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Micronutrient intake inadequate for a sample of pregnant African American women

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Abstract

Background—Micronutrient intake is critical for fetal development and positive pregnancy outcomes. Little is known about adequacy of micronutrient intake in pregnant African American women.

Objective—To describe nutrient sufficiency and top food groups contributing to dietary intake of select micronutrients in low-income pregnant African American women and determine if micronutrient intake varies with early pregnancy body mass index (BMI) and/or gestational weight gain.

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Design—Secondary analysis of data collected in a cohort study of pregnant African American women.

Participants/setting—A total of 93 women 18–36 years old, < 20 weeks pregnant, with early pregnancy BMIs ≥ 18.5 kg/m^2 and < 40.0 kg/m^2. The study was conducted during 2008–2012 with participants from university affiliated obstetrical clinics in an urban setting in Northeast USA.

Main outcome measures—Proportion of women with dietary intakes below Estimated Average Requirement (EAR) or Adequate Intake (AI) for vitamin D, folate, iron, calcium, and choline throughout pregnancy. Top food groups from which women derived these micronutrients.

Statistical analyses performed—Descriptive statistics included means, standard deviations and percentages. Percent of women reaching EAR/AI was calculated. Chi-square test was used to assess micronutrient intake differences based on early pregnancy BMI and gestational weight gain.

Results—A large percentage of pregnant women did not achieve the EAR/AI from dietary sources alone; EAR for folate (66%), vitamin D (100%), iron (89%), and AI for choline (100%). Mean micronutrient intake varied throughout pregnancy. Top food sources included reduced fat milk, eggs and mixed egg dishes, pasta dishes, and ready to eat cereal.

Conclusions—The majority of study participants had dietary micronutrient intake levels below EAR/AI throughout pregnancy. Findings suggest that practitioners should evaluate dietary adequacy in women to avoid deficits in micronutrient intake during pregnancy. Top food sources of these micronutrients can be considered when assisting women in improving dietary intake.

Keywords

micronutrients; micronutrient intake; African American; gestational weight gain; pregnancy

Introduction/Background

Adequate intake of micronutrients is critical to fetal development and pregnancy outcomes. Insufficient intake during pregnancy not only results in adverse maternal (e.g. anemia, preeclampsia) and fetal health (e.g. preterm birth, neural tube defect) outcomes in the short run, but may also influence chronic disease risk in the child later in life.[1] The negative effects of inadequate intake on the fetus for nutrients such as folate,[1] iron,[2] and calcium[1,3] are well characterized; for others such as vitamin D [3,4] and choline [1,5] the long-term effects are less clear.

Most clinicians recommend a prenatal vitamin to cover the gap in intake throughout pregnancy. However, pregnant African American women are inconsistent in their use of prenatal vitamins.[6] Prenatal supplements do not necessarily contain the recommended micronutrients in adequate amounts. Supplements can also increase the risk of micronutrient interactions, excessive intake and adverse effects (e.g. teratogenic effects).[7] In industrialized countries evidence of benefit from supplementation exists only for iron, folate and vitamin D.[8] Limited data on prenatal multiple micronutrient supplements show an increase in the levels of biomarkers for iron, folate, and vitamin D, but no effect on birth outcomes.[9] In the long run, nutrient needs are best met through healthy eating patterns that incorporate nutrient-dense foods.[10]

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Women are advised to follow the Institute of Medicine (IOM) guidelines for gestational weight gain. According to the guidelines, women should gain within specified weight ranges that vary based on pre-pregnancy body mass index (BMI).[11] Over-gain and under-gain during pregnancy are associated with maternal and offspring morbidity.[12–20] In the US (2012–2013 data) 37.6% of normal weight women, 61.6% of overweight women and nearly 56% of obese women over-gained during pregnancy.[21] The gestational weight gain guidelines do not specifically address dietary quality and whether adherence to the guidelines is accompanied by adequate micronutrient intake is largely unknown. In addition, higher pre-pregnancy BMI has been negatively associated with diet quality and micronutrient intake.[22] Consideration of gestational weight gain guidelines together with micronutrient intake is needed to effectively advise women on strategies for maintaining a healthy pregnancy.

The purpose of this study was to 1) describe the sufficiency of dietary intake for select micronutrients in pregnant African American women throughout pregnancy, 2) determine if micronutrient intake varies throughout pregnancy in relation to early pregnancy BMI status and gestational weight gain, and 3) determine the top food sources of selected micronutrients.

Materials and Methods

Design and sample

This is a secondary analysis of data collected in a prospective, observational study entitled 'Limiting the Phenotypic Effect of Pregnancy Related Weight Gain.'[23] In the original study, a convenience sample of 97 pregnant, primarily low-income African American women were enrolled and followed from prior to 20 weeks gestation until six months postpartum during October 2008–October 2012. Women 18 years of age and over, who entered prenatal care before 20 weeks gestation, had a singleton pregnancy, and had an early pregnancy BMI ≥ 18.5 kg/m^2 and < 40.0 kg/m^2 were included. Women with a medical or psychiatric condition that could preclude informed consent or influence weight gain or loss (i.e. diabetes mellitus, gastrointestinal disorder, and hypertension) were excluded. Data were collected during pregnancy and the first 6 months postpartum. The University of Rochester Institutional Review Board approved the study protocol and participants provided written informed consent. For the current study, data collected prior to 22 weeks gestation, between 24–29 weeks gestation and 32–37 weeks gestation were used. Women with at least one dietary recall were included. Women with preterm deliveries (< 37 weeks gestation) were excluded from all analyses that included gestational weight gain.

Measures

Demographic characteristics were collected at baseline. Pregnancy and delivery data were abstracted from medical records. Early pregnancy BMIs were calculated using the first recorded weight and height in the prenatal medical record. If the first recorded weight was after 14 weeks gestation, it was adjusted down based on usual weekly weight gain for African American women during the second trimester of pregnancy.[11] Standard BMI categories of normal weight (BMI ≥ 18.5 – 24.9 kg/m^2), overweight (BMI ≥ 25. – 29.9

kg/m^2) and obese (BMI ≥ 30 kg/m^2) were used.[24] Early pregnancy BMIs were a proxy for pre-pregnancy BMI since women generally gain little weight in the first trimester (1.1–4.4 pounds).[11] Gestational weight gain was calculated by subtracting the first recorded or adjusted weight from the final weight before delivery. Under-gain, appropriate-gain and over-gain were calculated based on early pregnancy BMI and the 2009 IOM guidelines, which indicate women should gain as follows: normal weight, 25–35 pounds; overweight, 15–25 pounds; and obese, 11–20 pounds.[11]

Dietary intake was assessed from 24-hour dietary recalls collected at three time points during pregnancy using the Nutrition Data System for Research software version 2009, developed by the Nutrition Coordinating Center (University of Minnesota, Minneapolis, MN).[25] Dietary intake was obtained by interview and entered into the Nutrition Data System for Research software. A multi-pass methodology was used to improve food intake recall.[26] A diet technician from the University of Rochester Clinical Research Center, trained in data collection using this system, interviewed participants and entered the data. Two 24-hour dietary recalls within two weeks of one another were collected at each time point, either face-to-face or via telephone. Nutritional supplements were not included for these analyses. Data were analyzed for dietary micronutrient content. To account for day to day variability in intake, estimated usual nutrient intake was calculated using the National Cancer Institute method[27] and compared to age and sex-specific recommendations defined by the Dietary Reference Intake.[28]

Estimated average requirement (EAR) is the average daily nutrient intake level estimated to meet the requirements of half the population of healthy individuals. Inadequate nutrient intake is estimated by the proportion of the population with usual intakes below the EAR.[28] Nutrients with established EARs for this study are: calcium, folate, iron, and vitamin D. The values were dichotomized as meets/does not meet EAR. Adequate intakes (AI) are used to assess adequacy when EARs have not been determined.—Intake levels above the AI imply a low likelihood of inadequate intake, but intake below AI does not necessarily indicate inadequacy.[28] The percentage of women with intakes below the AI was determined to reflect insufficiency of intake for choline,[28] and values were dichotomized as sufficient vs. insufficient. These micronutrients were selected because they are essential for maternal and fetal health[10,29,30] and because of their importance during pregnancy.[31–37]

Data analysis

Descriptive statistics included means, standard deviations, and percentages. All dietary recalls for each time point were included, irrespective of whether there was one vs. two recalls at each time point from individual women. Chi square tests or Fisher's exact tests, for small sample sizes, were used to assess whether the percent of women reaching EAR/AI differed by BMI category, gestational weight gain category, and gestational weight gain for each BMI category. All statistical analyses were conducted using the Statistical Package for the Social Science.[38]

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Results

Maternal age ranged from 18–36 years old (Table 1). Four women did not complete any dietary recalls and were excluded from the analyses, leaving a sample of 93 women. The majority of women had a high school education or less (77%), delivered full term infants (88%), had public health insurance (90%), and were unmarried (93%). Of women who completed dietary data, 55 (59%) completed 24-hour recalls at all three time points, 22 (24%) completed at least two time points and 16 (17%) completed one time point. Over 60% of participants at any data collection time point had two 24-hour recalls.

Gestational weight gain ranged from 7–87 pounds for all women except two who were obese before pregnancy and lost weight while pregnant. Over half of women (56%) who delivered full-term infants over-gained per IOM guidelines. Average early pregnancy BMI was 28.7 kg/m^2 with 40% of the sample obese. Of women who were obese and delivered full-term infants 67% over-gained and 21% gained appropriately. Of overweight women who delivered term infants, 70% over-gained and 15% gained appropriately. Thirty-one percent of normal weight women over-gained, while 46% gained appropriately. Chi Square tests were significant (Fisher's Exact p = .016) between BMI categories and gestational weight gain categories of under-gain, appropriate-gain or over-gain.

The overall adequacy of dietary intake of selected micronutrients is reported in Table 2. For most micronutrients, overall intake was below the EAR and AI for pregnancy regardless of early pregnancy BMI and gestational weight gain categories. The percent of women below EAR for calcium was markedly lower than other assessed micronutrients. One hundred percent of women were below the EAR for vitamin D and 89% were below the EAR for iron. None of the women achieved the recommended AI for choline, with the average choline intake being 309 mg/day versus the recommended AI of 450 mg/day.

The mean intake of micronutrients varied throughout pregnancy (Table 3), but overall intake of most micronutrients decreased during mid-pregnancy and increased in late pregnancy. The exception was folate, which showed an overall upward trend. For both vitamin D and choline, 100% of the women were below EAR/AI at all time points. Iron intake was also substantially below EAR for the majority at all time points. Chi square tests of each of the categories (early pregnancy BMI and gestational weight gain) vs. below EAR/AI for each micronutrient were non-significant.

The majority of women in each gestational weight gain by early pregnancy BMI category were below the EAR for all nutrients except calcium (Table 4). Obese over-gainers had the highest percent of women (46%) with intakes below EAR for calcium. Choline is not included in Table 4 because 100% of women were below AI. Chi square tests were not significant for early pregnancy BMI and gestational weight gain vs. EAR for any micronutrient.

The top five food sources for these micronutrients in our sample are presented in Table 5. Fortified foods, animal and dairy products were the major dietary contributors of these micronutrients. Pasta and pasta mixed dishes were also key contributors of calcium, folate, choline and iron. Women obtained folate, iron and vitamin D from ready-to-eat cereals. A

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majority of dietary calcium and vitamin D intake, and approximately 5% of choline intake, were from reduced fat milk. Other foods that contributed to micronutrient intake include eggs and egg mixed dishes, pizza, yeast breads, beef and beef mixed dishes, and chicken and chicken mixed dishes.

Discussion

We examined dietary micronutrient intake in a sample of pregnant African American women using data from a prospective cohort study. To our knowledge, this is the first study that reports dietary micronutrient intake at different times throughout pregnancy, and in relation to early pregnancy BMI and gestational weight gain category in a sample of African American women. Overall results indicated that the majority of these women had dietary micronutrient intake levels below EAR/AI throughout pregnancy.

Few studies have reported dietary micronutrient intake in pregnant African American women[39–42] and only two of those used the IOM recommended methodology, EAR/AI,[43] to assess micronutrient adequacy in population groups. Despite methodology differences, the pattern of micronutrient inadequacies was consistent across studies. In our study 100, 100, 89, 66, and 28% of subjects had intakes below the EAR/AI for choline, vitamin D, iron, folate and calcium respectively, based on dietary intake only. Siega Riz et al. in a sample of pregnant black (n = 971) and white (n = 1131) women found that 70% of the women had inadequate dietary intake of iron and 40% of folate.[39] Fortified grain products and ready to eat cereals were the largest contributors to folic acid and iron intake in both Siega Riz's and this study. Brunst et al. (2013) reported micronutrient inadequacies (95, 77, 57, 16 and 19% of subjects were below the EAR/AI for choline, vitamin D, iron, folate and calcium, respectively),[44] in primarily minority pregnant women (n = 274; 42% Hispanic, 17% African American, 9% other/mixed) based on dietary plus supplement intake (assessed one time using a food frequency questionnaire). The latter findings indicate that many of the women did not achieve adequate intake of key nutrients even with supplementation.

Notably, women who gained more weight did not necessarily have better micronutrient intake. The obese over-gainers had a similar or worse dietary profile than other over-gainers and over half of obese women over-gained. Moreover, women who gained appropriately did not achieve the recommended levels of estimated micronutrient intake regardless of their early pregnancy BMI. The inadequacies found at all BMI and gestational weight gain categories may be reflective of an energy-dense, nutrient poor 'standard American diet.'[45]

Dietary micronutrient intake based on early or pre-pregnancy BMI has been minimally assessed.[22,46,47] For the most part, women in this study who were obese before pregnancy had a lower intake of calcium, iron, folate, and choline, compared to the other women although the difference was not statistically significant, but may have clinical significance. For example, two studies found pre-pregnancy BMI was inversely associated with folate and iron intake. The third study assessed vitamin D status and found an inverse relationship of vitamin D with pre-pregnancy BMI,[47] suggesting a need to address these nutrient concerns in women with higher pre-pregnancy BMIs. The most salient point is the percent of women whose dietary intake was below EAR/AI.

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Implications

The findings of this study suggest that it may be important to assist pregnant women similar to the women in our study to overcome barriers such as food cravings, limited time, finances and knowledge of a healthy diet,[48] to achieve a diet adequate in essential micronutrients for pregnancy. Targeted interventions and counseling on identified challenges to achieve an adequate intake through diet[49–51] may reduce the risk of micronutrient insufficiency.

In our sample major food sources of the selected micronutrients (e.g. choline, folate, iron) were not consumed in sufficient quantity to serve as major food sources for these micronutrients (e.g. spinach, asparagus [folate/folic acid]; milk [calcium, vitamin D fortified]; cereal [iron/folic acid fortified]).[10,52] Experiential hands-on cooking classes targeting common foods consumed by the population[49–51,53] with a focus on appropriate ingredient substitution are effective in improving diet quality.[54] This approach could be adapted by focusing on foods rich in nutrients whose requirements increase during pregnancy.

The top five foods that contributed to the intake of micronutrients for these women were fortified foods (e.g. cereals, pastas), dairy products and animal products, which are all Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)-eligible food items. Women who use WIC have been found to have healthier diets than those who do not.[55,56] Thus, WIC could be a valuable resource for low-income women to reduce risk by facilitating acquisition of such micronutrient-rich foods. Health care providers can assist women in accessing WIC and also the Supplemental Nutrition Assistance Program.

The findings of this study suggest that the composition of the diet during pregnancy, in addition to gestational weight gain, should be actively monitored throughout pregnancy. Whether or not a woman with a healthy pre-pregnancy weight and appropriate gestational weight gain is meeting nutrition recommendations and providing an optimal intrauterine environment for fetal development requires further assessment. Additional areas for research include testing the feasibility and effectiveness of introducing healthier versions of culturally relevant, preferred foods; cooking and nutrition classes; and targeted interventions to overcome barriers to healthy eating in pregnant women as ways to improve micronutrient intake.

Strengths and limitations

The strengths of the study included the methods used to assess micronutrient adequacy. Estimated average requirement was used to assess micronutrient adequacy as opposed to the recommended dietary allowance, which overestimates inadequacy.[28] Nutrient intake was assessed twice at each time point in most women and adjusted to better reflect usual intake using an established methodology.[27] 24-hour dietary recalls were used to collect dietary recall and were obtained at more than one time point in pregnancy.

There were several limitations to the study. The sample was a convenience sample from an urban setting in the Northeast USA, which limits generalizability. Not all women completed dietary recalls at each time point, potentially reducing the reliability of the data to represent habitual dietary intakes. However, when we excluded women who provided only one dietary

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recall from the analysis, the percentage of women not meeting EAR/AI was unchanged. Furthermore, a single 24-hour dietary recall can be used to describe the dietary intake of a group.[57] Most of our participants have more than one recall; thus improving the validity of the estimates. Social desirability could influence dietary intake reporting of foods, affecting estimates of micronutrient intake. Women, non-Hispanic blacks, individuals with less than a high school education, a higher BMI or living in a low-income household are more likely to under-report their food intake.[58] Supplement intake was not assessed; therefore, total micronutrient intake may have been underestimated. However, choline is not typically supplied in adequate amounts in prenatal supplements, thus dietary intake is the main source. Blood samples were not available to verify actual micronutrients at the systemic level. The sample-size was relatively small; therefore, some of the estimates might be unreliable. However, the pattern of findings was consistent across measures, increasing confidence in results. Data was not collected on food insecurity and food assistance program participation so we were unable to consider how these factors were associated with dietary intake.

Conclusions

Pregnant African American study participants had low dietary intake of important micronutrients for an optimal pregnancy with possible adverse sequelae for their children. Dietary micronutrient intake below EAR/AI was prevalent. Dietary assessment, including appropriate supplementation, and intervention to improve micronutrient intake during this critical time point may be indicated to decrease the risk of adverse fetal programming and future disease risk. Further elucidation of associations between micronutrients, obesity and gestational weight gain is needed. Measurement of dietary intake, obesity and gestational weight gain throughout pregnancy in a larger sample that is representative of the larger population and includes supplement intake would provide an understanding of the extent of micronutrient insufficiency in pregnant women. Investigation of barriers to sufficient micronutrient intake and targeted efforts to improve micronutrient intake throughout pregnancy may be warranted.

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Table 1

Characteristics of 93 pregnant African American women who participated in an observational study on gestational weight gain between 2008–2012

Characteristics	**n (%)**
Age (years)	
•18 < 20	22 (24)
• 20–30	63 (68)
• >30–36	8 (8)
Education level	
• Some elementary school	4 (4)
• Some high school	38 (41)
• Completed high school	30 (32)
• Beyond high school	21 (23)
Parity	
• Primigravida	26 (28)
• Multigravida	67 (72)
Length of gestation	
• Preterm (<37 weeks)	11 (12)
• Term (≥ 37 weeks)	82 (88)
Marital status	
• Married	7 (7)
• Single with partner	64 (69)
• Never married, no partner	21 (23)
• Separated	1 (1)
Health insurance type	
• Public	84 (90)
• Private	9 (10)
Pre-pregnancy/early pregnancy BMI[a] (kg/m^2)	
• normal weight	28 (30)
• overweight	28 (30)
• obese	37 (40)
Gestational weight gain based on IOM[b] guidelines (full-term only; n = 82)	
• under-gain	14 (17)
• appropriate gain	22 (27)
• over-gain	46 (56)
	Mean (SD)
Early pregnancy BMI (kg/m^2)	28.7 (5.5)

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Characteristics	**n (%)**
Gestational weight gain (full-term only n = 82) (pounds)	31.3 (16.3)
Infant birth weight (full-term only ; n = 82) (grams)	3181 (655)

[a]body mass index: early pregnancy BMI is BMI ≤ 14 weeks gestation

[b]Institute of Medicine

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Table 2

Adequacy of dietary intake for selected micronutrients at three time points throughout pregnancy of 93 African American women who participated in an observational study between 2008 and 2012

Nutrient	EAR[a]	Entire pregnancy (n=93)		Early pregnancy (< 22 weeks) (n = 90)		Mid-pregnancy (24–29 weeks) (n = 68)		Late pregnancy (32–37 weeks) (n=67)	
		Below EAR (%)	Mean (SD)	Below EAR (%)	Mean (SD)	Below EAR (%)	Mean (SD)	Below EAR (%)	Mean (SD)
Calcium	800 mg/d	28	967 (235)	34	942 (321)	24	910 (176)	10	1061 (225)
Folate	520 μg/d	66	491 (100)	76	472 (96)	69	492 (96)	55	521 (145)
Vitamin D	400 IU/10 μg/d	100	5.2 (1.4)	99	5.2 (2.1)	100	5.0 (0.9)	100	5.4 (1.6)
Iron	22 mg/d	89	17.2 (3.1)	91	16.9 (3.2)	99	16.8 (2.3)	87	18.1 (3)
	AI[b]	Potential inadequate intake (%)		Potential inadequate intake (%)		Potential inadequate intake (%)		Potential inadequate intake (%)	
Choline	450 mg/d	100	306.9 (76)	100	318 (68)	100	289 (28)	100	306 (28)

[a]Estimated average requirement (EAR): Estimated average requirement is the average daily nutrient intake level estimated to meet the requirements of half the population of healthy individuals. Inadequate nutrient intake is estimated by the proportion of the population with intakes below the EAR.

[b]Adequate intake (AI): Adequate intakes are used to assess adequacy when EARs have not been determined—intake levels above the AI imply a low likelihood of inadequate intake. Intake below AI does not necessarily indicate inadequacy.

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Table 3

Percentage of dietary intakes below the EAR/AI at three time points throughout pregnancy categorized by early pregnancy body mass index and gestational weight gain in 93 pregnant African American women who participated in an observational study

	Early pregnancy < 22 weeks Mean (SD) n	% Below EAR[a]/AI[b]	Mid pregnancy 24–29 weeks Mean (SD) n	% Below EAR/AI	Late pregnancy 32–37 weeks Mean (SD) n	%Below EAR/AI
Calcium: EAR = 800 mg/d						
Total sample	942 (321) 90	34	910 (176) 68	24	1061 (225) 67	10
Early pregnancy BMI[c]						
Normal	950 (269) 28	36	910 (135) 19	18	1102 (220) 21	0
Overweight	957 (280) 27	33	944 (193) 22	5	1105 (215) 21	5
Obese	925 (389) 35	32	882 (189) 27	42	990 (229) 25	21
Gestational weight gain[d]						
Under-gain	896 (202) 15	36	958 (203) 10	10	1083 (209) 13	8
Appropriate gain	917 (254) 24	33	861 (156) 18	27	1077 (253) 20	0
Over-gain	968 (375) 51	33	920 (178) 40	25	1044 (220) 34	15
Choline: AI = 450 mg/d						
Total sample	318 (68) 90	100	289 (28) 68	100	306 (28) 67	100
Early pregnancy BMI						
Normal	328 (52) 28	100	290 (22) 19	100	311 (21) 21	100
Overweight	320 (60) 27	100	297 (29) 22	100	309 (22) 21	100
Obese	309 (83) 35	100	282 (30) 27	100	301 (36) 25	100
Gestational weight gain						
Under-gain	328 (48) 15	100	291 (33) 10	100	310 (27) 13	100
Appropriate gain	316 (56) 24	100	289 (31) 18	100	305 (22) 20	100
Over-gain	316 (78) 51	100	289 (26) 40	100	306 (32) 34	100
Iron: EAR = 22 mg/d						
Total sample	16.9 (3.2) 90	91	16.8 (2.3) 68	99	18.1 (3) 67	87
Early pregnancy BMI						
Normal	17.3 (3.1)28	92	17.3 (1.8) 19	100	18.6 (3.2) 21	75
Overweight	17.3 (3.1) 27	88	17.2 (3.0) 22	95	18.3 (2.5) 21	90

	Early pregnancy < 22 weeks Mean (SD) n	% Below EAR[a]/AI[b]	Mid pregnancy 24–29 weeks Mean (SD) n	% Below EAR/AI	Late pregnancy 32–37 weeks Mean (SD) n	%Below EAR/AI
Obese	16.4 (3.3) 35	94	16.3 (2.1) 27	100	17.3 (3.2) 25	92
Gestational weight gain						
Under-gain	16.7 (2.1) 15	100	17.1 (1.9) 10	100	18.1 (2.8) 13	83
Appropriate gain	17.7 (3.1) 24	86	16.5 (2.4) 18	100	18.5 (3.1) 20	79
Over-gain	16.7 (3.4) 51	91	16.9 (2.4) 40	97	17.8 (3.1) 34	91
Folate: EAR = 520 μg/d						
Total sample	472 (96) 90	76	492 (96) 68	69	521 (145) 67	55
Early pregnancy BMI						
Normal	472 (96) 28	80	509 (64) 19	47	531 (155) 21	45
Overweight	480 (79) 27	67	497 (71) 22	70	533 (118) 21	55
Obese	467 (109)35	74	476 (59) 27	75	502 (159) 25	67
Gestational weight gain						
Under-gain	473 (86) 15	71	495 (85) 10	70	574 (127) 13	50
Appropriate gain	476 (92) 24	76	475 (59) 18	60	517 (158) 20	58
Over-gain	471 (102) 51	73	498 (62) 40	67	502 (142) 34	58
Vitamin D EAR = 400 IU (10 μg/d) Reported as μg/d in this table)						
Total sample	5.2 (2.1) 90	99	5.0 (0.9) 68	100	5.4 (1.6) 67	100
Early pregnancy BMI						
Normal	5.4 (1.9) 28	100	5.0 (.1) 19	100	5.5 (1.5) 21	100
Overweight	5.5 (2.0) 27	100	5.0 (.1) 22	100	5.6 (1.3) 21	100
Obese	4.9 (2.3) 35	97	5.0 (.1) 27	100	5.3 (1.8) 25	100
Gestational weight gain						
Under-gain	5.2 (1.9) 14	100	5.0 (.1) 10	100	5.9 (1.1) 12	100
Appropriate gain	5.4 (1.5) 21	100	5.0 (1.6) 15	100	5.2 (1.6) 19	100
Over-gain	5.3 (2.4) 45	98	5.0 (1.6) 33	100	5.4 (1.6) 33	100

[a] Estimated Average Requirements: Estimated average requirement is the average daily nutrient intake level estimated to meet the requirements of half the population of healthy individuals. Inadequate nutrient intake is estimated by the proportion of the population with intakes below the EAR.

[b] Adequate Intake: Adequate intakes are used to assess adequacy when EARs have not been determined—intake levels above the AI imply a low likelihood of inadequate intake. Intake below AI does not necessarily indicate inadequacy.

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[c] Body mass index: Normal = 18.5 − < 25 kg/m^2; overweight = 25 − < 30 kg/m^2; obese = ≥ 30 kg/m^2

[d] Gestational weight gain: under-gain = less than Institute of Medicine guidelines for each pre-pregnant BMI category; appropriate gain = gain within the Institute of Medicine guidelines for each pre-pregnancy BMI category; over-gain = weight gain above the Institute of Medicine Guidelines for each pre-pregnancy BMI category

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Table 4

Percentage of pregnant African American women (n=93) who participated in an observational study whose average dietary intakes throughout pregnancy were below EAR according to early pregnancy BMI and gestational weight gain category

		Pregnancy weight gain per Institute of Medicine guidelines		
Pre-pregnancy BMI[a] category	**EAR[b]**	**Under-gain Below EAR (%)**	**Appropriate gain Below EAR (%)**	**Over-gain Below EAR (%)**
Normal weight	n = 25	n = 6	n = 12	n = 7
Calcium	800 mg/d	0	33	14
Folate	520 μ/d	33	50	71
Vitamin D	400 IU	100	100	100
Iron	22 mg/d	100	75	100
Overweight	n = 25	n = 4	n = 4	n= 17
Calcium	800 mg/d	25	25	24
Folate	520 μ/d	75	75	59
Vitamin D	400 IU	100	100	100
Iron	22 mg/d	75	75	88
Obese	n = 32	n = 4	n = 6	n = 22
Calcium	800mg/d	25	17	46
Folate	520 μ/d	50	83	73
Vitamin D	400 IU	100	100	100
Iron	22 mg/d	100	100	91

[a]Body mass index: Normal = 18.5 − < 25 kg/m^2; overweight = 25 − < 30 kg/m^2; obese = ≥ 30 kg/m^2

[b]Estimated Average Requirements: : Estimated average requirement is the average daily nutrient intake level estimated to meet the requirements of half the population of healthy individuals. Inadequate nutrient intake is estimated by the proportion of the population with intakes below the EAR.

Full term only with dietary data available (n = 82)

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Table 5

The top five foods that contributed to the dietary intake of key micronutrients in 93 pregnant African American women who participated in an observational study between 2008–2013

Ranking	Calcium (876 mg)[a]	Vitamin D (180 IU's)	Folate (444 mcg)	Choline (285 mg)	Iron (16 mg)
1	Reduced Fat Milk (13%)[b]	Reduced Fat Milk (22%)	Ready to Eat Cereal (28%)	Eggs & Egg Mixed Dish (13%)	Ready to Eat Cereal (24%)
2	Pizza (9%)	Ready to Eat Cereal (15%)	Pasta & Pasta Mixed Dish (7%)	Beef & Beef Mixed Dish (10%)	Yeast Breads (8%)
3	Pasta & Pasta Mixed Dish (7%)	Whole Milk (11%)	Yeast Breads (7%)	Chicken & Chicken Mixed Dish (10%)	Beef & Beef Mixed Dish (5%)
4	Regular Cheese (7%)	Eggs & Egg Mixed Dish (6%)	Pizza (5%)	Reduced Fat Milk (5%)	Pasta & Pasta Mixed Dish (5%)
5	100% Orange juice/Grapefruit juice (6%)	Fish & Fish Mixed Dish (6%)	Rice & Rice Mixed Dish (4%)	Pasta & Pasta Mixed Dish (5%)	Chicken & Chicken Mixed Dish (5%)

[a] Average daily intake per nutrient based on total intake for all time points

[b] Percent daily average intake per nutrient based on the top five contributors of intake for each nutrient for all time points