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Original Contribution

Healthy Lifestyle During Early Pregnancy and Risk of Gestational Diabetes Mellitus

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Previous studies have found associations between individual healthy behaviors and reduced risk of gestational diabetes mellitus (GDM); however, the association of composite healthy lifestyle during pregnancy with GDM has not been examined. Participants in the Omega Study (n = 3,005), a pregnancy cohort study conducted in Washington State (1996–2008), reported information on diet, physical activity, smoking, and stress during early pregnancy. Lifestyle components were dichotomized into healthy/unhealthy and then combined into a total lifestyle score (range, 0–4). Regression models were used to determine relative risk of GDM (n = 140 cases) in relation to healthy lifestyle. Twenty percent of participants had a healthy diet, 66% were physically active, 95% were nonsmokers, and 55% had low stress. Each 1-point increase in lifestyle score was associated with a 21% lower risk of GDM (95% confidence interval: 0.65, 0.96) after adjustment for age, race, and nulliparity. Adjustment for prepregnancy body mass index, prepregnancy physical activity, and prepregnancy smoking attenuated the associations slightly. Associations were similar in normal-weight and overweight/obese women. In this study, a composite measure of healthy lifestyle during early pregnancy was associated with substantially lower GDM risk. Public health messaging and interventions promoting multiple aspects of a healthy lifestyle during early pregnancy should be considered for GDM prevention.

diabetes mellitus; diet; gestational diabetes; life stress; lifestyle; physical activity; pregnancy; smoking

Abbreviations: AHEI-2010, Alternate Healthy Eating Index 2010; CI, confidence interval; GDM, gestational diabetes mellitus; RR, relative risk.

Gestational diabetes mellitus (GDM) is a common pregnancy complication characterized by new onset of glucose intolerance during pregnancy (1). In the United States, the prevalence of GDM ranges between 4.6% and 9.2% (2) and has been increasing over the last 2 decades (3). GDM has important health consequences for both mothers and children. Women with a history of GDM are at increased risk of GDM in subsequent pregnancies (4) and of type 2 diabetes postpartum (5). Children exposed to GDM in utero are at increased risk of macrosomia at birth (6) and of obesity and type 2 diabetes in childhood and adulthood (7).

Several healthy lifestyle behaviors before and during early pregnancy have been associated with reduced risk of GDM. Prepregnancy leisure-time physical activity is associated with 11%–86% decreased risk of GDM (8). Adherence to a healthy prepregnancy dietary pattern is associated with 15%–63% decreased risk of GDM (9–11). Early-pregnancy leisure-time physical activity is associated with 9%–49% decreased risk of GDM (8). Dietary interventions (promoting a healthy diet) during early pregnancy are associated with 31%–81% decreased risk of GDM (12). Studies of smoking and GDM risk have shown inconsistent results, but there is some evidence that not smoking before pregnancy or during early pregnancy may be associated with decreased risk of GDM (13–15).

Public health messaging and interventions designed to prevent GDM may be more successful if multiple maternal behaviors are targeted (16). However, most previous studies of maternal lifestyle before and during pregnancy have focused on individual maternal behaviors and have not examined healthy behaviors jointly. In a previous study investigating the

association of multiple maternal behaviors before pregnancy with GDM risk, Zhang et al. (17) found that women who were physically active, adhered to a healthy diet, maintained a healthy weight, and did not smoke had a 52% reduced risk of GDM. That study focused on prepregnancy behaviors and did not consider maternal lifestyle during pregnancy. In addition, maternal psychosocial stress, which has been associated with increased risk of GDM (18), was not considered as a modifiable maternal behavior for prevention of GDM.

Healthy maternal behaviors during early pregnancy may help mothers maintain glucose homeostasis in response to increased insulin resistance in the later periods of pregnancy (19). Further, early pregnancy, an important period that coincides with initiation of perinatal care, provides an opportunity to affect maternal behavior and subsequent health during pregnancy. Our objective in this study was to investigate the independent and joint associations of components of a healthy maternal lifestyle, including physical activity, a healthy diet, nonsmoking, and low stress levels, during early pregnancy with risk of GDM.

METHODS

Study setting and study population

Data used in this study were collected as part of the Omega Study, a prospective pregnancy cohort study designed to assess dietary risk factors for pregnancy complications. Details about the study design have been published previously (20). Briefly, pregnant women initiating prenatal care at clinics associated with Swedish Medical Center and Tacoma General Hospital in Washington State were recruited from 1996 to 2008. Women were eligible to participate in the Omega Study if they were at least 18 years of age, were able to speak and read English, initiated prenatal care prior to 20 weeks' gestation, and planned to carry the fetus to term and deliver at one of the 2 study hospitals. A total of 5,063 eligible women were approached, and 4,602 agreed to participate (91%). The Omega Study was approved by the institutional review boards of Swedish Medical Center and Tacoma General Hospital. All participants gave written informed consent.

Data collection

Study participants completed an in-person structured interview at an average of 15 weeks' gestation (standard deviation, 3 weeks). Interviews were conducted by trained study interviewers. Information collected during the interview included sociodemographic characteristics, reproductive and medical history, and lifestyle behaviors before and during pregnancy. Participants were followed until delivery, and trained study personnel abstracted maternal medical records for information on pregnancy complications (including GDM) and course of pregnancy. Prepregnancy body mass index (weight (kg)/height $(m)^2$) was calculated using reported height and prepregnancy weight and categorized according to standard cutoffs (underweight: <18.5; normal-weight: 18.5–24.9; overweight: 25–29.9; obese: ≥30) (21).

Lifestyle score components

Leisure-time physical activity. Physical activity during the week before the study interview was assessed in all participants using the following questions: 1) "Which recreational physical activities did you participate in during the last 7 days?," and for each activity reported, 2) "How many days?" and 3) "How much time did you spend in the activity per episode?". Participants were provided examples of leisure-time physical activity, including walking, swimming, jogging, weight-lifting, dance/aerobics, bicycling, hiking, and yoga. Based on activity descriptions, each activity reported was matched to a metabolic equivalent value, a measure of the energy expenditure of a physical activity (22). Activities with metabolic equivalent values greater than or equal to 3 were considered moderate/vigorous activities. The total duration of each moderate/vigorous leisure-time physical activity reported was calculated, and durations were summed to obtain total duration of moderate/vigorous leisure-time physical activity (minutes/week). Self-reported information on physical activity in early pregnancy, collected using an interviewer-administered questionnaire similar to the one we used, had moderate validity (Spearman correlation coefficient = 0.12–0.24) and good reliability (intraclass correlation coefficient = 0.82) compared with accelerometer data recorded among pregnant women (23, 24).

Diet. Participants were asked to recall diet over the past 3 months using a self-administered semiquantitative food frequency questionnaire. Diet was scored using a modified version of the Alternate Healthy Eating Index 2010 (AHEI-2010) (25). Ten of the 11 dietary components of the AHEI-2010 (higher intakes of vegetables, fruit, whole grains, nuts, long-chain (n-3) fatty acids, and polyunsaturated fatty acids and lower intakes of sugar-sweetened beverages, red/processed meat, *trans*-fat, and sodium) were each assigned a score ranging from 0 to 10, with 10 representing optimal dietary behavior, based on AHEI-2010 criteria. Alcohol consumption was not included in our score. Scores for each component were summed to obtain the total AHEI-2010 score for each participant, with a possible range from 0 to 100. Scoring criteria and descriptive statistics for each component are presented in Web Table 1 (available at https://academic.oup.com/aje). The food frequency questionnaire used in our study had good validity (Pearson correlation coefficient = 0.37) for total energy intake and moderate-to-good validity for nutrient intake (Pearson correlation coefficient = 0.18–0.63) compared with 24-hour dietary recalls and food diaries completed by women in previous studies (26, 27).

Smoking. Participants reported smoking history and smoking status at the beginning of pregnancy. Participants were categorized as having never smoked, quit before pregnancy, or smoked during pregnancy. Self-reported smoking in early pregnancy had good sensitivity (82%) and specificity (99%) compared with a plasma cotinine concentration cutoff value of 30 nmol/L in a similar cohort (28).

Stress. Stress was measured using the 4-item version of the Perceived Stress Scale (29), a scale designed to measure the degree to which situations in one's life are appraised as stressful. Participants were asked how often in the past 3 months each of the following statements had been true: 1) "How often have you felt confident about your ability to

handle personal problems?"; 2) "How often have you felt difficulties were piling up so high that you could not overcome them?"; 3) "How often have you felt you were unable to control important things in your life?"; and 4) "How often have you felt things were going your way?". Response options ranged from 0 to 4, where 0 was "never" and 4 was "very often." Responses were summed to obtain a total Perceived Stress Scale score for each participant, with a possible range from 0 to 16, where a greater score indicated higher stress levels. The 4-item version of the Perceived Stress Scale has also been shown to have good construct validity (Pearson correlation coefficient = −0.62) among pregnant women, as compared with the Mental Component Summary of the Short Form 12 Health Survey (30).

Healthy lifestyle score

Responses to questions describing each component of lifestyle during early pregnancy were dichotomized into a binary variable (healthy (1)/unhealthy (0)) for each participant, using the following criteria. Healthy leisure-time physical activity was considered to be ≥150 minutes per week of moderate/vigorous physical activity according to the American College of Obstetricians and Gynecologists recommendation for physical activity during pregnancy (31). Healthy diet was considered to be an AHEI-2010 score in the upper two-fifths of the distribution (≥62), as in previous studies of healthy lifestyle and GDM (17). Healthy smoking behavior was considered to be never smoking or quitting before pregnancy. Healthy levels of stress were considered to be Perceived Stress Scale scores less than or equal to the median of the distribution (≤3), as there are no diagnostic cutoffs for the Perceived Stress Scale. All healthy lifestyle criteria were defined a priori. The number of healthy lifestyle behaviors was summed for each participant to create a healthy lifestyle score with a range from 0 to 4. Healthy lifestyle score was used in models as both a continuous variable and a categorical variable. Healthy lifestyle score was also dichotomized on the basis of number of healthy behaviors: all 4 healthy behaviors versus 3 or fewer healthy behaviors and 3 or more healthy behaviors versus 2 or fewer healthy behaviors.

Gestational diabetes mellitus

All study participants were evaluated for GDM at 24–28 weeks' gestation using the Carpenter and Coustan criteria, according to the American Diabetes Association guidelines (32). Participants were screened for GDM using a 50-g oral glucose challenge test, and if they failed the glucose challenge, they were tested with a follow-up 100-g, 3-hour oral glucose tolerance test within 1–2 weeks of screening. GDM was defined as having 2 or more of the following abnormal plasma glucose concentrations on the oral glucose tolerance test: fasting glucose concentration ≥105 mg/dL; 1-hour glucose concentration ≥190 mg/dL; 2-hour glucose concentration ≥165 mg/dL; or 3-hour glucose concentration ≥145 mg/dL.

Statistical analyses

Mean values and standard deviations were used to characterize continuous variables. Frequencies and percentages were used to characterize categorical variables. Modified Poisson regression (33) was used to determine relative risks of GDM (and 95% confidence intervals) for each healthy lifestyle component individually and for each 1-point change in lifestyle score as both a continuous and a categorical variable. Results from all models were adjusted for confounders chosen a priori. Model 1 adjusted for maternal age, race (white/nonwhite), and nulliparity (yes/no). Model 2 adjusted for all covariates in model 1 and prepregnancy body mass index. Model 3 adjusted for all covariates in model 2 and prepregnancy healthy leisure-time physical activity (≥150 minutes/week) and prepregnancy smoking. *P* values for linear trend across increasing lifestyle scores were estimated from a model using lifestyle score as a continuous variable. To assess effect modification by prepregnancy overweight/obesity, we used stratified regression models and multiplicative interaction terms. Women who were underweight prior to pregnancy ($n = 55$) were excluded. A 2-sided alpha level of 0.05 was used for statistical significance in all analyses. All analyses were performed using SAS 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Participants with singleton births were included in this analysis ($n = 4{,}445$). Participants with a diagnosis of type 1 or type 2 diabetes prior to pregnancy ($n = 60$), missing information on GDM diagnosis ($n = 103$), implausible values for total energy intake (<500 kcal/day or >3,500 kcal/day; $n = 76$) or physical activity duration (>35 hours/week; $n = 138$), or missing information on any component of the healthy lifestyle score ($n = 1{,}063$) were excluded. After these exclusions, 3,005 study participants remained for analyses. Sociodemographic and medical characteristics were similar between the full Omega cohort, the 1,063 women excluded for missing lifestyle data, and the final analytical data set (Web Table 2).

A total of 140 women were diagnosed with GDM in our study. Overall, 7% of participants practiced all 4 healthy lifestyle behaviors, and 1% practiced none of the healthy lifestyle behaviors considered (Table 1). Participants with higher healthy lifestyle scores were more likely than participants with low healthy lifestyle scores to be white, nulliparous, married, and normal-weight (body mass index 18.5–24.9) before pregnancy, to have at least a high school education, and to have no family history of diabetes.

Twenty percent of participants had a healthy diet, 66% were physically active, 95% did not smoke during pregnancy, and 55% had low stress levels (Table 2). After adjustment for maternal age, race, parity, and all lifestyle components, only nonsmoking was significantly associated with reduced risk of GDM (for diet, relative risk (RR) = 0.85 (95% confidence interval (CI): 0.56, 1.22); for physical activity, RR = 0.88 (95% CI: 0.63, 1.22); for not smoking, RR = 0.55 (95% CI: 0.30, 0.99); and for low stress, RR = 0.75 (95% CI: 0.55, 1.04)). Adjusted estimates were similar to unadjusted estimates. Additional adjustment for prepregnancy body mass index, healthy prepregnancy physical activity, and prepregnancy smoking attenuated the associations slightly. Associations did not differ significantly between normal-weight and overweight/obese women (*P* values for interaction: diet, $P = 0.76$; physical

Table 1. Characteristics of Participants in the Omega Study, Overall and by Healthy Lifestyle Score, Seattle, Washington, 1996–2008

Characteristic	All Participants ($n = 3,005$)			Healthy Lifestyle Score[a]											
				0 ($n = 39$)			1 ($n = 427$)			2 ($n = 1,155$)			3 ($n = 1,152$)			4 ($n = 232$)		
	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%
Age, years	33 (4.3)			30 (4.7)			32 (5.0)			33 (4.2)			33 (4.0)			34 (4.2)		
Prepregnancy BMI[b]	23 (4.5)			25 (4.8)			24 (4.8)			24 (4.7)			23 (4.1)			23 (4.1)		
Weight gain by 20 weeks' gestation, kg	4.5 (2.2)			4.7 (2.2)			4.5 (2.2)			4.4 (2.3)			4.5 (2.1)			4.6 (2.0)		
White race		2,640	88		34	87		351	82		992	86		1,045	91		218	94
High school education or more		2,830	98		32	82		403	94		1,132	98		1,133	98		230	99
Nulliparous		1,913	64		26	67		243	57		712	63		761	66		171	74
Married		2,792	93		24	62		384	90		1,071	93		1,090	95		223	96
History of GDM		28	1		0	0		6	1		12	1		10	1		0	0
Family history of diabetes		400	13		8	21		69	16		162	14		133	12		22	10
Preeclampsia		66	2		0	0		16	4		26	2		18	2		6	3
Prepregnancy BMI category																		
Underweight (<18.5)		55	2		0	0		11	3		21	2		20	2		3	1
Normal-weight (18.5–24.9)		2,259	75		23	60		294	69		847	73		904	78		191	82
Overweight (25–29.9)		474	16		12	33		78	18		202	17		155	13		26	11
Obese (≥30)		217	7		3	8		44	10		85	7		73	6		12	5

Abbreviations: BMI, body mass index; GDM, gestational diabetes mellitus; SD, standard deviation.
[a] Lifestyle score (range, 0–4) included diet, leisure-time physical activity, smoking, and stress.
[b] Weight (kg)/height $(m)^2$.

activity, $P = 0.59$; smoking, $P = 0.50$; stress, $P = 0.92$ (Web Table 3)).

Each additional healthy lifestyle component was associated with 21% lower risk of GDM (95% CI: 0.65, 0.96) after adjustment for maternal age, race, and parity (Table 3). Women with no healthy lifestyle components had a 4.43 times' greater risk of GDM (95% CI: 1.33, 14.76) than women with all 4 healthy lifestyle components (P for trend = 0.02). Women with all 4 healthy lifestyle components had a 35% lower risk of GDM (95% CI: 0.30, 1.38) than women with 3 or fewer healthy lifestyle behaviors, though this association was not statistically significant. Women with 3 or more healthy behaviors had a non–statistically significant 20% reduced risk of GDM (95% CI: 0.57, 1.12) compared with women with 2 or fewer healthy behaviors. Associations were slightly attenuated after additional adjustment for prepregnancy body mass index, healthy prepregnancy physical activity, and prepregnancy smoking and did not differ between normal-weight and overweight/obese women (all P values for interaction > 0.27 (Web Table 4)).

DISCUSSION

In this large prospective cohort study of pregnant women, a healthy lifestyle during early pregnancy, consisting of a healthy diet, physical activity, low stress, and not smoking, was associated with reduced risk of GDM. Each additional healthy lifestyle behavior (adhering to a healthy diet, being physically active, not smoking, and having a low stress level) was associated with 23% reduced risk of GDM. Associations were similar among normal-weight and overweight/obese women.

To our knowledge, this is the first observational study that has investigated the association between multiple lifestyle behaviors during early pregnancy and GDM risk using a composite measure of healthy lifestyle. A similar study of lifestyle before pregnancy and risk of GDM also found that healthy lifestyle was associated with decreased risk of GDM (17). Zhang et al. (17) found that the combination of not smoking, participating in ≥150 minutes of physical activity per week, and adhering to a healthy diet (AHEI-2010 score in the top two-fifths of the distribution) was associated with a 41% lower risk

Table 2. Associations Between Components of a Healthy Lifestyle During Early Pregnancy and Risk of Gestational Diabetes Mellitus Among Omega Study Participants ($n = 3,005$), Seattle, Washington, 1996–2008

Healthy Lifestyle Component	Participants With a Healthy Lifestyle Score[a]		Participants With GDM Among Those With a Healthy Lifestyle Score		Unadjusted		Model					
							Model 1[b]		Model 2[c]		Model 3[d]	
	No.	%	No.	%	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Healthy diet	611	20	25	4	0.86	0.57, 1.32	0.85	0.56, 1.30	0.90	0.59, 1.37	0.92	0.61, 1.41
Physically active	1,990	66	85	4	0.82	0.59, 1.14	0.88	0.63, 1.22	0.89	0.64, 1.24	0.97	0.69, 1.36
Nonsmoker	2,854	95	129	5	0.68	0.37, 1.23	0.55	0.30, 0.99	0.58	0.33, 1.03	0.47	0.24, 0.92
Low stress	1,666	55	65	4	0.72	0.52, 0.99	0.75	0.55, 1.04	0.78	0.56, 1.07	0.80	0.58, 1.09

Abbreviations: CI, confidence interval; GDM, gestational diabetes mellitus; RR, relative risk.
[a] Criteria for a healthy score: Alternate Healthy Eating Index 2010 score ≥62 (healthy diet), ≥150 minutes/week of moderate/vigorous leisure-time physical activity (physically active), never smoking or quitting before pregnancy (nonsmoker), and Perceived Stress Scale score ≤3 (low stress).
[b] Model 1 adjusted for maternal age, race (white/nonwhite), nulliparity (yes/no), and all lifestyle components listed.
[c] Model 2 adjusted for all covariates in model 1 and prepregnancy body mass index.
[d] Model 3 adjusted for all covariates in model 2, prepregnancy physical activity (≥150 minutes/week of moderate/vigorous leisure-time physical activity), and prepregnancy nonsmoking.

of GDM in a study conducted within Nurses' Health Study II. Zhang et al. also found that associations did not differ between normal-weight and overweight/obese women (17).

In a meta-analysis of 6 randomized controlled trials of interventions targeting diet and exercise during pregnancy among overweight and obese women, Oteng-Ntim et al. (34)

Table 3. Associations Between Healthy Lifestyle Score During Early Pregnancy and Risk of Gestational Diabetes Mellitus Among Omega Study Participants ($n = 3,005$), Seattle, Washington, 1996–2008

Exposure	Participants With GDM		Model					
			Model 1[a]		Model 2[b]		Model 3[c]	
	No.	%	RR	95% CI	RR	95% CI	RR	95% CI
Linear healthy lifestyle score[d] (continuous)	140	5	0.79	0.65, 0.96	0.82	0.67, 0.997	0.84	0.69, 1.03
No. of healthy lifestyle behaviors (categorical)								
0	4	10	4.43	1.33, 14.76	3.82	1.19, 12.25	3.91	1.16, 13.13
1	29	7	2.10	0.93, 4.77	1.88	0.83, 4.29	1.69	0.74, 3.83
2	53	5	1.43	0.65, 3.13	1.31	0.59, 2.87	1.24	0.56, 2.73
3	47	4	1.40	0.63, 3.08	1.34	0.61, 2.96	1.29	0.59, 2.85
4	7	3	1.00	Referent	1.00	Referent	1.00	Referent
P for trend				0.02		0.05		0.09
No. of healthy lifestyle behaviors (dichotomous)								
All 4 behaviors vs. ≤3								
≤3	133	5	1.00	Referent	1.00	Referent	1.00	Referent
4	7	3	0.65	0.30, 1.38	0.70	0.33, 1.49	0.75	0.35, 1.60
≥3 behaviors vs. ≤2								
≤2	86	5	1.00	Referent	1.00	Referent	1.00	Referent
≥3	54	4	0.80	0.57, 1.12	0.85	0.61, 1.19	0.89	0.64, 1.25

Abbreviations: CI, confidence interval; GDM, gestational diabetes mellitus; RR, relative risk.
[a] Model 1 adjusted for maternal age, race (white/nonwhite), and nulliparity (yes/no).
[b] Model 2 adjusted for all covariates in model 1 and prepregnancy body mass index.
[c] Model 3 adjusted for all covariates in model 2, prepregnancy physical activity (≥150 minutes/week of moderate/vigorous leisure-time physical activity), and prepregnancy nonsmoking.
[d] Healthy lifestyle score was created by summing the total number of healthy lifestyle components (healthy diet, physically active, nonsmoker, and low stress) for each participant, for a score with a range of 0–4.

reported a 20% decreased risk of GDM associated with lifestyle intervention (95% CI: 0.58, 1.10). Other randomized controlled trials of interventions targeting both diet and exercise during early pregnancy have not found associations between healthy lifestyle during pregnancy and lower GDM risk (35, 36). Those studies were small and probably did not have adequate statistical power to detect differences in GDM risk, as GDM was not the primary outcome in either study. Previous intervention studies of healthy lifestyle during pregnancy and GDM risk have been limited by lack of adherence in the intervention group. Additionally, previous lifestyle interventions have not targeted stress as part of the maternal lifestyle. It is also possible that prepregnancy lifestyle is more strongly associated with GDM risk.

It is important to consider multiple behaviors when studying maternal lifestyle during pregnancy, because healthy behaviors promote and reinforce each other (37). Because of this, interventions and public health messaging targeting multiple components of maternal lifestyle may be more successful in preventing GDM than interventions and messages targeting individual behaviors (17).

Heathy diet, physical activity, not smoking, and low stress levels may all contribute to mitigating the metabolic stress that occurs during pregnancy, a state of insulin resistance (19). Several components of the AHEI-2010, including high fruit, vegetable, and long chain (n-3) fatty acid intake and low red and processed meat intake, have been associated with reduced systemic oxidative stress, which prevents pancreatic β-cell dysfunction (38–40). Muscular contractions during physical activity promote cellular uptake of glucose by causing translocation of glucose transporter protein 4 to the plasma membrane (41, 42). Smoking is associated with insulin resistance; hence, refraining from smoking may maintain insulin sensitivity and glucose uptake (43, 44). Maintaining low stress levels prevents the release of cortisol, a hormone that increases glucose production (45, 46). Our observation of an association between a composite measure of healthy lifestyle during early pregnancy and lower risk of GDM reflects the overlapping physiological contributions of these individual healthy lifestyle behaviors in maintaining glucose homeostasis.

Strengths of our study include its prospective design, its large sample size, and consideration of multiple aspects of a healthy lifestyle, including low stress, during early pregnancy in relation to GDM risk. Several limitations of our study should also be mentioned. All aspects of maternal lifestyle were recalled and self-reported. This may have resulted in misclassification of lifestyle behaviors in our study, although the measurement characteristics of each lifestyle component were generally good. Women may have participated in occupational or household physical activity; however, information on other domains of physical activity was not systematically collected in our questionnaire. Adjustment for 2 components of a healthy prepregnancy lifestyle, prepregnancy physical activity and nonsmoking, attenuated our results slightly, but information on prepregnancy diet and stress was not collected in the Omega Study. We were unable to fully assess whether associations of early pregnancy lifestyle with GDM were independent of prepregnancy lifestyle. There was also the potential for residual confounding by other lifestyle factors in our study. Thirty-five percent of the Omega study population was excluded from our analysis due to missing data, which raises concerns about the generalizability of our results to the full Omega population. However, characteristics were similar between the full Omega cohort and our analytical sample (Web Table 2). The majority of participants in the Omega Study were educated white women, and results may not be generalizable to more racially and socioeconomically diverse populations.

Results of our study suggest a role for multiple maternal healthy lifestyle behaviors during early pregnancy—including a healthy diet, physical activity, low stress, and not smoking—in jointly reducing risk of GDM. Similar studies in other populations should incorporate multiple aspects of maternal healthy lifestyle during pregnancy. These studies can help guide public health messaging for GDM prevention and interventions that promote a healthy lifestyle during early pregnancy, the most common time for initiation of prenatal care.

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