Abstract

**Purpose:** To develop a profile of common nutritional patterns among pregnant African American women that will assist healthcare providers in identifying areas for improvement and change.

**Study Design:** This study was part of a larger NIH-funded (R03NR008548-01) study that examined risk factors associated with preterm labor and birth in high- and low-risk African American women. Data were collected on high-risk mothers (women experiencing preterm labor) before 34 weeks gestation and every 4 weeks until birth. Data were also collected on the low-risk mothers beginning at 28 weeks and then every 4 weeks until birth. For this study, high- and low-risk groups were collapsed to examine food choices over time in all participants (n = 58).

**Methods:** Nutrition intake was examined by conducting one 24-hour diet recall at each time point. Food models and portion size pictures were used to improve accuracy.

**Results:** Overall, dietary intake was suboptimal, and micro- and macronutrient intake during the third trimester did not vary. Energy (caloric) intake was inadequate with the time-averaged probability of having inadequate caloric intake 64.4%. Protein intake was the most likely nutritional factor to be inadequate with a time-averaged estimated probability of inadequate intake 25.1%. Micronutrient intake from food was also inadequate.

**Clinical Implications:** The persistence of suboptimal nutritional intake during the third trimester supports the importance of continually assessing nutritional status throughout pregnancy, with a focus on caloric requirements and protein intake.

**Key words:** Maternal nutritional physiology; Nutritional requirements; Pregnant women; Prenatal nutritional physiology; Vulnerable populations.
Pregnancy is a time of increased maternal nutritional requirements. Adequate maternal nutrition is an important component of a healthy pregnancy, and dietary deficiencies have been linked to negative fetal outcomes, including premature birth before 37 weeks gestational age, low birthweight, and structural abnormalities such as neural tube defects (Keen et al., 2003; Wu, Bazer, Cudd, Meininger, & Spencer, 2004). Dietary deficiencies during pregnancy have also been linked to the development of maternal preeclampsia during pregnancy and obesity later in life (Frederick et al., 2005; Siega-Riz, Evenson, & Dole, 2004). In light of the importance of nutrition to positive maternal and neonatal outcomes, pregnancy represents a significant opportunity to evaluate adequate nutrition, healthy eating habits, and appropriate weight gain.

The federal government has been responsive to the opportunity to improve pregnancy outcomes by supporting programs aimed at enhancing nutritional status. Inadequate nutrition in pregnancy disproportionally affects low-income women and children. The U.S. federal government established The Special Supplemental Nutrition Program for Women, Infants, and Children in 1974. Commonly referred to as WIC, this program provides food and nutrition information to those who fall at or below 185% of the U.S. Poverty Income Guidelines, or an annual income of less than $39,200 (WIC: The Special Supplemental Nutrition Program for Women, Infants, and Children, 2009). With a budget of almost $7 billion, approximately 2 million pregnant, postpartum, and breastfeeding women participated in WIC for fiscal year 2008.

Other resources designed to improve pregnancy outcomes related to nutrition include Institute of Medicine (IOM) guidelines, which have recently reevaluated established weight gain recommendations for pregnancy (IOM, 2009). Based on prepregnancy BMI, these recommendations were aimed at not only optimizing the health of the infant by decreasing the number of preterm and low–birthweight infants, but also optimizing the health of the mother by attempting to address the fact that many women today are entering pregnancy overweight or obese (IOM, 2009). Approximately, one-third of pregnant women in the United States are obese (King, 2006), and African American women have disproportionately higher rates of obesity (Mehta, 2008). Additionally, African American women are over 50% more likely to experience a preterm birth than White women (Martin et al., 2006).

Weight gain during pregnancy is easier to measure than is nutritional intake, so not surprisingly weight gain often serves as a proxy for nutrition and much research has focused on this area. Stotland et al. (2005) investigated target gestational weight gain and revealed that a woman’s belief about how much weight to gain during pregnancy varied according to her prepregnancy BMI and healthcare provider recommendations. Women in this study with a high BMI aimed to gain more weight than the previously set 1990 IOM guidelines and women with a low BMI aimed to gain less weight than recommended. Insufficient weight gain during pregnancy increased the risk of perinatal morbidity and mortality (Stotland et al., 2005). Only 30% to 40% of U.S. women gain weight as clinically recommended, and a majority of pregnant women report not being told about appropriate pregnancy weight gain by their healthcare providers, which leads to both inadequate and excessive weight gain (Abrams, Altman, & Pickett, 2000; Brawarsky et al., 2005). Psychosocial factors also appear to affect maternal weight gain. Higher depressive symptoms during pregnancy have been positively associated with weight gain that exceeds clinical recommendations (Webb, Siega-Riz, & Dole, 2008).

How much weight a mother gains can affect her infant’s health later in life. Maternal overnutrition and high infant birthweight has been associated with subsequent increased BMI and obesity in childhood (Oken & Gillman, 2003; Parsons, Power, & Manor, 2001). Additionally, offspring of obese women who experience overnutrition are at greater risk for developing metabolic disorders such as diabetes and obesity (Boney, Verma, Tucker, & Vohr, 2005; Hillier et al., 2007). Researchers have also suggested that inadequate maternal weight gain and undernutrition in pregnancy may lead to alterations in fetal tissues that predispose the infant to chronic conditions in adulthood, such as hypertension and diabetes (Gluckman & Hanson, 2004; Gluckman, Hanson, Cooper, & Thornburg, 2008).
The dietary intake of pregnant women has also been investigated. Among 44,612 Danish women, participants who reported a high-fat diet in the second trimester, specifically red and processed meat and high-fat dairy products, had an increased risk of having a small for gestational age infant as determined by a birthweight below the 2.5 percentile (Knudsen, Orozova-Bekkevold, Mikkelsen, Wolff, & Olsen, 2008). In the United States, researchers suggested that increased maternal protein intake in the third trimester may be protective against excessive infant birthweight (Andreasyan et al., 2007). Among 1,040 mother–infant pairs, an additional maternal protein intake of 10 g/day in the third trimester was associated with an average 17.8 g birthweight reduction among large birthweight infants but not low–birthweight infants. Siega-Riz, Bodnar, and Savitz (2002) studied 2,247 pregnant women to examine nutrient differences in a cohort of Whites and African American women during the second trimester of pregnancy. For both groups, low–nutrient-dense foods were major sources of calories, fat, and carbohydrates. Although African American women consumed the highest amount of calories, White women had a greater intake of protein, iron, folate, and fiber.

Previous studies of maternal nutrition have only examined one point in time during the second trimester (Siega-Riz et al., 2002; Webb et al., 2008). It is not known whether patients who are assessed to have inadequate nutrition at a clinical prenatal visit are likely to continue to have inadequate nutrition throughout the remainder of the pregnancy. Given that African American women are disproportionally affected by obesity and poorer nutrition (Mehta, 2008), the purpose of this study was to examine common nutritional patterns among pregnant African American women in the third trimester to determine the stability of nutrition and discover specific areas in which healthcare providers can intervene to improve nutritional intake.

Study Design and Methods

This study was part of a larger NIH-funded (R03NR 008548-01) study that examined risk factors associated with preterm labor and preterm birth in high- (women who experienced preterm labor) and low-risk African American women. This article reports the nutritional findings of the larger study and examines the stability of nutrition over time as well as the adequacy of nutrition for the entire sample (n = 58).

Sample

The participants in this study were pregnant African American women receiving prenatal care at one hospital in the Northeast United States. All of the women in this study had a singleton pregnancy, and had no chronic disease(s). The sample comprised 58 pregnant women who were recruited into the study as they met the criteria to be in one of two groups of women. High-risk pregnant women (n = 38) were recruited because they were experiencing preterm labor before 34 weeks gestation. A woman was considered to actually be in preterm labor if she experienced more than 8 contractions in an hour, and had cervical changes. A smaller group of women (n = 20) were recruited at around 28 weeks gestation if they were experiencing an uncomplicated pregnancy, were receiving prenatal care at the same academic health center, and came from the same geographic location and socioeconomic background as women experiencing high-risk pregnancies. The women in the low-risk group were experiencing pregnancies in which no complications had been identified and they had no history of past obstetrical problems. All but one of the low-risk women (19/20) gave birth at term. Of the 38 women who presented in preterm labor, 12 gave birth to a preterm infant. Therefore, of the 58 women in this study, there were a total of 13 preterm births (31% of women who had preterm labor delivered preterm) at an average gestational age of 32.1 weeks (SD = 4.0). Given that both high- and low-risk women had preterm infants and that so many high-risk women went on to deliver at term, nutrition was examined across all women in the study.

Sample Size Calculations

For this secondary analysis, sample size calculations were conducted using Nquery Advisor@4.0 sample size software, assuming a 5% type one error rate and two-sided confidence intervals (CIs). A sample size of 58 was determined to have good precision to estimate the proportion of subjects who are not meeting the recommended guidelines with respect to energy intake.

Data Collection Time Periods

Data were collected on the high-risk mothers when they initially diagnosed as experiencing preterm labor before 34 weeks gestation and every 4 weeks until birth. Data were collected on the low-risk mothers beginning at 28 weeks and then every 4 weeks until birth. Women were
initially approached when they presented to the clinic for routine care and followed at subsequent visits. Participants were given $10 per visit as compensation for their time. Both the attrition and refusal rates were less than 5%.

Nutrition intake was examined by conducting one 24-hour diet recall at each time point on what each subject ate. Diet recalls were used to record an accurate account of food eaten. Additionally, diet recalls are time efficient and eliminated participant burden of filling out long and complex food questionnaires. Food models were used to help subjects more accurately identify portion sizes. The target day for the diet recall was 24 hours in advance of the data collection point (which occurred Monday–Friday). This ensured that subjects were providing information about weekend days (Sundays) as well as weekdays so a more complete picture of nutrient intake was obtained. Additionally, pictures of normal portion sizes were used so that subjects have a variety of ways in which they could determine portion sizes.

Participants were asked brand names of food whenever possible so that food composition could more be accurately examined in a computerized database. This technique has been used successfully before with this research team, and childbearing subjects were found to be quite thorough in recounting nutritional data (Gennaro, Fedor, York, & Douglas, 1997).

Information from the diet histories were analyzed using a computerized database Food Processor (Esha Research, 2000) that contains over 2,400 foods. Nutrient values assigned by the database are in accord with information provided by the United States Department of Agriculture and over 550 other research sources. Fast foods from major franchises are included as are over 1,182 convenience food items. The database is updated yearly.

All analyses were conducted in Stata 11.0, with twosided tests of hypotheses and a p < .05 as the criterion for statistical significance. Initial analyses were descriptive and included tabulation of categorical variables and calculation of means, standard deviations (SDs), and ranges of continuous variables. The method of generalized estimating equations was then used to assess change over time in the nutrient variables. In addition, quasi-least squares (QLS) models were also implemented (Shults, Ratcliffe, & Leonard, 2007); QLS allowed for implementation of a Markov correlation structure that is appropriate for measurements that are unequally spaced in time. Graphical displays of the nutrient variables that were based on the QLS models were also obtained for selected nutrient variables: Scatter plots of nutrient values were constructed, which also included predicted values (with 95% CI values) based on the QLS models, versus time (Figure 1).

The QLS analysis with a Markov correlation structure and robust standard errors indicated that there was no significant change in any energy intake variable over time. The proportion of subjects who failed to meet the recommendation with respect to each variable at any measurement occasion was then computed. Exact 95% CIs for the proportion of expectant mothers who failed to meet the recommendation at any measurement occasion for each nutrient category were also calculated.

The time-averaged probability of failing to achieve the recommendation with respect to each intake variable was then estimated by fitting a logistic QLS model that allowed for adjustment for the potential correlation among the repeated measurements on each subject. Because the initial QLS models had failed to identify a significant change over time in any intake variable, the logistic QLS models included a constant only, which allowed for estimation of the probability of failure to achieve the recommendation, averaged over the multiple measurements on each subject. The time-averaged probability could be viewed as an estimate of the probability that subjects fail to achieve the recommendation averaged across time within the subjects.

Results

The average age of the sample was 23 (standard deviation [SD] = 5.7); most mothers were single (n = 46, 79.3%) and most were multiparas (n = 45, 77.6%). Almost half of the women in this study reported an income of less than $5,000 a year, with only six women (10.3%) reporting incomes over 25,500 a year. The average BMI at 28 weeks was 29.4 (SD = 5.9, range = 18.6–45.7) and included pregnancy weight, as prepregnancy BMI measurements were not available. Macronutrients, or nutrients that supply energy (IOM, 1990), included protein, fat, and carbohydrates.

Energy Intake

The average caloric intake at 28 weeks was 2,936 calories (SD = 1,446.7). The recommended caloric intake for women in the third trimester is approximately 1,855 (American Dietetic Association [ADA], 2010), and 43 of 58 (74.1%, exact CI = [61.0%, 84.7%]) subjects at some time had less than the recommended caloric intake. The time-averaged estimated probability of having less than the recommended daily kilocalorie intake at any measurement occasion was 64.4%. Intake above 4,000

[Figure 1: Kilocalorie intake]

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would be considered overconsuming, and 17 of 58 subjects (29.3%; exact CI = [18.1, 42.7]) overconsumed at some time. The time-averaged probability of overconsumption was 17.7%, so that subjects were more likely to have less than the recommended daily intake than they were to overconsume. Figure 1 details the recommended calorie intake at 28 weeks and displays those participants that fell above and below this value.

**Protein Intake Requirement During Pregnancy**
Thirty-nine of 58 (67.2%, 95% Exact CI = [53.7%, 79.0%]) subjects at some time had protein intakes less than the recommended 1.1 g/kg/day. The time-averaged estimated probability of having a protein intake less than 1.1 g at any measurement occasion was 24.6%.

**Fat Intake Requirements During Pregnancy**
Forty-six of 58 (79.3%, 95% Exact CI = [66.6%, 88.8%]) of the subjects at some time had fat intakes above the recommended 20% to 35% of total energy per day. The time-averaged estimated probability of having a fat intake outside the recommended 20% to 35% of total energy per day at any measurement occasion was 27.2%.

**Carbohydrate Intake Requirement During Pregnancy**
The recommended carbohydrate intake is 175 g (IOM) and 18 of the 58 women (31.0%, 95% Exact CI = [19.5%, 44.5%]) had carbohydrate intakes less than the recommended amounts. The time-averaged estimated probability of having a carbohydrate intake less than 175 g at any measurement occasion was 8.2%. Energy and macronutrient values are displayed in Table 1.

**Micronutrients From Food**
As well as examining adequacy of nutrition in major nutrient categories we also examined micronutrients obtained from food. Micronutrients are nutrients that are needed by the body in smaller amounts (IOM, 1990) and iron, folate, vitamins D, C, and E, and calcium were examined in this study. Although pregnant women also do take prenatal vitamins (PNV), we were interested in determining the adequacy of micronutrients from food intake alone.

**Iron Intake Requirement During Pregnancy**
Iron intake in 48 of 58 subjects (82.8%, 95% Exact CI = [70.6, 91.4%]) was less than the recommended 27 mg of iron/day. The time-averaged estimate probability of having a value at any measurement occasion less than the recommended 27 mg of iron/day was 33.2%.

**Table 1. Recommended vs. Actual Nutrient Intake for Sample Population**

<table>
<thead>
<tr>
<th>Nutritional Component</th>
<th>Recommended Intake (28 wks)</th>
<th>Actual Intake (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g/kg/day)</td>
<td>1.1</td>
<td>86.73</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>175</td>
<td>377</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35% total calories (≥80 g)</td>
<td>119g</td>
</tr>
<tr>
<td>Energy (calories)</td>
<td>2,855</td>
<td>2,936</td>
</tr>
</tbody>
</table>

**Folate Intake Requirements During Pregnancy**
The recommended intake of folate during pregnancy is 600 μg/day and 52 of the 58 subjects (89.7%, 95% Exact CI = [81.0%, 97.1%]) had less than the recommended 600 μg of dietary folate equivalents per day. The time-averaged estimated probability of having less than the recommended 600 μg of dietary folate equivalents per day at any measurement occasion was 36.8%.

**Vitamin D Requirements During Pregnancy**
The recommended intake of vitamin D during pregnancy is 5 μg/day and 53 of 58 (91.4%, 95% Exact CI = [81.0%, 97.1%]) of the subjects had less than this recommended intake. The time-averaged estimated probability of having an inadequate intake at any measurement occasion was 36.1%.

**Vitamin C Requirements During Pregnancy**
Forty-six of 58 (79.3%, 95% Exact CI = [66.7%, 88.9%]) subjects had less than the recommended 85 mg/day. The time-averaged estimated probability of having less than the recommended vitamin C intake at any measurement occasion was 27.4%.

**Vitamin E Requirements During Pregnancy**
The recommended intake of vitamin E is 15 mg of tocopheral/day but 57 of 58 (98.3%, Exact CI = [90.8%, 99.9%]) subjects at some time had less than this recommendation. The time-averaged estimated probability of having less than the recommended vitamin E intake at any measurement occasion was 46.7%.

**Calcium Requirements During Pregnancy**
Among women <19 years of age, the recommended intake of calcium is 1,300 mg/day but 9 of the 9 women who were <19 years of age (100.0%, Exact CI = [66.4%, 100.0%]) had less than this recommendation. The time-averaged probability of not achieving the recommendation with respect to calcium among women <19 years of age was 46.6%. Among women ≥19 years of age, the recommended intake of calcium is 1,000 mg/day but 40 of the 47 women who were ≥19 years of age (85.1%, Exact CI = [71.7%, 93.8%]) had less than this recommendation. The time-averaged estimate of the probability of not achieving the recommendation with respect to calcium was 32.6% for women ≥19.

**Limitations**
This sample in this study was small and focused on only African American women, so the results may not be representative of other cultures and countries. Prepregnancy BMI values were not available, and therefore BMIs reported in this study represent those taken at enrollment and include some pregnancy weight. Additionally, women experiencing high-risk pregnancies and normal pregnancies were analyzed together and comparisons between groups were not made.
foods that are available and can be easily incorporated into meals and snacks. Possible choices for an additional serving of protein include nuts, beans, legumes, eggs, yogurt, tofu, milk, cheeses, fish, poultry, and meats. Dietary restrictions, food allergies, cultural influences, and personal and family food preferences all need to be considered when making recommendations for dietary change.

Micronutrient intake from food alone was inadequate for the majority of participants. For example, nearly 90% of participants had inadequate folate intake. Although PNV supplementation is commonly prescribed in pregnancy, not all women take PNVs consistently. Between 25% and 50% of women do not take prescribed vitamins on a regular basis due to forgetting and/or common side effects such as nausea and constipation (Bodnar, Tang, Ness, Harger, & Roberts, 2006; Jasti, Siega-Riz, Cogswell, Hartzema, & Bentley, 2005; Sullivan, Ford, Azrak, & Mokdad, 2009). Given that dietary sources of micronutrients were consistently low, nutrition counseling for pregnant women should include an assessment of PNV intake and any reasons for inconsistent use. Healthcare providers should work with patients to formulate strategies to remember daily vitamins, and any gastrointestinal side effects should be acknowledged and corrected if possible.

Conclusions
The importance of maternal nutrition during pregnancy for both the mother and the fetus is significant and is a central focus of prenatal care. The participants in this study had nutritional profiles that remained stable over the third trimester of pregnancy, suggesting that once an eating pattern was established, it remained that way until birth. Therefore, continuing to evaluate eating patterns...
Suggested Nursing Implications: Nurses working with pregnant African American women receiving prenatal care can make a difference when they:

- Identify nutritional inadequacies at every prenatal visit
- Reinforce investment for prenatal nutritional education and programs
- Provide clear guidelines for correct caloric requirements during pregnancy and information to make healthy food choices
- Reinforce with patients the need of adequate protein intake
- Work with patients to develop plans to facilitate the intake of prenatal vitamins

and adequacy of nutrition during the third trimester provides additional opportunities for education and interventions to improve dietary intake that can have a positive impact on maternal and fetal health. 

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