 5% increase	-76.1 (0.05)	-62.2 (0.13)
5% increase or greater	-34.8 (0.39)	-11.0 (0.80)
Total activity change	N=839	N=805
25% decrease or greater	Ref	Ref
5%-25% decrease	-37.0 (0.32)	-6.2 (0.87)
5% decrease to 5% increase	-28.6 (0.51)	13.8 (0.77)
5% increase or greater	12.3 (0.81)	61.5 (0.27)

* Adjusted for maternal age, pre-pregnancy BMI, maternal education, pregnancy smoking, gestational age, and pre-pregnancy activity level. GA denotes gestational age at birth

APPENDIX: PERMISSION TO ABSTRACT DATA

UNIVERSITY OF MASSACHUSETTS
AMHERST

Department of Public Health
405 Arnold House
715 North Pleasant Street
Amherst, MA 01003-9304

School of Public Health
and Health Sciences

voice: 413.545.1664
fax: 413.545.1645
www.umass.edu.sphhs

December 3, 2008

I give permission to Audra Gollenberg to access relevant data from my grant-funded research for her dissertation, "PHYSICAL ACTIVITY AND MATERNAL/FETAL OUTCOMES IN PREGNANT LATINA WOMEN."

Sincerely,

Lisa Chasan-Taber, Sc.D.
Associate Professor of Epidemiology

BIBLIOGRAPHY

1. Hamilton BE, Martin JA, Sutton PD, Centers for Disease Control and Prevention NCfHS. Births: preliminary data for 2003. National vital statistics reports : from the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System 2004;53:1-17.

2. Pollard K. Faster growth, more diversity in U.S. projections. Population today 1993;21:3, 10.

3. Trevino FM, Moyer ME, Valdez RB, Stroup-Benham CA. Health insurance coverage and utilization of health services by Mexican Americans, mainland Puerto Ricans, and Cuban Americans. JAMA : the journal of the American Medical Association 1991;265:233-7.

4. Freeman G, Lethbridge-Cejku M. Access to health care among Hispanic or Latino women: United States, 2000-2002. Advance Data 2006;(368):1-25.

5. Lara M, Akinbami L, Flores G, Morgenstern H. Heterogeneity of childhood asthma among Hispanic children: Puerto Rican children bear a disproportionate burden. Pediatrics 2006;117:43-53.

6. Nielsen AL. Examining drinking patterns and problems among hispanic groups: results from a national survey. Journal of studies on alcohol 2000;61:301-10.

7. Smith CA, Barnett E. Diabetes-related mortality among Mexican Americans, Puerto Ricans, and Cuban Americans in the United States. Revista panamericana de salud publica = Pan American journal of public health 2005;18:381-7.

8. Weinick RM, Jacobs EA, Stone LC, Ortega AN, Burstin H. Hispanic healthcare disparities: challenging the myth of a monolithic Hispanic population. Medical care 2004;42:313-20.

9. Zsembik BA, Fennell D. Ethnic variation in health and the determinants of health among Latinos. Social science & medicine (1982) 2005;61:53-63.

10. Reichman NE, Kenney GM. Prenatal care, birth outcomes and newborn hospitalization costs: patterns among Hispanics in New Jersey. Family planning perspectives 1998;30:182-7, 200.

11. Kieffer EC, Carman WJ, Gillespie BW, Nolan GH, Worley SE, Guzman JR. Obesity and gestational diabetes among African-American women and Latinas in Detroit: implications for disparities in women's health. Journal of the American Medical Women's Association (1972) 2001;56:181-7, 196.

12. Chiriboga CA. Fetal alcohol and drug effects. The neurologist 2003;9:267-79.

13. Dew PC, Guillory VJ, Okah FA, Cai J, Hoff GL. The Effect of Health Compromising Behaviors on Preterm Births. Maternal and child health journal 2006.

14. Hedderson MM, Weiss NS, Sacks DA, Pettitt DJ, Selby JV, Quesenberry CP, Ferrara A. Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia. Obstetrics and gynecology 2006;108:1153-61.

15. Kaiser LL, Allen L, American Dietetic A. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. Journal of the American Dietetic Association 2002;102:1479-90.

16. Rudra CB, Williams MA, Lee IM, Miller RS, Sorensen TK. Perceived exertion during prepregnancy physical activity and preeclampsia risk. Medicine and science in sports and exercise 2005;37:1836-41.

17. Szymanowski K, Chmaj-Wierzchowska K, Florek E, Opala T. Influence of tobacco smoking to development of the fetus, newborn and child--a review. Przeglad lekarski 2006;63:1135-7.

18. Udipi SA, Ghugre P, Antony U. Nutrition in pregnancy and lactation. Journal of the Indian Medical Association 2000;98:548-57.

19. Zhang C, Solomon CG, Manson JE, Hu FB. A prospective study of pregravid physical activity and sedentary behaviors in relation to the risk for gestational diabetes mellitus. Archives of Internal Medicine 2006;166:543-8.

20. Oken E, Ning Y, Rifas-Shiman SL, Radesky JS, Rich-Edwards JW, Gillman MW. Associations of physical activity and inactivity before and during pregnancy with glucose tolerance. Obstetrics and gynecology 2006;108:1200-7.

21. Sorensen TK, Williams MA, Lee IM, Dashow EE, Thompson ML, Luthy DA. Recreational physical activity during pregnancy and risk of preeclampsia. Hypertension 2003;41:1273-80.

22. Kind KL, Moore VM, Davies MJ. Diet around conception and during pregnancy--effects on fetal and neonatal outcomes. Reproductive biomedicine online 2006;12:532-41.

23. Moore VM, Davies MJ. Diet during pregnancy, neonatal outcomes and later health. Reproduction, fertility, and development 2005;17:341-8.

24. Moore VM, Davies MJ, Willson KJ, Worsley A, Robinson JS. Dietary composition of pregnant women is related to size of the baby at birth. The Journal of nutrition 2004;134:1820-6.

25. Sepe SJ, Connell FA, Geiss LS, Teutsch SM. Gestational diabetes. Incidence, maternal characteristics, and perinatal outcome. Diabetes 1985;34 Suppl 2:13-6.

26. Gonzalez-Quintero VH, Tolaymat L, Luke B, Gonzalez-Garcia A, Duthely L, O'Sullivan MJ, Martin D. Outcome of pregnancies among Hispanics: revisiting the epidemiologic paradox. The Journal of reproductive medicine 2006;51:10-4.

27. Rosenberg TJ, Raggio TP, Chiasson MA. A further examination of the "epidemiologic paradox": birth outcomes among Latinas. Journal of the National Medical Association 2005;97:550-6.

28. Centers for Disease Control and P. Infant health among Puerto Ricans--Puerto Rico and U.S. mainland, 1989-2000. MMWR.Morbidity and mortality weekly report 2003;52:1012-6.

29. Fuentes-Afflick E, Lurie P. Low birth weight and Latino ethnicity. Examining the epidemiologic paradox. Archives of Pediatrics & Adolescent Medicine 1997;151:665-74.

30. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA : the journal of the American Medical Association 1995;273:402-7.

31. American College of Obstetricians and G. Nutrition During Pregnancy. Patient Education Pamphlet AP001 2002.

32. American College of Obstetricians and G. Exercise During Pregnancy. Patient Education Pamphlet #AP119 2003.

33. Chambers CD, Hughes S, Meltzer SB, Wahlgren D, Kassem N, Larson S, Riley EP, Hovell MF. Alcohol consumption among low-income pregnant Latinas. Alcoholism, Clinical and Experimental Research 2005;29:2022-8.

34. Guendelman S, Abrams B. Dietary, alcohol, and tobacco intake among Mexican-American women of childbearing age: results from HANES data. American Journal of Health promotion : AJHP 1994;8:363-72.

35. Harley K, Eskenazi B. Time in the United States, social support and health behaviors during pregnancy among women of Mexican descent. Social science & medicine (1982) 2006;62:3048-61.

36. Harley K, Eskenazi B, Block G. The association of time in the US and diet during pregnancy in low-income women of Mexican descent. Paediatric and perinatal epidemiology 2005;19:125-34.

37. Kieffer EC, Sinco B, Kim C. Health behaviors among women of reproductive age with and without a history of gestational diabetes mellitus. Diabetes care 2006;29:1788-93.

38. Petersen AM, Leet TL, Brownson RC. Correlates of physical activity among pregnant women in the United States. Medicine and science in sports and exercise 2005;37:1748-53.

39. Evenson KR, Savitz DA, Huston SL. Leisure-time physical activity among pregnant women in the US. Paediatric and perinatal epidemiology 2004;18:400-7.

40. Walsh RA, Redman S, Brinsmead MW, Fryer JL. Predictors of smoking in pregnancy and attitudes and knowledge of risks of pregnant smokers. Drug and Alcohol Review 1997;16:41-67.

41. Perreira KM, Cortes KE. Race/ethnicity and nativity differences in alcohol and tobacco use during pregnancy. American Journal of Public Health 2006;96:1629-36.

42. Chasan-Taber L, Schmidt MD, Pekow P, Sternfeld B, Manson J, Markenson G. Correlates of physical activity in pregnancy among Latina women. Maternal and child health journal 2007;11:353-63.

43. Detjen MG, Nieto FJ, Trentham-Dietz A, Fleming M, Chasan-Taber L. Acculturation and Cigarette Smoking among Pregnant Hispanic Women Residing in the United States. AJPH 2007;(in press).

44. Tucker KL, Bianchi LA, Maras J, Bermudez OI. Adaptation of a food frequency questionnaire to assess diets of Puerto Rican and non-Hispanic adults. American Journal of Epidemiology 1998;148:507-18.

45. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. Preventive medicine 1999;28:313-23.

46. Ainsworth BE, Sternfeld B, Richardson MT, Jackson K. Evaluation of the kaiser physical activity survey in women. Medicine and science in sports and exercise 2000;32:1327-38.

47. Schmidt MD, Freedson PS, Pekow P, Roberts D, Sternfeld B, Chasan-Taber L. Validation of the Kaiser Physical Activity Survey in pregnant women. Medicine and science in sports and exercise 2006;38:42-50.

48. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, O'Brien WL, Bassett DR, Jr., Schmitz KH, Emplaincourt PO, Jacobs DR, Jr., Leon AS. Compendium of physical activities: an update of activity codes and MET intensities. Medicine and science in sports and exercise 2000;32:S498-S504.

49. Landale NS, Oropesa RS. Migration, social support and perinatal health: An origin-destination analysis of Puerto Rican women. J Health Soc Behav 2001;42:166-82.

50. Cohen B, Friedman DJ, Mahan CM, Lederman R, Munoz D. Ethnicity, Maternal Risk, and Birth Weight Among Hispanics in Massachusetts, 1987-89. Public Health Reports 1993;108:363-71.

51. Hajat A, Lucus JB, Kington R. Health Outcomes Among Hispanic Subgroups: Data from the National Health Interview Survey, 1992-95. Vital and Health Statistics of the CDC/National Center for Health Statistics 2000.

52. Eyler AE, Wilcox S, Matson-Koffman D, Evenson KR, Sanderson B, Thompson J, Wilbur J, Rohm-Young D. Correlates of physical activity among women from diverse racial/ethnic groups. Journal of women's health & gender-based medicine 2002;11:239-53.

53. Monaco MT, Hull EE, Aaron DJ, Nagle EF, Robertson RJ. Physical Activity and Substance Use in Young Adults. Medicine and science in sports and exercise 40(5)[Supplement 1], S483. 2008.

54. Rodondi N, Pletcher MJ, Liu K, Hulley SB, Sidney S, Coronary Artery Risk Development in Young Adults S. Marijuana use, diet, body mass index, and cardiovascular risk factors (from the CARDIA study). The American Journal of Cardiology 2006;98:478-84.

55. Smit E, Crespo CJ. Dietary intake and nutritional status of US adult marijuana users: results from the Third National Health and Nutrition Examination Survey. Public health nutrition 2001;4:781-6.

56. Lenz BK. Tobacco, depression, and lifestyle choices in the pivotal early college years. Journal of American college health : J of ACH 2004;52:213-9.

57. Christensen AE, Tobiassen M, Jensen TK, Wielandt H, Bakketeig L, Host A. Repeated validation of parental self-reported smoking during pregnancy and infancy: a prospective cohort study of infants at high risk for allergy development. Paediatric and perinatal epidemiology 2004;18:73-9.

58. George L, Granath F, Johansson AL, Cnattingius S. Self-reported nicotine exposure and plasma levels of cotinine in early and late pregnancy. Acta Obstetricia et Gynecologica Scandinavica 2006;85:1331-7.

59. Parazzini F, Davoli E, Rabaiotti M, Restelli S, Stramare L, Dindelli M, La Vecchia C, Fanelli R. Validity of self-reported smoking habits in pregnancy: a saliva cotinine analysis. Acta Obstetricia et Gynecologica Scandinavica 1996;75:352-4.

60. Klebanoff MA, Levine RJ, Morris CD, Hauth JC, Sibai BM, Ben Curet L, Catalano P, Wilkins DG. Accuracy of self-reported cigarette smoking among pregnant women in the 1990s. Paediatric and perinatal epidemiology 2001;15:140-3.

61. Rifas-Shiman SL, Rich-Edwards JW, Willett WC, Kleinman KP, Oken E, Gillman MW. Changes in dietary intake from the first to the second trimester of pregnancy. Paediatric and perinatal epidemiology 2006;20:35-42.

62. A.D.A. Gestational Diabetes Mellitus: Position Statement. Diabetes Care 2004;27:S88-S90.

63. Oken E, Ning Y, Rifas-Shiman SL, Radesky JS, Rich-Edwards JW, Gillman MW. Associations of physical activity and inactivity before and during pregnancy with glucose tolerance. Obstet Gynecol 2006;108:1200-7.

64. Kieffer EC, Nolan GH, Carman WJ, Sanborn CZ, Guzman R, Ventura A. Glucose tolerance during pregnancy and birth weight in a Hispanic population. Obstet Gynecol 1999;94:741-6.

65. Langer O, Brustman L, Anyaegbunam A, Mazze R. The significance of one abnormal glucose tolerance test value on adverse outcome in pregnancy. Am J Obstet Gynecol 1987;157:758-63.

66. Langer O, Kozlowski S, Brustman L. Abnormal growth patterns in diabetes in pregnancy: a longitudinal study. Isr J Med Sci 1991;27:516-23.

67. Bo S, Menato G, Gallo ML, Bardelli C, Lezo A, Signorile A, Gambino R, Cassader M, Massobrio M, Pagano G. Mild gestational hyperglycemia, the metabolic syndrome and adverse neonatal outcomes. Acta Obstet Gynecol Scand 2004;83:335-40.

68. Hedderson MM, Ferrara A, Sacks DA. Gestational diabetes mellitus and lesser degrees of pregnancy hyperglycemia: association with increased risk of spontaneous preterm birth. Obstet Gynecol 2003;102:850-6.

69. Lapolla A, Dalfra MG, Bonomo M, Castiglioni MT, Di Cianni G, Masin M, Mion E, Paleari R, Schievano C, Songini M, Tocco G, Volpe L, Mosca A. Can plasma glucose and HbA1c predict fetal growth in mothers with different glucose tolerance levels? Diabetes Res Clin Pract 2007;77:465-70.

70. Catalano PM, Thomas A, Huston-Presley L, Amini SB. Increased fetal adiposity: a very sensitive marker of abnormal in utero development. Am J Obstet Gynecol 2003;189:1698-704.

71. Gruendhammer M, Brezinka C, Lechleitner M. The number of abnormal plasma glucose values in the oral glucose tolerance test and the feto-maternal outcome of pregnancy. Eur J Obstet Gynecol Reprod Biol 2003;108:131-6.

72. Yogev Y, Langer O. Spontaneous preterm delivery and gestational diabetes: the impact of glycemic control. Arch Gynecol Obstet 2007;276:361-5.

73. Yogev Y, Langer O. Pregnancy outcome in obese and morbidly obese gestational diabetic women. Eur J Obstet Gynecol Reprod Biol 2007.

74. Di Cianni G, Seghieri G, Lencioni C, Cuccuru I, Anichini R, De Bellis A, Ghio A, Tesi F, Volpe L, Del Prato S. Normal glucose tolerance and gestational diabetes mellitus: what is in between? Diabetes Care 2007;30:1783-8.

75. Herman G, Raimondi B. Glucose tolerance, fetal growth, and pregnancy complications in normal women. Am J Perinatol 1988;5:168-71.

76. Lurie S, Levy R, Weiss R, Boultin G, Hagay ZJ. Low values on 50 gram glucose challenge test or oral 100 gram glucose tolerance test are associated with good perinatal outcome. J Obstet Gynaecol 1998;18:451-4.

77. Tallarigo L, Giampietro O, Penno G, Miccoli R, Gregori G, Navalesi R. Relation of glucose tolerance to complications of pregnancy in nondiabetic women. N Engl J Med 1986;315:989-92.

78. Hillier TA, Pedula KL, Schmidt MM, Mullen JA, Charles MA, Pettitt DJ. Childhood obesity and metabolic imprinting: the ongoing effects of maternal hyperglycemia. Diabetes Care 2007;30:2287-92.

79. Cheung NW, Byth K. Population health significance of gestational diabetes. Diabetes Care 2003;26:2005-9.

80. Corrado F, D'Anna R, Cannata ML, Cannizzaro D, Caputo F, Raffone E, Di Benedetto A. Positive association between a single abnormal glucose tolerance test value in pregnancy and subsequent abnormal glucose tolerance. Am J Obstet Gynecol 2007;196:339.

81. Lee AJ, Hiscock RJ, Wein P, Walker SP, Permezel M. Gestational diabetes mellitus: clinical predictors and long-term risk of developing type 2 diabetes: a retrospective cohort study using survival analysis. Diabetes Care 2007;30:878-83.

82. Pettitt DJ, Bennett PH, Saad MF, Charles MA, Nelson RG, Knowler WC. Abnormal glucose tolerance during pregnancy in Pima Indian women. Long-term effects on offspring. Diabetes 1991;40 Suppl 2:126-30.

83. Buchanan TA, Xiang AH. Gestational diabetes mellitus. J Clin Invest 2005;115:485-91.

84. Brody SC, Harris R, Lohr K. Screening for gestational diabetes: a summary of the evidence for the U.S. Preventive Services Task Force. Obstet Gynecol 2003;101:380-92.

85. Sepe SJ, Connell FA, Geiss LS, Teutsch SM. Gestational Diabetes. Incidence, maternal characteristics and perinatal outcome. Diabetes 1985;34:13-6.

86. Nielsen Report on Television. 1998.

87. Dempsey JC, Butler CL, Sorensen TK, Lee IM, Thompson ML, Miller RS, Frederick IO, Williams MA. A case-control study of maternal recreational physical activity and risk of gestational diabetes mellitus. Diabetes Res Clin Pract 2004;66:203-15.

88. Rudra CB, Williams MA, Lee IM, Miller RS, Sorensen TK. Perceived exertion in physical activity and risk of gestational diabetes mellitus. Epidemiology 2006;17:31-7.

89. Zhang C, Solomon CG, Manson JE, Hu FB. A prospective study of pregravid physical activity and sedentary behaviors in relation to the risk for gestational diabetes mellitus. Arch Intern Med 2006;166:543-8.

90. Tucker LA, Bagwell M. Television viewing and obesity in adult females. Am J Public Health 1991;81:908-11.

91. Slattery ML, Sweeney C, Edwards S, Herrick J, Murtaugh M, Baumgartner K, Guiliano A, Byers T. Physical activity patterns and obesity in Hispanic and non-Hispanic white women. Med Sci Sports Exerc 2006;38:33-41.

92. Rana JS, Li TY, Manson JE, Hu FB. Adiposity compared with physical inactivity and risk of type 2 diabetes in women. Diabetes Care 2007;30:53-8.

93. McGavock J, Sellers E, Dean H. Physical activity for the prevention and management of youth-onset type 2 diabetes mellitus: focus on cardiovascular complications. Diab Vasc Dis Res 2007;4:305-10.

94. Hu FB. Sedentary lifestyle and risk of obesity and type 2 diabetes. Lipids 2003;38:103-8.

95. Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, Stampfer MJ, Speizer FE, Spiegelman D, Manson JE. A prospective study of pregravid determinants of gestational diabetes mellitus. Jama 1997;278:1078-83.

96. Hu FB, Leitzmann MF, Stampfer MJ, Colditz GA, Willett WC, Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med 2001;161:1542-8.

97. Dunstan DW, Salmon J, Owen N, Armstrong T, Zimmet PZ, Welborn TA, Cameron AJ, Dwyer T, Jolley D, Shaw JE. Physical activity and television viewing in relation to risk of undiagnosed abnormal glucose metabolism in adults. Diabetes Care 2004;27:2603-9.

98. Hu FB, Li TY, Colditz GA, Willett WC, Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. Jama 2003;289:1785-91.

99. Jakes RW, Day NE, Khaw KT, Luben R, Oakes S, Welch A, Bingham S, Wareham NJ. Television viewing and low participation in vigorous recreation are independently associated with obesity and markers of cardiovascular disease risk: EPIC-Norfolk population-based study. Eur J Clin Nutr 2003;57:1089-96.

100. Johnson KM, Nelson KM, Bradley KA. Television viewing practices and obesity among women veterans. J Gen Intern Med 2006;21 Suppl 3:S76-S81.

101. Kronenberg F, Pereira MA, Schmitz MK, Arnett DK, Evenson KR, Crapo RO, Jensen RL, Burke GL, Sholinsky P, Ellison RC, Hunt SC. Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI Family Heart Study. Atherosclerosis 2000;153:433-43.

102. Dempsey JC, Sorensen TK, Williams MA, Lee IM, Miller RS, Dashow EE, Luthy DA. Prospective study of gestational diabetes mellitus risk in relation to maternal recreational physical activity before and during pregnancy. Am J Epidemiol 2004;159:663-70.

103. Dye TD, Knox KL, Artal R, Aubry RH, Wojtowycz MA. Physical activity, obesity, and diabetes in pregnancy. Am J Epidemiol 1997;146:961-5.

104. Crespo CJ, Smit E, Andersen RE, Carter-Pokras O, Ainsworth BE. Race/ethnicity, social class and their relation to physical inactivity during leisure time: results from the Third National Health and Nutrition Examination Survey, 1988-1994. Am J Prev Med 2000;18:46-53.

105. Marshall SJ, Jones DA, Ainsworth BE, Reis JP, Levy SS, Macera CA. Race/ethnicity, social class, and leisure-time physical inactivity. Med Sci Sports Exerc 2007;39:44-51.

106. Bertrais S, Beyeme-Ondoua JP, Czernichow S, Galan P, Hercberg S, Oppert JM. Sedentary behaviors, physical activity, and metabolic syndrome in middle-aged French subjects. Obes Res 2005;13:936-44.

107. Ford ES, Kohl HW, III, Mokdad AH, Ajani UA. Sedentary behavior, physical activity, and the metabolic syndrome among U.S. adults. Obes Res 2005;13:608-14.

108. Annuzzi G, Riccardi G, Capaldo B, Kaijser L. Increased insulin-stimulated glucose uptake by exercised human muscles one day after prolonged physical exercise. Eur J Clin Invest 1991;21:6-12.

109. Devlin JT. Effects of exercise on insulin sensitivity in humans. Diabetes Care 1992;15:1690-3.

110. Richter EA, Wojtaszewski JF, Kristiansen S, Daugaard JR, Nielsen JN, Derave W, Kiens B. Regulation of muscle glucose transport during exercise. Int J Sport Nutr Exerc Metab 2001;11 Suppl:S71-S77.

111. Bowman SA. Television-viewing characteristics of adults: correlations to eating practices and overweight and health status. Prev Chronic Dis 2006;3:A38.

112. Eisenmann JC, Bartee RT, Wang MQ. Physical activity, TV viewing, and weight in U.S. youth: 1999 Youth Risk Behavior Survey. Obes Res 2002;10:379-85.

113. Bloomgarden ZT. Diabetes and obesity: part 1. Diabetes Care 2007;30:3145-51.

114. Antuna-Puente B, Feve B, Fellahi S, Bastard JP. Adipokines: The missing link between insulin resistance and obesity. Diabetes Metab 2007.

115. Ye J, Kraegen T. Insulin resistance: central and peripheral mechanisms. The 2007 Stock Conference Report. Obes Rev 2008;9:30-4.

116. Chan JM, Rimm EB, Colditz GA, Stampfer MJ, Willett WC. Obesity, fat distribution, and weight gain as risk factors for clinical diabetes in men. Diabetes Care 1994;17:961-9.

117. Colditz GA, Willett WC, Stampfer MJ, Manson JE, Hennekens CH, Arky RA, Speizer FE. Weight as a risk factor for clinical diabetes in women. Am J Epidemiol 1990;132:501-13.

118. Halford JC, Boyland EJ, Hughes GM, Stacey L, McKean S, Dovey TM. Beyond-brand effect of television food advertisements on food choice in children: the effects of weight status. Public Health Nutr 2007;1-8.

119. Jeffery RW, French SA. Epidemic obesity in the United States: are fast foods and television viewing contributing? Am J Public Health 1998;88:277-80.

120. Powell LM, Szczypka G, Chaloupka FJ, Braunschweig CL. Nutritional content of television food advertisements seen by children and adolescents in the United States. Pediatrics 2007;120:576-83.

121. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, O'Brien WL, Bassett DR, Jr., Schmitz KH, Emplaincourt PO, Jacobs DR, Jr., Leon AS. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000;32:S498-S504.

122. Ching PL, Willett WC, Rimm EB, Colditz GA, Gortmaker SL, Stampfer MJ. Activity level and risk of overweight in male health professionals. Am J Public Health 1996;86:25-30.

123. Damm P, Breitowicz B, Hegaard H. Exercise, pregnancy, and insulin sensitivity--what is new? Appl Physiol Nutr Metab 2007;32:537-40.

124. Hu G, Lakka TA, Kilpelainen TO, Tuomilehto J. Epidemiological studies of exercise in diabetes prevention. Appl Physiol Nutr Metab 2007;32:583-95.

125. Mottola MF. The role of exercise in the prevention and treatment of gestational diabetes mellitus. Curr Sports Med Rep 2007;6:381-6.

126. Weijers RN, Bekedam DJ. Relationship between gestational diabetes mellitus and type 2 diabetes: evidence of mitochondrial dysfunction. Clin Chem 2007;53:377-83.

127. Dunstan DW, Salmon J, Healy GN, Shaw JE, Jolley D, Zimmet PZ, Owen N. Association of television viewing with fasting and 2-h postchallenge plasma glucose levels in adults without diagnosed diabetes. Diabetes Care 2007;30:516-22.

128. Landy HJ, Gomez-Marin O, O'Sullivan MJ. Diagnosing gestational diabetes mellitus: use of a glucose screen without administering the glucose tolerance test. Obstet Gynecol 1996;87:395-400.

129. Atilano LC, Lee-Parritz A, Lieberman E, Cohen AP, Barbieri RL. Alternative methods of diagnosing gestational diabetes mellitus. Am J Obstet Gynecol 1999;181:1158-61.

130. Schmidt MD FPP. Validation of the Kaiser Physical Activity Survey in pregnant women. Med Sci Sports Exerc. 2006;38:42-50.

131. Kieffer EC, Sinco B, Kim C. Health behaviors among women of reproductive age with and without a history of gestational diabetes mellitus. Diabetes Care 2006;29:1788-93.

132. Petersen AM, Leet TL, Brownson RC. Correlates of physical activity among pregnant women in the United States. Med Sci Sports Exerc 2005;37:1748-53.

133. Healy GN, Dunstan DW, Salmon J, Shaw JE, Zimmet PZ, Owen N. Television time and continuous metabolic risk in physically active adults. Med Sci Sports Exerc 2008;40:639-45.

134. Sugiyama T, Healy GN, Dunstan DW, Salmon J, Owen N. Is television viewing time a marker of a broader pattern of sedentary behavior? Ann Behav Med 2008;35:245-50.

135. McElduff A, Goldring J, Gordon P, Wyndham L. A direct comparison of the measurement of a random plasma glucose and a post-50 g glucose load glucose, in the detection of gestational diabetes. Aust N Z J Obstet Gynaecol 1994;34:28-30.

136. Radesky JS, Oken E, Rifas-Shiman SL, Kleinman KP, Rich-Edwards JW, Gillman MW. Diet during early pregnancy and development of gestational diabetes. Paediatr Perinat Epidemiol 2008;22:47-59.

137. Goldenberg RL, Rouse DJ. Prevention of premature birth. N Engl J Med 1998;339:313-20.

138. Hamilton BE, Martin JA, Ventura SJ, Sutton PD, Menacker F. Births: preliminary data for 2004. Natl Vital Stat Rep 2005;54:1-17.

139. Goldenberg RL, Culhane JF. Low birth weight in the United States. Am J Clin Nutr 2007;85:584S-90S.

140. Ong KK. Size at birth, postnatal growth and risk of obesity. Horm Res 2006;65 Suppl 3:65-9.

141. Pettitt DJ, Bennett PH, Saad MF, Charles MA, Nelson RG, Knowler WC. Abnormal glucose tolerance during pregnancy in Pima Indian women. Long-term effects on offspring. Diabetes 1991;40 Suppl 2:126-30.

142. Tanis BC, Kapiteijn K, Hage RM, Rosendaal FR, Helmerhorst FM. Dutch women with a low birth weight have an increased risk of myocardial infarction later in life: a case control study. Reprod Health 2005;2:1.

143. Oken E, Kleinman KP, Rich-Edwards J, Gillman MW. A nearly continuous measure of birth weight for gestational age using a United States national reference. BMC Pediatr 2003;3:6.

144. Ananth CV, Wen SW. Trends in fetal growth among singleton gestations in the United States and Canada, 1985 through 1998. Semin Perinatol 2002;26:260-7.

145. Ananth CV. Menstrual versus clinical estimate of gestational age dating in the United States: temporal trends and variability in indices of perinatal outcomes. Paediatr Perinat Epidemiol 2007;21 Suppl 2:22-30.

146. Thomas P, Peabody J, Turnier V, Clark RH. A new look at intrauterine growth and the impact of race, altitude, and gender. Pediatrics 2000;106:E21.

147. Cohen BB, Friedman DJ, Mahan CM, Lederman R, Munoz D. Ethnicity, maternal risk, and birth weight among Hispanics in Massachusetts, 1987-89. Public Health Rep 1993;108:363-71.

148. Reichman NE, Kenney GM. Prenatal care, birth outcomes and newborn hospitalization costs: patterns among Hispanics in New Jersey. Fam Plann Perspect 1998;30:182-7, 200.

149. Rosenberg TJ, Raggio TP, Chiasson MA. A further examination of the "epidemiologic paradox": birth outcomes among Latinas. J Natl Med Assoc 2005;97:550-6.

150. Fuentes-Afflick E, Lurie P. Low birth weight and Latino ethnicity. Examining the epidemiologic paradox. Arch Pediatr Adolesc Med 1997;151:665-74.

151. MacDorman MF, Callaghan WM, Mathews TJ, Hoyert DL, Kochanek KD. Trends in preterm-related infant mortality by race and ethnicity, United States, 1999-2004. Int J Health Serv 2007;37:635-41.

152. Kieffer EC, Sinco B, Kim C. Health behaviors among women of reproductive age with and without a history of gestational diabetes mellitus. Diabetes Care 2006;29:1788-93.

153. Evenson KR, Savitz DA, Huston SL. Leisure-time physical activity among pregnant women in the US. Paediatr Perinat Epidemiol 2004;18:400-7.

154. Petersen AM, Leet TL, Brownson RC. Correlates of physical activity among pregnant women in the United States. Med Sci Sports Exerc 2005;37:1748-53.

155. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. Jama 1995;273:402-7.

156. Clapp JF, III, Dickstein S. Endurance exercise and pregnancy outcome. Med Sci Sports Exerc 1984;16:556-62.

157. Clapp JF, III. Pregnancy outcome: physical activities inside versus outside the workplace. Semin Perinatol 1996;20:70-6.

158. Wolfe LA, Walker RM, Bonen A, McGrath MJ. Effects of pregnancy and chronic exercise on respiratory responses to graded exercise. J Appl Physiol 1994;76:1928-36.

159. Morris SN, Johnson NR. Exercise during pregnancy: a critical appraisal of the literature. J Reprod Med 2005;50:181-8.

160. Chasan-Taber L, Evenson KR, Sternfeld B, Kengeri S. Assessment of recreational physical activity during pregnancy in epidemiologic studies of birthweight and length of gestation: methodologic aspects. Women Health 2007;45:85-107.

161. Kramer MS, McDonald SW. Aerobic exercise for women during pregnancy. Cochrane Database Syst Rev 2006;3:CD000180.

162. Ham SA, Yore MM, Kruger J, Heath GW, Moeti R. Physical activity patterns among Latinos in the United States: putting the pieces together. Prev Chronic Dis 2007;4:A92.

163. Clapp JF, III, Kim H, Burciu B, Lopez B. Beginning regular exercise in early pregnancy: effect on fetoplacental growth. Am J Obstet Gynecol 2000;183:1484-8.

164. Poudevigne MS, O'Connor PJ. Physical activity and mood during pregnancy. Med Sci Sports Exerc 2005;37:1374-80.

165. Poudevigne MS, O'Connor PJ. A review of physical activity patterns in pregnant women and their relationship to psychological health. Sports Med 2006;36:19-38.

166. Clapp JF, III. Acute exercise stress in the pregnant ewe. Am J Obstet Gynecol 1980;136:489-94.

167. Curet LB, Orr JA, Rankin HG, Ungerer T. Effect of exercise on cardiac output and distribution of uterine blood flow in pregnant ewes. J Appl Physiol 1976;40:725-8.

168. Clapp JF, III, Little KD, ppleby-Wineberg SK, Widness JA. The effect of regular maternal exercise on erythropoietin in cord blood and amniotic fluid. Am J Obstet Gynecol 1995;172:1445-51.

169. Hassan TJ, Ibrahim K, Sadiqua, Jabarey SN. Excessive physical work during pregnancy and birth weight. Asia Oceania J Obstet Gynaecol 1990;16:17-20.

170. Thomas DM, Clapp JF, Shernce S. A foetal energy balance equation based on maternal exercise and diet. J R Soc Interface 2008;5:449-55.

171. Pivarnik JM. Potential effects of maternal physical activity on birth weight: brief review. Med Sci Sports Exerc 1998;30:400-6.

172. Wolfe LA, Weissgerber TL. Clinical physiology of exercise in pregnancy: a literature review. J Obstet Gynaecol Can 2003;25:473-83.

173. Lotgering FK, Gilbert RD, Longo LD. Exercise responses in pregnant sheep: blood gases, temperatures, and fetal cardiovascular system. J Appl Physiol 1983;55:842-50.

174. Clapp JF, III. The changing thermal response to endurance exercise during pregnancy. Am J Obstet Gynecol 1991;165:1684-9.

175. Marbury MC. Relationship of ergonomic stressors to birthweight and gestational age. Scand J Work Environ Health 1992;18:73-83.

176. Grisso JA, Main DM, Chiu G, Synder ES, Holmes JH. Effects of physical activity and life-style factors on uterine contraction frequency. Am J Perinatol 1992;9:489-92.

177. Veille JC, Hohimer AR, Burry K, Speroff L. The effect of exercise on uterine activity in the last eight weeks of pregnancy. Am J Obstet Gynecol 1985;151:727-30.

178. Zahn V, Raabe V. [Effect of exercise during pregnancy on uterine contractions]. Zentralbl Gynakol 1984;106:33-9.

179. Lokey EA, Tran ZV, Wells CL, Myers BC, Tran AC. Effects of physical exercise on pregnancy outcomes: a meta-analytic review. Med Sci Sports Exerc 1991;23:1234-9.

180. Beckmann CR, Beckmann CA. Effect of a structured antepartum exercise program on pregnancy and labor outcome in primiparas. J Reprod Med 1990;35:704-9.

181. Collings CA, Curet LB, Mullin JP. Maternal and fetal responses to a maternal aerobic exercise program. Am J Obstet Gynecol 1983;145:702-7.

182. Duncombe D, Skouteris H, Wertheim EH, Kelly L, Fraser V, Paxton SJ. Vigorous exercise and birth outcomes in a sample of recreational exercisers: a prospective study across pregnancy. Aust N Z J Obstet Gynaecol 2006;46:288-92.

183. Fortier I, Marcoux S, Brisson J. Maternal work during pregnancy and the risks of delivering a small-for-gestational-age or preterm infant. Scand J Work Environ Health 1995;21:412-8.

184. Haas JS, Fuentes-Afflick E, Stewart AL, Jackson RA, Dean ML, Brawarsky P, Escobar GJ. Prepregnancy health status and the risk of preterm delivery. Arch Pediatr Adolesc Med 2005;159:58-63.

185. Horns PN, Ratcliffe LP, Leggett JC, Swanson MS. Pregnancy outcomes among active and sedentary primiparous women. J Obstet Gynecol Neonatal Nurs 1996;25:49-54.

186. Jarrett JC, Spellacy WN. Jogging during pregnancy: an improved outcome? Obstet Gynecol 1983;61:705-9.

187. Kardel KR, Kase T. Training in pregnant women: effects on fetal development and birth. Am J Obstet Gynecol 1998;178:280-6.

188. Klebanoff MA, Shiono PH, Carey JC. The effect of physical activity during pregnancy on preterm delivery and birth weight. Am J Obstet Gynecol 1990;163:1450-6.

189. Leiferman JA, Evenson KR. The effect of regular leisure physical activity on birth outcomes. Matern Child Health J 2003;7:59-64.

190. Magann EF, Evans SF, Weitz B, Newnham J. Antepartum, intrapartum, and neonatal significance of exercise on healthy low-risk pregnant working women. Obstet Gynecol 2002;99:466-72.

191. Marquez-Sterling S, Perry AC, Kaplan TA, Halberstein RA, Signorile JF. Physical and psychological changes with vigorous exercise in sedentary primigravidae. Med Sci Sports Exerc 2000;32:58-62.

192. Orr ST, James SA, Garry J, Prince CB, Newton ER. Exercise and pregnancy outcome among urban, low-income, black women. Ethn Dis 2006;16:933-7.

193. Berkowitz GS, Kelsey JL, Holford TR, Berkowitz RL. Physical activity and the risk of spontaneous preterm delivery. J Reprod Med 1983;28:581-8.

194. Evenson KR, Siega-Riz AM, Savitz DA, Leiferman JA, Thorp JM, Jr. Vigorous leisure activity and pregnancy outcome. Epidemiology 2002;13:653-9.

195. Hatch M, Levin B, Shu XO, Susser M. Maternal leisure-time exercise and timely delivery. Am J Public Health 1998;88:1528-33.

196. Hegaard HK, Hedegaard M, Damm P, Ottesen B, Petersson K, Henriksen TB. Leisure time physical activity is associated with a reduced risk of preterm delivery. Am J Obstet Gynecol 2008;198:180.

197. Misra DP, Strobino DM, Stashinko EE, Nagey DA, Nanda J. Effects of physical activity on preterm birth. Am J Epidemiol 1998;147:628-35.

198. Petridou E, Salvanos H, Skalkidou A, Dessypris N, Moustaki M, Trichopoulos D. Are there common triggers of preterm deliveries? Bjog 2001;108:598-604.

199. Watson PE, McDonald BW. Activity levels in pregnant New Zealand women: relationship with socioeconomic factors, well-being, anthropometric measures, and birth outcome. Appl Physiol Nutr Metab 2007;32:733-42.

200. Homer CJ, Beresford SA, James SA, Siegel E, Wilcox S. Work-related physical exertion and risk of preterm, low birthweight delivery. Paediatr Perinat Epidemiol 1990;4:161-74.

201. Luke B, Mamelle N, Keith L, Munoz F, Minogue J, Papiernik E, Johnson TR. The association between occupational factors and preterm birth: a United States nurses' study. Research Committee of the Association of Women's Health, Obstetric, and Neonatal Nurses. Am J Obstet Gynecol 1995;173:849-62.

202. Mamelle N, Laumon B, Lazar P. Prematurity and occupational activity during pregnancy. Am J Epidemiol 1984;119:309-22.

203. McDonald AD, McDonald JC, Armstrong B, Cherry NM, Nolin AD, Robert D. Prematurity and work in pregnancy. Br J Ind Med 1988;45:56-62.

204. Ramirez G, Grimes RM, Annegers JF, Davis BR, Slater CH. Occupational physical activity and other risk factors for preterm birth among US Army primigravidas. Am J Public Health 1990;80:728-30.

205. Ahlborg G, Jr., Bodin L, Hogstedt C. Heavy lifting during pregnancy--a hazard to the fetus? A prospective study. Int J Epidemiol 1990;19:90-7.

206. Kramer MS. Aerobic exercise for women during pregnancy. Cochrane Database Syst Rev 2002;CD000180.

207. Meyer BA, Daling JR. Activity level of mother's usual occupation and low infant birth weight. J Occup Med 1985;27:841-7.

208. Pompeii LA, Savitz DA, Evenson KR, Rogers B, McMahon M. Physical exertion at work and the risk of preterm delivery and small-for-gestational-age birth. Obstet Gynecol 2005;106:1279-88.

209. Rabkin CS, Anderson HR, Bland JM, Brooke OG, Chamberlain G, Peacock JL. Maternal activity and birth weight: a prospective, population-based study. Am J Epidemiol 1990;131:522-31.

210. Schramm WF, Stockbauer JW, Hoffman HJ. Exercise, employment, other daily activities, and adverse pregnancy outcomes. Am J Epidemiol 1996;143:211-8.

211. Sternfeld B, Quesenberry CP, Jr., Eskenazi B, Newman LA. Exercise during pregnancy and pregnancy outcome. Med Sci Sports Exerc 1995;27:634-40.

212. Zuckerman BS, Frank DA, Hingson R, Morelock S, Kayne HL. Impact of maternal work outside the home during pregnancy on neonatal outcome. Pediatrics 1986;77:459-64.

213. Clapp JF, III, Kim H, Burciu B, Schmidt S, Petry K, Lopez B. Continuing regular exercise during pregnancy: effect of exercise volume on fetoplacental growth. Am J Obstet Gynecol 2002;186:142-7.

214. Hall DC, Kaufmann DA. Effects of aerobic and strength conditioning on pregnancy outcomes. Am J Obstet Gynecol 1987;157:1199-203.

215. Hatch MC, Shu XO, McLean DE, Levin B, Begg M, Reuss L, Susser M. Maternal exercise during pregnancy, physical fitness, and fetal growth. Am J Epidemiol 1993;137:1105-14.

216. Nieuwenhuijsen MJ, Northstone K, Golding J. Swimming and birth weight. Epidemiology 2002;13:725-8.

217. Piravej K, Saksirinukul R. Survey of patterns, attitudes, and the general effects of exercise during pregnancy in 203 Thai pregnant women at King Chulalongkorn Memorial Hospital. J Med Assoc Thai 2001;84 Suppl 1:S276-S282.

218. Armstrong BG, Nolin AD, McDonald AD. Work in pregnancy and birth weight for gestational age. Br J Ind Med 1989;46:196-9.

219. Bell RJ, Palma SM, Lumley JM. The effect of vigorous exercise during pregnancy on birth-weight. Aust N Z J Obstet Gynaecol 1995;35:46-51.

220. Clapp JF, III, Capeless EL. Neonatal morphometrics after endurance exercise during pregnancy. Am J Obstet Gynecol 1990;163:1805-11.

221. Magann EF, Evans SF, Newnham JP. Employment, exertion, and pregnancy outcome: assessment by kilocalories expended each day. Am J Obstet Gynecol 1996;175:182-7.

222. Nurminen T, Lusa S, Ilmarinen J, Kurppa K. Physical work load, fetal development and course of pregnancy. Scand J Work Environ Health 1989;15:404-14.

223. Perkins CC, Pivarnik JM, Paneth N, Stein AD. Physical activity and fetal growth during pregnancy. Obstet Gynecol 2007;109:81-7.

224. Rao S, Kanade A, Margetts BM, Yajnik CS, Lubree H, Rege S, Desai B, Jackson A, Fall CH. Maternal activity in relation to birth size in rural India. The Pune Maternal Nutrition Study. Eur J Clin Nutr 2003;57:531-42.

225. Alderman BW, Zhao H, Holt VL, Watts DH, Beresford SA. Maternal physical activity in pregnancy and infant size for gestational age. Ann Epidemiol 1998;8:513-9.

226. Campbell MK, Mottola MF. Recreational exercise and occupational activity during pregnancy and birth weight: a case-control study. Am J Obstet Gynecol 2001;184:403-8.

227. Klebanoff MA, Shiono PH, Rhoads GG. Outcomes of pregnancy in a national sample of resident physicians. N Engl J Med 1990;323:1040-5.

228. Launer LJ, Villar J, Kestler E, de Onis M. The effect of maternal work on fetal growth and duration of pregnancy: a prospective study. Br J Obstet Gynaecol 1990;97:62-70.

229. Spinillo A, Capuzzo E, Baltaro F, Piazza G, Nicola S, Iasci A. The effect of work activity in pregnancy on the risk of fetal growth retardation. Acta Obstet Gynecol Scand 1996;75:531-6.

230. Tuntiseranee P, Geater A, Chongsuvivatwong V, Kor-anantakul O. The effect of heavy maternal workload on fetal growth retardation and preterm delivery. A study among southern Thai women. J Occup Environ Med 1998;40:1013-21.

231. Alderman BW, Bradley CM, Greene C, Fernbach SK, Baron AE. Increased risk of craniosynostosis with maternal cigarette smoking during pregnancy. Teratology 1994;50:13-8.

232. Sidney S, Jacobs DR, Jr., Haskell WL, Armstrong MA, Dimicco A, Oberman A, Savage PJ, Slattery ML, Sternfeld B, Van Horn L. Comparison of two methods of assessing physical activity in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. Am J Epidemiol 1991;133:1231-45.

233. Schmidt MD, Pekow P, Freedson PS, Markenson G, Chasan-Taber L. Physical activity patterns during pregnancy in a diverse population of women. J Womens Health (Larchmt) 2006;15:909-18.

234. Berrigan D, Troiano RP, McNeel T, Disogra C, Ballard-Barbash R. Active transportation increases adherence to activity recommendations. Am J Prev Med 2006;31:210-6.

235. Alexander GR, Kogan MD, Himes JH. 1994-1996 U.S. singleton birth weight percentiles for gestational age by race, Hispanic origin, and gender. Matern Child Health J 1999;3:225-31.

236. Lynch CD, Zhang J. The research implications of the selection of a gestational age estimation method. Paediatr Perinat Epidemiol 2007;21 Suppl 2:86-96.

237. Backe B, Nakling J. Term prediction in routine ultrasound practice. Acta Obstet Gynecol Scand 1994;73:113-8.

238. Campbell S, Warsof SL, Little D, Cooper DJ. Routine ultrasound screening for the prediction of gestational age. Obstet Gynecol 1985;65:613-20.

239. Kieler H, Axelsson O, Nilsson S, Waldenstrom U. Comparison of ultrasonic measurement of biparietal diameter and last menstrual period as a predictor of day of delivery in women with regular 28 day-cycles. Acta Obstet Gynecol Scand 1993;72:347-9.

240. Kramer MS, McLean FH, Boyd ME, Usher RH. The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations. Jama 1988;260:3306-8.

241. Mongelli M, Wilcox M, Gardosi J. Estimating the date of confinement: ultrasonographic biometry versus certain menstrual dates. Am J Obstet Gynecol 1996;174:278-81.

242. Alexander GR, Tompkins ME, Petersen DJ, Hulsey TC, Mor J. Discordance between LMP-based and clinically estimated gestational age: implications for research, programs, and policy. Public Health Rep 1995;110:395-402.

243. Mustafa G, David RJ. Comparative accuracy of clinical estimate versus menstrual gestational age in computerized birth certificates. Public Health Rep 2001;116:15-21.

244. Schmidt MD, Freedson PS, Pekow P, Roberts D, Sternfeld B, Chasan-Taber L. Validation of the Kaiser Physical Activity Survey in pregnant women. Med Sci Sports Exerc 2006;38:42-50.

245. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385-96.

246. Newton RW, Webster PA, Binu PS, Maskrey N, Phillips AB. Psychosocial stress in pregnancy and its relation to the onset of premature labour. Br Med J 1979;2:411-3.

247. Newton RW, Hunt LP. Psychosocial stress in pregnancy and its relation to low birth weight. Br Med J (Clin Res Ed) 1984;288:1191-4.

248. Tucker KL, Bianchi LA, Maras J, Bermudez OI. Adaptation of a food frequency questionnaire to assess diets of Puerto Rican and non-Hispanic adults. Am J Epidemiol 1998;148:507-18.

249. Collings C, Curet LB. Fetal heart rate response to maternal exercise. Am J Obstet Gynecol 1985;151:498-501.

250. Juhl M, Andersen PK, Olsen J, Madsen M, Jorgensen T, Nohr EA, Andersen AM. Physical exercise during pregnancy and the risk of preterm birth: a study within the Danish National Birth Cohort. Am.J.Epidemiol. 2008;167:859-66.

251. Barnes DL, Adair LS, Popkin BM. Women's physical activity and pregnancy outcome: a longitudinal analysis from the Philippines. Int J Epidemiol 1991;20:162-72.

252. Hemming K, Hutton JL, Glinianaia SV, Jarvis SN, Platt MJ. Differences between European birthweight standards: impact on classification of 'small for gestational age'. Dev.Med.Child Neurol. 2006;48:906-12.

253. Rodrigues T, Teles TP, Miguel C, Pereira A, Barros H. [Small for gestational age newborn infants. The effect of standard curves of birth weight on the calculation of the prevalence and of the risk factors]. Acta Med.Port. 1996;9:335-40.

254. Clapp JF. Influence of endurance exercise and diet on human placental development and fetal growth. Placenta 2006;27:527-34.

255. Clapp JF, III. The effects of maternal exercise on fetal oxygenation and feto-placental growth. Eur J Obstet Gynecol Reprod Biol 2003;110 Suppl 1:S80-S85.