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Pre-Pregnancy Fitness and Risk of Gestational Diabetes: A Longitudinal Analysis

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Abstract

Purpose—To assess the associations of pre-pregnancy cardiorespiratory fitness, moderate-to-vigorous-intensity physical activity (MVPA), and time spent watching television with subsequent development of gestational diabetes mellitus (GDM).

Methods—Participants were 1,333 women enrolled in the Coronary Artery Risk Development in Young Adults (CARDIA) study who did not have diabetes either at baseline (1985-86) or prior to births occurring after baseline. Baseline fitness was estimated using a graded symptom-limited maximal exercise treadmill test and expressed in metabolic equivalent (MET) units. Baseline MVPA (exercise units/day) was measured using the CARDIA physical activity history questionnaire, and television viewing (hours/day) was assessed by self-report in 1990-91. Logistic regression analysis was used to derive odds ratios (OR) and 95% confidence intervals (CI), adjusting for time from baseline to delivery and baseline study center, age, race, education, parity,

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family history of diabetes, smoking, alcohol, saturated fat intake, waist circumference, HOMA-IR, and HDL-Cholesterol.

Results—Over 25 years of follow up, 164 women developed GDM. The odds of developing GDM were 21% lower for each 1 standard deviation increment in baseline level of fitness (2.3 METs; OR 0.79, 95% CI 0.65, 0.96). Pre-pregnancy MVPA and television viewing were not statistically associated with the development of GDM.

Conclusion—Study findings indicate that objectively assessed pre-pregnancy fitness, but not self-reported MVPA or television time, is associated with GDM. Clinicians should counsel women on the benefits of improving fitness in the pre-conception period, particularly among women at greater risk for GDM.

Keywords

cardiorespiratory fitness; physical activity; sedentary behavior; television viewing

Introduction

Gestational diabetes mellitus (GDM) is a common pregnancy complication, affecting up to 14% of pregnant women, depending on the population and diagnostic criteria (1). Risk factors for the development of GDM include family history of diabetes, older maternal age, and other pre-pregnancy attributes, including overweight or obesity, low high density lipoprotein cholesterol (HDL-C), impaired fasting glucose, and higher fasting insulin (2, 3). Women with GDM are at increased risk for perinatal morbidity and future risk of type 2 diabetes and metabolic syndrome (4, 5). Furthermore, offspring born to women with GDM are at greater risk for obesity and type 2 diabetes, thus perpetuating a cycle of adverse health outcomes (6).

It is well known that lifestyle behaviors, such as physical activity, can delay or prevent the development of type 2 diabetes (7). Physical activity increases the rate of glucose uptake in the skeletal muscle, thereby improving glucose tolerance and insulin sensitivity. Moderate-to-vigorous-intensity physical activity (MVPA) and higher levels of cardiorespiratory fitness (henceforth known as fitness) are both associated with a reduced risk of type 2 diabetes (8, 9). Emerging evidence also suggests that time spent in sedentary behaviors, such as television viewing, is related to a greater risk of diabetes, independent of physical activity level and body mass index (BMI) (9, 10). Therefore, MVPA, fitness, and sedentary behaviors may play important roles in the development of GDM.

Findings from epidemiologic studies on the associations of MVPA before or during pregnancy with subsequent risk of GDM are inconsistent. Several studies have shown an inverse relationship (11-19), while others report no association (12, 13, 20-22). Randomized controlled studies suggest that MVPA in pregnancy provides a small beneficial effect on GDM risk, although again the literature is mixed, in part because pregnant women struggle with adhering to exercise routines (23). There are several limitations of the existing literature. First, prior studies examining the association of MVPA with risk of GDM have not evaluated pre-pregnancy metabolic status, including fasting blood glucose, insulin, or

insulin resistance, which are known risk factors of GDM (2). This is particularly important because approximately half of women have recurrent GDM, indicating that traditional metabolic risk factors do not fully explain the association with GDM (24). A second limitation is the reliance on self-reported physical activity. Fitness may be a better measure of habitual MVPA (25). Third, although sedentary behaviors have been linked with type 2 diabetes, few studies have evaluated sedentary behaviors and subsequent risk of GDM (13, 15, 21).

To address these gaps in knowledge, we examined the associations between objectively measured fitness, self-reported MVPA, and self-reported time spent watching television (a surrogate for sedentary behaviors) before pregnancy with subsequent development of GDM, independent of potential confounders and other risk factors for GDM, including pre-pregnancy obesity and cardiometabolic status. A better understanding of the relationships between pre-pregnancy fitness, physical activity, and sedentary behaviors with GDM can inform the development of targeted behavioral interventions to reduce the risk of developing GDM.

Methods

CARDIA is an ongoing prospective cohort study of 5,115 black and white adults who were initially recruited in 1985-1986 from four field centers (Birmingham, AL; Chicago, IL; Minneapolis, MN; and Oakland, CA). Participants completed follow-up visits in 1987-1988 (Year 2), 1990-1991 (Year 5), 1992-1993 (Year 7), 1995-1996 (Year 10), 2000-2001 (Year 15), 2005-2006 (Year 20), and 2010-2011 (Year 25). Attendance rates at each exam were 91%, 86%, 81%, 79%, 74%, 72%, and 72% of the surviving cohort, respectively. Data collection and follow-up protocols were approved by institutional review boards at each field center. All participants provided written informed consent.

A total of 2,787 women were enrolled in baseline, and 1,362 women had at least one birth during the 25 years of follow-up. Women were excluded from analyses if they reported type 1 or type 2 diabetes at baseline or prior to births occurring after baseline ($n=12$), self-reported GDM in a pregnancy before baseline ($n=3$), or were missing data on fitness ($n=13$) or MVPA ($n=1$), resulting in a final sample size of 1,333 for analyses of fitness and MVPA. Data on television viewing were first collected at year 5; therefore, for these analyses, participants were eligible if they had one or more births between years 5-25. Of the 1,333 women eligible at baseline for the fitness and MVPA analyses, 906 attended the year 5 visit and had at least one birth subsequently during follow-up. Women who self-reported GDM at year 2 or 5 ($n=20$) or were missing data on television viewing at year 5 ($n=130$) were excluded from these analyses, resulting in a sample size of 756 for the analyses of television viewing and GDM.

Fitness was assessed in all medically eligible participants with a graded symptom-limited maximal exercise treadmill test using a modified Balke protocol at baseline (26). The test progressively increased in difficulty for up to nine 2-minute stages. Stage 1 consisted of a 2% grade at 3 miles per hour, stages 2-6 used a 6-22% grade at 3.4 miles per hour, increasing grade by 4% each stage, stages 7 and 8 were at a 22 and 25% grade at 4.2 miles

per hour, and stage 9 used a 25% grade at 5.6 miles per hour. Participants were encouraged to continue the test for as long as possible until reaching maximal exertion. The rate of energy expenditure at the end of each stage was estimated and reported in metabolic equivalents (METs). One MET is the energy expenditure per minute of sitting at rest, expressed in oxygen consumption (3.5 ml/kg/min). Estimated rate of energy expenditure in METs for completing each stage ranged from 4.1 for stage 1 to 19.0 for stage 9. We examined maximal METs as a continuous variable and also classified into quintiles and then categorized into three levels as previously reported in CARDIA and the Aerobics Center Longitudinal Study (27, 28). Women in the lowest 20% were classified as low fitness (8.3 METs), women in the 20th to 60th percentile were classified as intermediate fitness (8.4-10.6 METs), and women above the 60th percentile were classified as high fitness (10.7 METs).

Self-reported physical activity was assessed with the validated CARDIA Physical Activity History at each exam (29, 30). Participants were asked about the frequency of participation in 13 moderate or vigorous activities related to recreational sports, exercise, leisure, and occupational activities. Total MVPA was calculated by multiplying the intensity of the activity by the number of months the activity was performed, weighting activities performed more frequently, and then summing across all activities. Details on frequency or duration of physical activity were not assessed directly; therefore physical activity is conveyed in exercise units. Separate scores are reported for moderate, vigorous, and total physical activity. Physical activity was expressed as a continuous variable and also categorized into tertiles based on the sampling distribution: <200, 200-400, and >400 exercise units. The equivalent of meeting physical activity recommendations is approximately 300 exercise units, or 30 minutes of moderate physical activity 5 days per week (30).

To assess television viewing, participants were asked how often they watched television during their leisure time at the Year 5 exam. Response options were never, seldom, sometimes, often, or very often. A never response was assigned a value of 0. If participant responded seldom, sometimes, often, or very often, they were then asked “on average, about how many hours per day do you watch television?” We examined hours per day of television viewing as a continuous variable, and because of the right skewed distribution we also categorized into three groups: 0-1, 2, or 3 hours per day.

Pregnancy history and GDM diagnosis were ascertained through self-report at each CARDIA study visit. Women were asked how many times they had been pregnant at baseline and the number of pregnancies since the previous CARDIA visit, including abortions, miscarriages, stillbirths, or live births, as well as delivery dates and lengths of gestation. Pregnancies that ended in abortion, miscarriage, or those <20 weeks gestation were classified as pregnancy losses. We defined live births as those delivered 20 weeks gestation that occurred between baseline and year 25. Women were asked at each exam, and for each birth, whether the pregnancy was complicated by diabetes. In the absence of type 1 or type 2 diabetes prior to pregnancy, the pregnancy with diabetes was classified as GDM. Prenatal chart reviews from a subsample of 165 parous women, reflecting 200 births, were used to validate self-reported GDM. Sensitivity and specificity for self-reported GDM was 100% and 92%, respectively (31).

Participants self-reported their race, education, first-degree family history of diabetes, cigarette smoking status, and alcohol consumption. Percent of total calories from saturated fat was derived from an interviewer-administered diet history questionnaire developed for the CARDIA study (32). Body weight was measured in light clothing with no shoes to the nearest 0.2 kg using a calibrated balance beam scale. Height was measured using a vertical rule to the nearest 0.5 cm. BMI was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured horizontally midway between the iliac crest and the lowest portion of the ribcage and anteriorly midway between the xiphoid process of the sternum and the umbilicus. Fasting serum collection for glucose, insulin, and HDL-C were conducted based on standardized CARDIA protocols and processed at central laboratories. Glucose was measured using hexokinase coupled to glucose-6-phosphate dehydrogenase. Insulin levels were assessed using radioimmunoassay. We used the homeostasis model assessment of insulin resistance (HOMA-IR) to evaluate insulin resistance ($\text{fasting glucose (mg/dl)} \times \text{fasting insulin (}\mu\text{U/mL)} / 405.0$), because of its strong correlation with physiologic measures of insulin sensitivity across a range of glucose levels (33). HDL-C levels were measured using enzymatic methods after dextran-sulfate-magnesium precipitation of other lipoproteins, and categorized into two groups: < 40 mg/dl and ≥ 40 mg/dl.

Descriptive statistics, stratified by GDM status were calculated for all baseline variables, using chi-square and t-test for categorical and continuous variables, respectively. For non-normally distributed continuous variables, differences across groups were examined using the Wilcoxon-Mann-Whitney test with data presented as medians with interquartile ranges. Spearman correlations were examined between fitness, physical activity, television viewing, and potential confounders.

Multivariable logistic regression analysis was used to estimate the odds ratio (OR) and 95% confidence intervals (CI) for the associations of baseline fitness and MVPA and year 5 television viewing with risk of GDM. Each exposure was included in separate models as both continuous and categorical variables. For continuous models, results are expressed per 1 standard deviation (SD) increment in fitness (2.3 METs), MVPA (256 exercise units), or television viewing (2.1 hours/day) to allow for comparison between the exposures of interest. The crude association is depicted in Model 1. Covariates were then added to the model in a stepwise fashion. Model 2 was adjusted for study center, age, race, education, first-degree family history of diabetes, parity, cigarette smoking status, alcohol consumption, percent of total calories from saturated fat, and time from baseline to delivery. For women with multiple GDM diagnoses or pregnancies, we used the time from baseline to the first GDM diagnosis or first pregnancy, respectively. Based on the known relationships between fitness, physical activity, and sedentary behaviors with obesity and cardiometabolic risk factors, we consider these potential mediators of the relationship between fitness, physical activity, and television viewing with GDM. Our theoretical models can be summarized as follows: fitness/physical activity/television viewing $\rightarrow$ obesity $\rightarrow$ adverse cardiometabolic risk factors $\rightarrow$ GDM. Therefore, Model 3 was additionally adjusted for baseline body mass index (BMI) or waist circumference, but not both, because of the high correlation between these variables ($r=0.87$). Results did not differ between the BMI and waist circumference models; therefore we present the models with waist circumference only. Model 4

additionally adjusted for baseline cardiometabolic status, (i.e. HOMA-IR and HDL-C category). Television viewing models (first assessed at year 5) were adjusted separately, using either baseline or year 5 covariates. Results did not differ; therefore due to higher levels of missing data at year 5 we present models with baseline covariate adjustment.

In exploratory analyses, we controlled for MVPA in the fitness and television viewing models; results were not changed, therefore MVPA was removed from final analyses. The associations of moderate physical activity and vigorous physical activity with GDM were also examined separately. Analyses were also examined controlling for an overall diet quality score assessed at baseline (34). Findings were unchanged; therefore due to missing dietary data (n=24), we present data controlling for percent of calories from saturated fat only. We further examined the interactions of race, BMI, and waist circumference with each exposure. All statistical analyses were conducted using SAS, version 9.4 (SAS Institute, Inc., Cary, North Carolina). All tests were 2-sided, with statistical significance set at $p < 0.05$.

Results

A total of 164 women reported GDM during the 25 years of follow-up (12% of eligible sample). Baseline participant characteristics, stratified by GDM status, are presented in Table 1. Women who developed GDM were more likely to have a family history of diabetes, higher pre-pregnancy BMI and waist circumference, and lower levels of fitness compared to those without GDM. Women with GDM also had worse cardiometabolic profiles, including elevated fasting glucose, insulin, and HOMA-IR levels and lower HDL levels (all $p < 0.05$).

Baseline fitness was positively associated with total, moderate, and vigorous intensity physical activity and inversely associated with year 5 television time in bivariate analyses (See Table, Supplemental Digital Content 1, Spearman correlations). Significant inverse associations were also observed between fitness and BMI, waist circumference, fasting insulin, HOMA-IR, and HDL-C at baseline. Similar, but weaker associations were observed between total physical activity and measures of obesity or cardiometabolic status. Year 5 television time was positively associated with baseline BMI, waist circumference, fasting insulin, HOMA-IR, and inversely associated with HDL-C.

As shown in Table 2, for each additional 1-SD increment in pre-pregnancy fitness (2.3 METS), there was a 28% lower odds of GDM after controlling for demographic and lifestyle factors (Model 2: OR 0.72, 95% CI 0.61-0.86). The association between GDM and fitness was slightly attenuated, but remained significant, after additional adjustment for pre-pregnancy waist circumference (Model 3: OR 0.79, 95% CI 0.65, 0.95), and cardiometabolic status (Model 4: OR 0.79, 95% CI 0.65-0.96). When fitness was modeled categorically, women with high fitness (>10.7 METS) had a 52% lower odds of GDM compared to those with low fitness (<8.3 METS) after adjustment for demographics and lifestyle factors (Model 2: OR 0.48, 95% CI 0.29, 0.80). This association was attenuated with the addition of waist circumference and cardiometabolic status, but remained in the hypothesized direction (Model 4: OR 0.74, 95% CI 0.41, 1.35).

Self-reported MVPA was not associated with odds of GDM when modeled continuously in all of the tested models (Table 3). When modeled categorically, the odds of GDM did not differ between those reporting intermediate (200-400 exercise units) or high (>400 exercise units) levels of MVPA, as compared to those reporting the lowest levels of MVPA (<200 exercise units). Findings did not differ when examining moderate physical activity and vigorous physical activity separately (data not shown).

For the television viewing analyses, a total of 86 women reported GDM between years 5-25 (52.4% of all GDM cases). Self-reported television time, whether modeled continuously or categorically, was not associated with GDM (Table 4).

There were no differences in the associations of fitness, MVPA, and television viewing with odds of GDM by race, BMI, or waist circumference (p for interaction > 0.1 for all; data not shown). Participants included in the final models for fitness, MVPA, and television viewing were similar to the eligible study population in characteristics and health behaviors at study entry (see Table, Supplemental Digital Content 2, baseline characteristics of study population and sub-populations).

Discussion

In this population-based longitudinal study, a higher level of objectively measured pre-pregnancy fitness was associated with lower odds of GDM, independent of baseline demographics, lifestyle behaviors, obesity, and cardiometabolic measures. We did not observe an association between self-reported pre-pregnancy MVPA or television viewing with GDM. Our findings contribute to the care of reproductive-age women in several important ways. First, our results show the importance of fitness versus MVPA as it pertains to GDM risk. To our knowledge, this is the first study to examine associations of objectively measured pre-pregnancy fitness with subsequent development of GDM. Second, this information can be used to aid clinicians in preconception counseling on lifestyle behaviors to reduce GDM in pregnancy.

Many studies have shown that MVPA before pregnancy is associated with a reduced risk of GDM (11-16), although others have not (20, 21). Similar to our study, Van der Ploeg and colleagues reported that self-reported pre-pregnancy physical activity was not associated with GDM in the Australian Longitudinal Study on Women's Health (21). The lack of association between MVPA before pregnancy and GDM observed in our study and others may be due in part to the reliance on self-reported measures of physical activity, which generally have low-to-moderate correlations with objectively measured physical activity (35). Even if pre-pregnancy physical activity was accurately reported, this may not reflect activity levels during early pregnancy, which others have shown is a predictor of GDM risk (11, 12, 16-19). Women who engage in physical activity both before and during pregnancy appear to be at the lowest risk for GDM (12, 16). In the current study, we did not assess MVPA during pregnancy, which may in part explain the lack of association observed in this study.

While MVPA was not significantly associated with GDM in this study, we did observe an inverse association with higher levels of fitness. One possible explanation for the discrepancy in findings is that fitness may be a more reliable and objective measure of higher-intensity habitual physical activity than self-reported MVPA. While MVPA was significantly associated with fitness, the effect size was weak ($r=0.31$, $p<0.001$), which is consistent with other studies examining the associations of objectively measured fitness and self-reported physical activity (36, 37). There may be a threshold of exercise intensity, frequency, and duration that must be achieved to modify GDM risk, which was not captured using self-reported physical activity. Vigorous intensity activities in particular have a larger effect on fitness than activities performed at lower intensities (38); therefore our findings point to the importance of encouraging higher intensity activity early in life, before a pregnancy occurs, in order to decrease GDM risk.

Given that fitness is inversely associated with overall adiposity, fasting insulin, homeostatic model assessment-insulin resistance, and glycosylated hemoglobin A1C (39), it is logical that women with higher pre-pregnancy fitness have a reduced risk of GDM because they enter pregnancy with higher insulin sensitivity and lower central and overall adiposity than women with lower levels of fitness. However, in our study the association between fitness and GDM persisted even after including measures of pre-pregnancy obesity and cardiometabolic status, indicating that the relationship between fitness and GDM may not be fully explained by body size or biomarkers of cardiometabolic risk. Further research is needed to elucidate the mechanisms responsible for the fitness-GDM relationship.

For our analyses of sedentary behavior, we failed to observe significant associations between television viewing and risk of GDM. While less is known about television viewing or overall sedentary behaviors and GDM, our findings are largely consistent with the existing literature (13, 15, 21). Zhang and colleagues found that greater time spent watching television was associated with higher GDM risk among women in the Nurses Health Study II; however, this association was attenuated after additional adjustment for BMI (15). Similarly, Oken et al. found no associations between television viewing before or during pregnancy with risk of GDM (13). Therefore, while evidence suggests that sedentary time is detrimentally associated with cardiometabolic risk in non-pregnant populations, current findings do not support a direct association between sedentary time, assessed by self-report, and risk of GDM. Additional studies with objectively measured sedentary time are needed.

A major strength of this study is the inclusion of three exposure measures, namely fitness, MVPA, and television viewing, as this provides a more comprehensive analysis of activity patterns. Further, we are one of the only studies to evaluate the impact of pre-pregnancy biochemical measures of cardiometabolic risk (HOMA-IR and HDL-C) in addition to measures of adiposity. The longitudinal population-based cohort design allows us to prospectively examine the associations of activity-related variables with future development of GDM. Furthermore, the CARDIA study population also included an approximately equal number of white and black women, while the majority of studies in the literature have focused exclusively on non-Hispanic white populations.

Limitations of this study include the use of treadmill test duration to estimate fitness, rather than a direct measure of maximum oxygen consumption. However, previous studies have reported a high correlation between test duration on a symptom-limited test and maximal oxygen consumption (40). MVPA and television viewing were self-reported, which may be subject to social desirability bias and non-differential misclassification, biasing results toward the null. Television viewing was first assessed at the year 5 visit and therefore the sample size of participants was smaller for these analyses. Given that we adjusted for baseline covariates in the television viewing analyses, this assumes that television viewing is correlated across time within a person, which may not be the case. However, study findings were not changed when we adjusted for year 5 covariates. Additionally, the amount of time between assessment of the exposure and pregnancy varied across individuals, and we did not have data on the specific date of GDM diagnosis. However, we did control for time from baseline to delivery in our analyses. Finally, the CARDIA cohort includes Black and White adults only, therefore these findings may not be generalizable to other racial/ethnic groups.

In conclusion, objectively measured pre-pregnancy fitness, but not self-reported MVPA or television viewing, was associated with subsequent development of GDM. Our findings indicate that habitual engagement in physical activities that achieve the frequency, intensity, and duration required to improve fitness in the pre-conception period is important for reducing GDM risk. These findings may be useful for guiding patient-provider counseling on physical activity before and during pregnancy. While there are many health benefits associated with increasing moderate intensity physical activities and reducing sedentary time, it may be important for clinicians to also emphasize the importance of improving fitness in the pre-conception period through high-intensity physical activities, particularly among women at higher risk for GDM. Given that this is the first study, to our knowledge, to report associations between pre-pregnancy fitness and GDM, additional studies are needed to replicate these findings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1
Sociodemographic and Pre-pregnancy Characteristics at Baseline by Subsequent Gestational Diabetes Status, the CARDIA Study (1985-2011)

Pre-pregnancy Characteristics*	Non-GDM Pregnancy (N=1169)	GDM Pregnancy (N=164)	P-value†
Age (years)	24.0 ± 3.6	24.4 ± 3.9	0.230
Black (%)	594 (50.8)	79 (48.2)	0.526
High school education or less (%)	420 (35.9)	52 (31.7)	0.290
Family history of diabetes (%)	166 (14.2)	35 (21.3)	0.017
Nulliparous (%)	795 (68.0)	108 (65.9)	0.581
Past or current smoker (%)	448 (38.5)	72 (44.4)	0.146
Alcohol (ml/day)	2.4 [0.0, 9.6]	2.4 [0.0, 8.7]	0.904
Diet quality score‡	63.8 ± 13.7	65.0 ± 12.4	0.278
Saturated fat (% of total kcals)	14.2 [3.8]	14.3 [3.7]	0.720
Physical activity (exercise units)			
Total	295.0 [154.0, 477.0]	294.0 [166.0, 477.0]	0.869
Moderate	107.0 [48.0, 180.0]	111.5 [60.0, 171.5]	0.521
Vigorous	172.0 [72.0, 316.0]	150.0 [72.0, 326.0]	0.893
Cardiorespiratory fitness (METs)	10.3 [9.2, 12.0]	10.1 [8.9, 11.5]	0.011
Television viewing (hours/day)§	2.0 [1.0, 3.0]	2.0 [1.0, 4.0]	0.665
Body mass index (kg/m²)	22.3 [20.4, 25.2]	22.9 [20.8, 28.1]	0.011
Waist circumference (cm)	69.8 [65.5, 76.0]	70.8 [66.0, 83.0]	0.010
Fasting glucose (mg/dl)	79.0 [74.0, 83.0]	80.0 [75.0, 87.0]	0.010
Impaired fasting glucose (%)	11 (1.0)	4 (2.5)	0.100
Fasting Insulin (µU/mL)	7.3 [6.2, 9.0]	8.2 [6.3, 10.1]	0.005
HOMA-IR	1.4 [1.2, 1.8]	1.6 [1.2, 2.1]	0.001
Low HDL-C (%)¶	76 (6.5)	18 (11.1)	0.033

METS = metabolic equivalents; HOMA-IR = homeostasis model assessment of insulin resistance; HDL-C = high density lipoprotein cholesterol. Data are N (%) or Mean ± SD or Median [IQR].

* Some variation in sample sizes across covariates due to missing data.

† Differences between groups examined using Wilcoxon-Mann-Whitney, chi-square, or Fisher's exact test, as appropriate. Bolded values are statistically significant (p<0.05).

‡ Diet quality score, higher scores indicate better diet quality (possible score range 0-132).

§ Television assessed at year 5 (1990-1991), N=756.

|| Impaired fasting glucose defined as > 100 mg/dl.

¶ Low HDL-Cholesterol defined as < 40 mg/dl.

Associations of Baseline Fitness with Risk of Gestational Diabetes, the CARDIA Study (1985-2011)

Table 2

Cardiorespiratory Fitness (METS)										
Continuous*			Low 8.3		Intermediate 8.4-10.6		High 10.7			
Fitness Models	N	OR (95% CI)	P-value	N	OR (95% CI)	N	OR (95% CI)	N	OR (95% CI)	P-value for Trend
Model 1	1333	0.78 (0.66-0.91)	0.001	204	1.00 (Ref)	523	0.63 (0.40-0.98)	606	0.52 (0.34-0.81)	0.007
Model 2	1274	0.72 (0.61-0.86)	<0.001	188	1.00 (Ref)	500	0.65 (0.41-1.05)	586	0.48 (0.29-0.80)	0.005
Model 3	1269	0.79 (0.65-0.95)	0.013	188	1.00 (Ref)	499	0.85 (0.51-1.42)	582	0.70 (0.39-1.25)	0.210
Model 4	1248	0.79 (0.65-0.96)	0.017	184	1.00 (Ref)	485	0.93 (0.54-1.57)	579	0.74 (0.41-1.35)	0.263

Table 3
Associations of Baseline Physical Activity with Risk of Gestational Diabetes, the CARDIA Study (1985-2011)

Total Physical Activity (Exercise Units)										

Table 4
Associations of Year 5 Television Viewing Time with Risk of Gestational Diabetes, the CARDIA Study (1990-2011)

Television Viewing (Hours/Day)										
		Continuous*			Low (0-1)		Intermediate (2)		High (3)	
Television Viewing Models	N	OR (95% CI)	P-value	N	OR (95% CI)	N	OR (95% CI)	N	OR (95% CI)	P-value for Trend
Model 1	756	1.07 (0.87-1.32)	0.519	252	1.00 (Ref)	200	0.86 (0.46-1.62)	304	1.39 (0.31-2.34)	0.178
Model 2	723	0.96 (0.74-1.25)	0.783	242	1.00 (Ref)	190	0.77 (0.40-1.50)	291	1.15 (0.62-2.11)	0.614
Model 3	721	0.95 (0.73-1.24)	0.715	241	1.00 (Ref)	190	0.77 (0.40-1.49)	290	1.06 (0.57-1.98)	0.807
Model 4	709	0.95 (0.72, 1.24)	0.694	238	1.00 (Ref)	189	0.76 (0.39, 1.48)	282	1.01 (0.54, 1.90)	0.953

Model 1 is the unadjusted association; Model 2 adjusted for center, time from baseline to delivery, race, age, parity, education, family history of diabetes, smoking, alcohol, and dietary fat; Model 3 additionally adjusted for waist circumference; Model 4 additionally adjusted for HOMA-IR and HDL-C.

* Continuous models expressed per 1 SD of television viewing (2.1 hours/day).