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# Dietary Behavior in Low Income Postpartum Women: Psychosocial and Body Weight Correlates

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# Dietary Behavior in Low Income Postpartum Women: Psychosocial and Body Weight Correlates

**by**

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# Dedication

I would like to dedicate this dissertation to my parents, Joseph and Grace Chacko for their role in instilling in me a yearning for higher education and to my husband, Joseph for his constant support and encouragement.

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# Dietary Behavior in Low Income Postpartum Women: Psychosocial and Body Weight Correlates

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The purpose of this research was to examine psychosocial and body weight correlates of dietary behavior in low-income tri-ethnic women. In Study 1, a semi-quantitative food frequency questionnaire (FFQ) was developed and validated against diet records in 95 college women and 50 low-income postpartum women. Pearson's correlations were 0.42 among college women and 0.45 among low-income women. Cross-classification of participants into quartiles resulted in 76% of college women and 79% of low-income women being classified correctly. These results suggested that the FFQ was valid for dietary assessment among young women in the southwestern United States.

In Study 2, approximately 160 mothers were recruited in the hospital 0-1 days following childbirth, and prepregnancy weight and demographic information were obtained. Weight was measured at 6 months and 1 year postpartum; psychosocial factors were assessed at 1 year. Diet during pregnancy and postpartum was assessed via food frequency questionnaires administered at 1.5 months, and at 6 and 12 months postpartum, respectively.

From pregnancy to postpartum, % calories from fat (delta = +1.1%, $p<0.05$) and added sugar (delta = +2.0%, $p<0.05$) increased. A greater percentage of lactating than non-lactating women (64% vs. 38%, $p<0.05$) met recommendations for fruits during pregnancy. Mean intakes of calcium, vitamin A and dairy foods were higher in women who had retained <10% of their prepregnancy weight at 1 year postpartum than in those who had gained $\geq$10%. During late postpartum, women in the highest tertile of compliance with dietary recommendations had a more positive body image ($p<0.041$) than those in the lowest tertile, and less neglect of self-care ($p<0.001$), weight-related distress ($p<0.006$), stress ($p<0.009$), depressive symptoms ($p<0.020$), and perceived barriers to weight loss ($p<0.039$). These findings suggest that the transition from pregnancy to postpartum is associated with a negative impact on dietary behavior in low-income women. Intakes of calcium, vitamin A and dairy foods may be associated with lower weight retention in postpartum. Furthermore, psychosocial variables may influence adherence to dietary guidelines during this time.

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# Chapter 1: Review of Literature

The postpartum period marks a critical life transition (Devine et al. 2000) as women adapt to the maternal role. Women may find the period demanding and stressful (Albers and Williams 2002) as they balance care of a newborn infant with family responsibilities and personal care (Devine et al. 2000). New mothers also may struggle with weight concerns (Groer et al. 2002), diminished psychosocial functioning (Brockington 2004, Green 2004), and inadequate social support. Low-income women may encounter additional problems in postpartum related to insufficient access to medical care, health insurance (Miranda et al. 2003), childcare (Friedman 2001), and transportation (Brown and Barbosa 2001). It is plausible that dietary behavior may be compromised during postpartum (Devine and Olson 1992), especially in women with low levels of education (Devine et al. 2000), and limited income. Dietary behavior in low-income women may be measured with the use of food frequency questionnaires.

## FOOD FREQUENCY QUESTIONNAIRES AND VALIDATION

Food frequency questionnaires are widely recognized as preferred instruments for dietary assessment in epidemiological studies (Willett 2001) due to their time and cost-effectiveness (Subar 2001) and ability to measure habitual dietary intake (Hill and Davies 2001). Food frequency questionnaires often need to be tailored to the eating patterns of their target populations, and to be validated in the specific populations for which they are intended (Willet 1998).

To date, food frequency questionnaires have been developed for several different groups within the United States. These include the general U.S. population (Vandenlangenberg et al. 1997; Hu et al. 1999; Flagg et al. 2000; Willett et al. 2001; Thompson et al. 2000) and specific sub-groups including Asians and Hawaiians (Kolonel et al. 2000), African-Americans (Yanek et al. 2001, Warneke et al. 2001, Resnicow et al. 2000, Kumanyika et al. 2003), Korean-Americans (Kim et al. 2002), Hispanics and non-Hispanic Whites (Baumgartner et al. 1998, Tucker et al. 1998), tri-ethnic samples of non-Hispanic Whites, African-Americans, and Hispanics (Kristal et al. 1997), and minority/multiethnic populations in the southwest (Pillow et al. 1997, Stern et al. 1993, Patterson et al. 1999, Jones et al. 1997, Baumgartner et al. 1998, McPherson et al. 1995, Foote et al. 2000).

Food frequency questionnaires may be validated against diet records or multiple 24-hour dietary recalls, food records, diet histories or serum nutrient levels (Willett 1998). It is preferred that sources of error in the reference instrument be independent of those in food frequency questionnaires. Hence, biochemical measures are being increasingly used in food frequency validation studies. Commonly used biomarkers include urinary nitrogen, serum nutrient levels, and doubly labeled water (Kipnis et al. 2001, Livingstone and Black 2003).

Criteria used to compare food frequency questionnaires against reference instruments include comparison of absolute estimates of nutrient means, and concordance in ranking of subjects produced by the food frequency questionnaire and the reference instrument as determined via Pearson's or Spearman's correlation coefficients, and cross-classification of subjects into quantiles of nutrient intake.

Results from separate validation studies may differ due to variations in study populations, length of questionnaires, study designs, and types of reference instruments. Hence, it may not be appropriate to compare results across validation studies directly. Recent validation studies of food frequency questionnaires have been summarized in Table 1.

Table 1: Comparison of validation studies with respect to mean differences and range of correlations obtained between FFQs and other diet assessment methods

| Source | No of items on FFQ | Population | Reference method | Interval | Difference between means | Mean correlation |
|---|---|---|---|---|---|---|
| Baumgartner 1998 | 140 | New Mexico Hispanic and Caucasian women (n=132) | 4-d food records | DR collected over a month preceding FFQ | Energy and energy-yielding nutrients over-estimated by an average of 15.5% | Unadjusted 'r'=0.48 Energy-adjusted 'r'=0.45 |
| Bodner 1998 | - | Scottish males and females (n=273) | Biochemical (plasma) measures of antioxidants | None; concurrently | NA | Energy-adj 'r'=0.23 |
| Bonifacj 1997 | 98 | Males and females from French Mediterranean region (n=98) | 4-d weighed diet record and 7-d estimated-diet record (diet history) | Between 0 days and 1 year | Energy, fat and protein over-estimated by 25.8 %; CHO under-estimated by 9% | Unadjusted 'r'= 0.38 Energy-adjusted and de-attenuated 'r'= 0.48 |
| Brown 1996 | Willett, '85 | Women planning to become pregnant (n=56) | 4-d food record | DR in sub-study completed within 45 days prior to the FFQ | FFQ under-estimated energy by 7.9%, and other energy-yielding nutrients by 7.5% | Unadjusted 'r'=0.35 Deattenuated 'r'=0.55 |
| Decarli 1996 | 77 | Italian males and females (n=395) | Two 7-d diet records | DR kept during a week after FFQ | 18% over-estimation bias | Enrgy-adj 'r'= 0.54 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Egami 1999 | 97 | Japanese men and women (n=88) | Four 4-d weighed dietary records | DR completed 3-months after FFQ | 6% for energy; 1.2% for other energy-yielding macronutrients | Crude ‘r’= 0.34; energy adj ‘r’=0.47; energy adjusted deattenuated ‘r’=0.53 |
| Green 1998 | 116 | Adolescent females from Canada (n=105) | 3-d weighed food record and biochemical measures | DR completed during the week after FFQ | FFQ over-estimated by 10.6% for energy and 54% for folate, and 158% for B12 | - |
| Hebert 2001 | 61, 7-item fruit / veg screener + single qn on fruit / veg intake | Female employees at five health centers in E. Massachusetts (n = 132) | 3-d mean intakes derived from 24 hour recalls | Conducted as part of worksite intervention trial – 24 hr recalls completed within 2 weeks of conclusion of trial | FFQ under-estimated energy by 100Kcal and fruit and veg intake (1.6 and 1.7 servings /day) w.r.t. 24HR. | |
| Jain 1996 | 132 | Canadian men and women (n=203) | 7-d food record | 1-month between methods; order of methods reversed in a cross-over design | 24.4% over-estimation bias for energy and 22.6% for other energy-yielding macro-nutrients | Unadjusted ‘r’=0.43; energy-adjusted ‘r’= 0.50 |
| Jones 1997 | - | Houston area, Hispanic women (n=23) | 3-day food record | DR completed on 3 randomly selected days over 3-week period; 2 FFA’s administered 1 month apart | 25% over estimation bias for energy and 30.25% for total dietary fiber | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Kim 2002 | 118 item KFFQ modified Block HHHQ | Korean Americans (n=73) | 7-d diet record | DR and KFFQ completed 1 week after instructions were provided | Mean nutrient values in FFQ differed by at most 25% from DR, with exception of Vitamin A | Adj Spearman rank order correlation for nutrients=0.45-0.84 |
| Kristal 1997 | 100 | Low-income black (28.1%), Hispanic (16.2%) and white women (n=1015) | 4-d food record | | FFQ over-estimated % energy from fat by 4.6 % | 'r' for % energy from fat=0.26-0.49. |
| Kumanyika 2003 | 68 | U.S. Black Women aged 21 to 69 (n=408) | Three 24-hr recalls and one 3-d food diary | Completed over 1 year period | Mean energy intake for diary (1716) greater than FFQ (1601) or recalls | Energy adj correlation from 0.5-0.8, except for energy and vitamin E. |
| Stern 1993 | 85 items | Low income women from Mexico City (n=150) | Four consecutive 24-hour dietary recalls on 4 occasions throughout a year, once per season | | | |
| Yanek 2001 | 100-item scannable Block 1995 | African-American women 40 years and older (n=429 complete) | Three 24-hour dietary recalls | 92% completed within 2 months, rest within 3 months of FFQ administration | FFQ overestimated energy by 26% and % energy from fat by 18% | All correlations significant ($p < 0.01$) |

## DIETARY BEHAVIOR DURING PREGNANCY AND POSTPARTUM

The periods of pregnancy and postpartum may represent key transition points in the lives of many women. Several studies have looked at dietary behavior defined in terms of nutrient intakes during pregnancy and/or postpartum (Gennaro et al. 1997, Giddens et al. 2000, Berg et al. 2001, Swenson et al. 2001). For example, Berg et al. (2001) reported that dietary intakes of folate, vitamin B-12 and zinc remained constant between pregnancy and postpartum. Mackey et al. (1998) found that diets of lactating women did not meet recommendations for calcium, zinc, folate, vitamin B-6, vitamin D and vitamin E at 6-months postpartum. However, food-related dietary behavior has received less attention during these periods (Elias and Innis 2002, Abrams and Guendelman 1995, Siega-Riz et al. 2002).

Existing literature suggests that global aspects of diet may remain stable while other aspects may change as women make the transition from pregnancy to postpartum (Baker et al. 1999) and assume the maternal role (Devine and Olson 1992). Devine et al. (2000) posited that in the majority of women, basic attitudes towards diet and weight remain constant during prepregnancy, pregnancy and postpartum. In a study of 36 participants from the Special Supplementary Program for Women, Infants and Children (WIC), women's orientations towards diet and weight in postpartum were characterized. Women with the least levels of education reported ingestion of excessive total energy, and energy-dense snacks, and low levels of physical activity in the period following childbirth. Furthermore, these women recorded high levels of postpartum weight retention.

Devine et al. (2000) observed consumption of greater amounts of milk and less soda during pregnancy than during postpartum. Similarly, Guendelman and Abrams

(1994) found that Mexican-American women reported higher milk intakes, and that non-Hispanic white women reported higher intakes of fruits and vegetables during pregnancy than in postpartum. In some women, the period following childbirth may be characterized also by an increase in eating disorder psychopathology (Stein and Fairburn 1996) and dieting (Baker et al. 1999). Healthier diets during pregnancy may be attributed to widely accepted norms that govern pregnancy-related diet (Baric and Macarthur 1977). Certain differences in food choices between pregnancy and postpartum may be due to cravings and aversions during gestation. For example, Bayley et al. (2002) showed that women might experience cravings for fruit and fruit juices, sweets, chocolates and desserts during pregnancy.

Low-income and minority women are at increased nutritional risk. Using a national sample from NHANES 3, Bodnar et al. (2002) showed that approximately 10% of U.S. women are anemic during the first six months postpartum. The risk was higher in women with low incomes. This was attributed to low iron stores being available in postpartum due to inadequate supplementation with the mineral during pregnancy (Bodnar et al. 2002). Women with limited economic means also suffer a higher risk of obesity and consequently a greater likelihood of caesarian sections and postpartum hemorrhages, resulting in excessive blood loss (Bodnar et al. 2002).

Gennaro et al. (1997) and Morin et al. (1999) found compromised dietary behaviors, such as skipping of meals and subsequent snacking and high fat intakes in ethnically diverse inner-city postpartum mothers. In their study of 218 low-income women, Quan et al. (2000) identified fruit and vegetable consumption as areas that were at or below recommended daily consumption levels. Food insufficiency also is more prevalent among low-income populations. This can lead to poor health and an increased risk for obesity (Adams et al. 2003, Gibson 2003).

Mardis and Anand (2001) observed that low-income women consumed higher percentage of calories from fat, saturated fat and cholesterol than women whose family incomes were above 185% of federal poverty guidelines. In a study with 2247 low- and middle-income pregnant women (50.3% whites and 43.2% African-Americans), Siega-Riz et al. (2002) found that biscuits, muffins, whole milk, French fries and fried potatoes were among the most frequently consumed foods. Soft drinks and fruit juices were the two highest contributors to carbohydrate intake, while hamburgers, beef/bean burrito, cheese and cheese spreads made significant contributions towards protein intake.

**FACTORS THAT CONTRIBUTE TO POOR FOOD CHOICES IN LOW-INCOME WOMEN**

Eating away-from-home and food pricing may contribute to unhealthful food choices (French et al. 2003) among populations with limited economic means. French et al. (2003) highlighted the increased consumption of energy-rich foods, including fats and sugars, as a result of cost-conscious food choices and pointed out that patrons at restaurants have little control over the nutritional quality of food consumed. These authors posited that a 50% reduction in price on lower fat snacks resulted in 93% increase in sales. Also, Darmon et al. (2002) showed through a mathematical model that financial constraints resulted in poor food choices, such as increased consumption of added fats and refined cereals, and reduced intakes of fruits and vegetables.

French et al. (2000) have shown that fast food consumption in women is associated with lower income and ethnic minority status. Fast food restaurant use was related positively to body weight, and intakes of energy, fat, hamburgers and French fries; an inverse relation existed between fast food consumption and vegetable intake, eating restraint and low-fat eating behaviors (French et al. 2000). Paeratakul et al. (2003) also showed that fast food use was associated with increased intakes of total calories, fat, sodium, soft drinks, and fried potatoes, and low intakes of milk, fruits, vegetables, dietary fiber and vitamin A, vitamin C and beta-carotene.

Bodnar et al. (2002) describe the lack of postpartal care and education as contributing to the increased prevalence of nutritional deficiency in women 0-6 months postpartum. Other factors that influence dietary behavior during postpartum include parity, education and hours of employment, commitment to the maternal role, and the mother's beliefs regarding the degree of influence she may have on the health of the fetus (Walker et al. 1999). Postpartum women who have to balance work with taking care of a child, may not take sufficient care of their own health (Walker and Best 1991).

McLaughlin et al. (2003) found that increased frequency and complexity of at-home food preparation led to higher intakes of energy and all the major food groups in low-income women. Insufficient food shopping (Hersey et al. 2001) and cooking (Dibsdall et al. 2002; McLaughlin et al. 2003) skills, and lack of nutrition knowledge (Hanss-Nuss et al. 2003) may contribute to poor diets in low-income women.

### EXERCISE PATTERNS DURING POSTPARTUM

Downs and Hausenblas (2003) reported that exercise was lower during postpartum relative to prepregnancy. Women were aware of the weight reducing effects of exercise during postpartum. Lack of time was cited as a barrier to regular physical activity, and partner/family support was cited as a promoter (Downs and Hausenblas 2003). Physical activity during postpartum has been linked with improved overall fitness, serum lipid profiles, insulin sensitivity and emotional well-being (Larson-Meyer 2001). Reasons for limited exercise in postpartal women may include childcare demands; lack of time, financial resources and transportation (Hinton and Olson 2001); negative body image; lack of affordable access to exercise facilities, and issues related to safety (Kieffer et al. 2002).

## RELATIONSHIP BETWEEN DIET AND WEIGHT STATUS IN POSTPARTUM

The postpartum period is associated with increased risk for weight gain and weight retention, and is associated with overweight development in women (Rooney and Schauberger 2002). In a sample of 540 healthy primarily white women, Olson et al. (2003) found that although the average weight retained at 1 year postpartum was 1.51 ± 5.95 kg, retained weight exceeded 4.55 kg. (10 lbs.) in 25.6% of women. Also, Rooney and Schauberger (2002) reported that although the mean weight retained at 1year postpartum centered at 1 to 2 kgs (2-5 lbs.), some women gain over 5 kg (10 lbs). Ethnic minorities (Williamson et al. 1994) and persons with low incomes are at greater risk of excessive postpartum weight retention.

Excess pregnancy-related weight gain and failure to lose weight in postpartum were found to be associated with obesity 8-10 years later in 795 women (Rooney and Schauberger 2002). The issue of obesity is important because two out of every three adults in the United States is overweight or obese (Butler 2004). Obesity causes increased morbidity and mortality through its association with health conditions such as diabetes, coronary heart disease, respiratory problems, dyslipidemia, hypertension and arthritis (Mokdad et al. 2003).

Gestational weight gain is an important predictor of weight retention in postpartum (Linne and Rossner 2003; Olson and Strawderman 2003). A study in 419 African-American, Hispanic and White Medicaid-eligible women found that weight gain during pregnancy was the predominant predictor of weight retention at 1.5 months postpartum (Walker et al. 2004). Family incomes <185% of the federal poverty guidelines were associated with higher gestational weight gains (Olson and Strawderman 2003).

Gunderson et al. (2001) examined patterns of weight gain and weight loss during and after pregnancy in a group of 985 healthy women, aged 18-41 years, who had singleton live births. Women who were underweight or normal-weight prior to pregnancy had higher gestational weight gains and greater weight loss in postpartum than those who were overweight or obese. Weight change patterns during pregnancy and postpartum did not differ according to ethnicity, but did vary by pregravid body weight status (Gunderson et al. 2001). Those with obese pregravid body weights experienced the greatest percentages of net weight loss during early postpartum compared to underweight, normal weight and overweight persons. Also, obese women in postpartum experienced the lowest percentages of net weight loss during late postpartum compared with underweight, normal weight and overweight persons (Gunderson et al. 2001).

In a long-term prospective study of 1423 women, Linne and Rossner (2003) found that weight retention during the first pregnancy was predictive of weight increases during subsequent pregnancies. Women who were overweight prior to pregnancy had similar rates of postpartum weight retention at 1 year following childbirth compared to women who had normal weights before becoming pregnant (Linne and Rossner 2003).

Breastfeeding is associated with lower prepregnant body mass index (Hilson et al. 2004) and decreased postpartum weight retention (Kac et al. 2004). Health practices were not associated with weight retention at 1.5 months postpartum in a tri-ethnic sample of low-income women (Walker et al. 2004).

Lifestyle factors such as diet are related to weight gain. At the crux of the etiology of weight changes is an imbalance between energy intake and energy expenditure (Schulz et al. 2002). Various dietary and other environmental factors interact to cause this imbalance. Dietary factors that have been implicated in the development of obesity in the general population include percentage of energy from fat, energy density, palatability, dietary variety, dietary fiber, glycemic index, portion size, macronutrient, fiber and water content (McCrory et al. 2000). Frequency of meals, skipping of breakfast, and food deprivation followed by overeating impact risk of obesity (Ma et al. 2003). Increasing portion sizes (Rolls, Morris and Roe 2002), greater palatability of the food supply (McCrory et al. 2002), glycemic index (Ludwig 2000), increased snacking (McCrory et al. 2002), restaurant and away-from-home food consumption (Ma et al. 2003) and sedentary lifestyles also have been implicated in the causation of weight gain. "Dietary disinhibition" described as the tendency to overeat certain foods in the presence of disinhibiting stimuli (e.g. "social facilitation of food intake" at buffets and parties, the use of alcohol and emotional distress), has also been implicated in the etiology of obesity (McCrory et al. 2002, Pearcey and deCastro 2002).

Darmon et al. (2002) demonstrated that financial constraints, such as those experienced by low-income individuals in industrialized countries were sufficient to cause shifts towards the selection of energy-dense foods such as cereals, sweets and added fats, as these foods were more economically viable on reduced food budgets. Food insecurity, defined as the "limited or uncertain availability of nutritionally adequate and safe foods," was found to be associated with an increased risk of obesity in 8169 California women aged >18 y (Adams et al. 2003). Proposed mechanisms by which food insecurity may result in obesity include the selection of inexpensively priced energy-dense food choices, periods of overeating followed by periods of normal eating or deprivation, disordered eating, or metabolic changes induced as a result of stress (Gibson

2003). Gibson (2003) also found that participation in the Food Stamp Program was associated with obesity in low-income women.

Pearcey and deCastro (2002) found higher intakes of energy, carbohydrate and fat in those who were gaining weight than in those whose weights were stable. Dietary fiber also has been hypothesized to suppress energy intake by inducing satiation and satiety (Burton-Freeman 2000).

Specific foods and nutrients have also been implicated in the development of overweight and obesity in women. In a multiethnic sample of 514 women, Maskarinec et al. (2000) reported that high intakes of red meats, fish, poultry, eggs, fats and oils, and condiments were associated with higher body mass indices; vegetables, legumes, tofu and soy protein, fruit, fruit juice and cold breakfast cereals were associated negatively with overweight development.

Schulz et al. (2002) found that women who gained weight reported higher intakes of meats, sauces, fats, eggs, sweets, coffee/tea, milk and milk products and soft drinks compared with weight maintainers. Quatromoni et al. (2002) found that those consuming diets rich in sweets and fats with fewer servings of fruits, vegetables and lean food choices were 1.4 times more likely to become overweight/obese than those who ate a lower fat and nutritionally varied diet with adequate amounts of vegetables, fruits, low-fat milk and other low-fat and whole grain foods.

Recent data indicate that calcium and dairy components may play a role in weight gain (Teegarden and Zemel 2003). Heaney (2003) hypothesized that increasing the calcium intake of the population would decrease markedly the prevalence of overweight and obesity. A study by Jacqmain et al. (2003) showed that low calcium intake was associated with greater weight, adiposity and BMI in women (Jacqmain et al. 2003).

### RELATIONSHIP BETWEEN PSYCHOSOCIAL FACTORS AND DIETARY BEHAVIOR IN POSTPARTUM

The postpartum period is associated with fluctuations in psychosocial factors. It has been established recently that certain psychosocial variables might influence health-related behaviors, including diet (Hinton and Olson 2001). Walker et al. (1999) described a relationship between psychosocial and demographic factors and health behaviors during pregnancy. This relationship might extend into the postpartum period.

Psychological distress may occur as a result of overweight status in postpartum may be a source of in women during postpartum (Walker 1999). In a study of 227 new mothers, 40% experienced mild dissatisfaction with weight and 8% experienced weight-related distress (Walker 1998). Walker (1999) showed greater overweight status and postpartum weight retention, disordered and emotional eating and greater weight related distress among postpartal women who wished to prevent further weight gain. Women who desired to lose weight in the following six months also had higher body mass indices, greater postpartum weight retention and weight-related distress than those who were not trying to lose weight (Walker 1999). Stein and Fairburn (1996) reported that excessive concern surrounding weight retention may precipitate eating disorders in some postpartum women. Weight-related distress also was higher in those with eating disorders than in those without such disorders (Walker 1999).

Postpartum depression has been described by Beck (2001) as a debilitating mood disorder. These authors suggested that a woman's genetic make-up and unique brain chemistry may be compared to a fault line that determines the risk of earthquakes (in this case, the inherent risk of depression). Stressful life events and hormonal changes (such as those that occur during pregnancy and postpartum) impact this fault line and an earthquake or mood disorder results when the internal pressure on the fault line increases to such an extent that an eruption follows in order for the pressure to be relieved.

Predictors of postpartum depression include personal or family history of depression or other mental illness, prenatal depression, history of difficult life events, hormonal changes and reproductive blues, low self-esteem, stress related to childcare, poor quality of marital relationship, and low social support (Beck 2001). Depression in low-income minority women also has been linked with Hispanic ethnicity, low levels of education, use of cigarettes, and employment of hormonal birth control pills before the age of 13 (Berenson et al. 2003). In addition, single mothers and women with limited economic means have a greater risk of experiencing depressive symptoms during postpartum (Beck 2001). A recent study also found that low hemoglobin levels may be associated with depressive symptoms in postpartum (Corwin et al. 2003).

In a national sample of 6190 US adults aged 25-74 years, depression was linked with increased risk of diabetes in those with less than a high school education (Carnethon et al. 2003). A study of 1024 adults with stable coronary artery disease by Ruo et al. (2003) found that depressive symptoms were related to greater angina-related symptoms and physical limitation, and worse overall health and quality of life.

High rates of depression during postpartum have been reported in the African-American community (Logsdon et al. 2000). Postpartum depression diminishes the quality of mother-child interactions and relationships with significant others, as well as ability to conceptualize and achieve life goals (Logsdon et al. 2000). Carnethon et al. (2003) have shown also a high correlation between depression and anxiety.

Miranda et al. (2003) reported a high incidence of depression in low-income ethnic minorities. Low-income minority women also are unlikely to seek or receive care for depression due to financial constraints, lack of insurance, and childcare and transportation problems (Miranda et al. 2003). Current treatment for depression includes antidepressant medications (serotonin reuptake inhibitors) and psychotherapy. Using a randomized controlled trial design, 267 low-income ethnic minority women with depressive symptoms were randomly assigned to receive antidepressant medication, undergo psychotherapy or were referred to community care. Miranda et al. (2003) proved that evidence-based care could be effective among low-income women as long as they were aided in overcoming barriers to care. This could be done by arranging for childcare and transportation, and by repeated contacts with these women. (Miranda et al. 2003).

Logsdon et al. (2000) described a great need for social support in low-income women with young children. Support that matches needs and wide social networks can help alleviate psychosocial distress and reduce depressive symptoms during postpartum (Logsdon et al. 2000). Also, intimacy with partner and self-esteem may reduce risk for postpartum depression (Logsdon and Usui 2001).

The postpartum period may be stressful in many women. Common stressors include concerns regarding competency for infant care, weight and body image concerns, fatigue, need to regulate demands from family members and employment (Groer et al. 2002), and coping with sibling jealousy among children and emotional tension (Groer et al. 2002). Furthermore, sleep deprivation during postpartum can increase fatigue and weaken the ability of the body to deal with stress (Groer et al. 2002). Albers and Williams (2002) posited that key life events such as birth may create stress as they require behavioral changes within a short period of time. The stress in the lives of women during postpartum can be alleviated by social support (Albers and Williams 2002).

Daily sources of stress were more closely linked with depressive symptoms than stress arising from major life events (Groer et al. 2002). Excessive stress during postpartum has negative effects on maternal, infant and family well-being (Groer et al. 2002). Psychosocial or physiological stress changes the neuroendocrine profile of women, with increased release of catecholamines, epinephrine, norepinephrine, glucocorticoids, corticotropin, cortisol and endogenous opioid peptides. Carnethon et al. (2003) reported that stressful situations may hasten the development of clinical diabetes in persons with a high genetic predisposition, through the induction of hyperglycemia. Breastfeeding is believed to alleviate stress in postpartum as lactation releases oxytocin, a hormone that promotes feelings of calmness, and diminished maternal reactivity to stress (Groer et al. 2002).

Body image has been defined as "an individual's mental representation of him/herself" (Friedman et al. 2002). Baker et al. (1999) found that body image dissatisfaction was higher in postpartum than during pregnancy. In a sample of 45 postpartum African-American women, Morin et al. (2002) found that women were likely to overestimate the space their bodies occupied in comparison to reality. These authors also reported that negative body image was more pervasive in overweight participants. Greater dissatisfaction with body image may cause greater weight-related distress (Walker 1998). In a socio-economically diverse cohort of 622 women, 56% reported dissatisfaction with body weight and shape at 1 year postpartum (Hinton and Olson 2001). Walker and Freeland-Graves (1998) found that dissatisfaction with body image was associated with lower levels of exercise, unhealthy lifestyle and diminished capacity for self-regulation of negative emotions. Greater social support, body image satisfaction, acceptance of weight gain, and self-efficacy for regulating food intake and body weight were associated with decreased food intake in postpartum (Hinton and Olson 2001).

In summary, there is need for a greater understanding of multiple dimensions of dietary behavior in low-income women of diverse ethnicities in the first postpartal year. Psychosocial and body weight correlates of dietary behavior during postpartum also need to be identified. Potential applications of this research will include the development of a culturally appropriate diet assessment tool and nutritional interventions for low-income mothers in postpartum.

# Chapter 2: Development and Validation of a Semi-Quantitative Food Frequency Questionnaire for Young Adult Women in the Southwestern United States [1]

## INTRODUCTION

The southwestern United States comprises a culturally diverse population, with sizeable proportions of Hispanics, African-Americans and non-Hispanic whites (U.S. Census Bureau 2000). This multicultural society has led to a steady assimilation of ethnic foods into the mainstream diet. Dietary patterns in the region also have been influenced by nationwide changes in the food supply, such as the increased consumption of fat-modified foods (Kennedy and Bowman 2001), restaurant/fast foods (Lin et al. 1999), functional foods (Milner 2000), and new types of frozen convenience foods. Consequently, instruments that seek to assess dietary patterns must be revised continually to reflect these changes.

Food frequency questionnaires are widely used for dietary assessments in epidemiologic studies (Willett 2001) due to their cost- and time-effectiveness (Subar et al. 2001), and ability to measure "habitual" dietary intake (Hill and Davies 2001). Unlike diet records that reflect intrinsically the diverse nature of dietary patterns, food frequency questionnaires must be tailored specifically to encompass the diets of the target population.

The purpose of the present study was to develop a multicultural, up-to-date food frequency questionnaire (FFQ) suitable for multiethnic female populations in the southwestern United States. This paper describes the validation of the FFQ against diet

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[1] "Reprinted from Nutrition Research, 24, George, G. C., Milani, T., Hanss-Nuss, H., Kim, M., Walker, L. O. & Freeland-Graves, J., Development and validation of a semi-quantitative food frequency questionnaire for young adult women in the southwestern United States, 29-43., Copyright (2004), with permission from Elsevier."

records in a sample of college women, and cross-validation against 24-hour recalls and diet records in a group of low-income postpartal women. The two specific populations of college and low-income postpartal women were chosen because future studies using this instrument are planned in both of these target groups. As the FFQ was designed to capture overall diet, a wide range of nutrients was included in the present validation study.

## METHODS

### Study Design

In Study 1, a food frequency questionnaire was developed and validated using 3-day diet records from 95 female college students enrolled in an introductory nutrition class at a major University in the southwestern United States. The questionnaire was administered on the first class day prior to any lecture. Methods of recording diets were explained and college women maintained 3-day food intake records in the following week.

In Study 2, the instrument was cross-validated utilizing 24-hour recalls and diet records in a multiethnic sample of 50 low-income women, derived from a longitudinal study on postpartal weight retention (Walker and Kim 2002). Women were recruited 0-1 days following delivery in a hospital and visited our research site at 1.5-, 3- and 6-months postpartum. The 1.5-month postpartal visit was used to provide training to the low-income postpartal women to complete food records accurately. The FFQ was administered at 6-months postpartum. Twenty-four hour recalls and 2-day diet records were obtained at 3- and 6-months postpartum. These time points were within the "previous six months" reference period of the FFQ.

**Subjects**

Subject selection criteria for the undergraduate student sample in Study 1 included enrollment in an introductory nutrition course, female gender and accurate completion of the food frequency questionnaire. Parameters established for valid completion of the FFQ were caloric intakes within a pre-defined range of 500 to 3700 kcals. The upper threshold of the range was slightly higher than that used previously by Willett (1998) to compensate for the high levels of physical activity that are associated with this population of young, health-conscious college women.

In the spring of 2000, completed food frequency questionnaires and 3-day diet records were obtained from 106 college women. Five subjects were eliminated due to errors detected via a modified DietSys® edit-check system (Block et al. 1994) and six subjects were excluded due to unreasonable energy intakes. The modified edit check function was used to identify improbable responses to FFQ questions, such as consuming too many (>50) foods daily. The final sample of 95 college women belonged to a variety of disciplines and comprised mostly freshmen and sophomores (75.3%). The majority of the sample (75.3%) had normal body weights (BMI 19-24); 12.4% were overweight or obese (BMI = 25) (Table 2).

Table 2: Demographic characteristics of participants

| Characteristic | College women (n = 95) | Low-income women (n = 50) |
|---|---|---|
| Age (y) (Mean $\pm$ SD) | 20.1 ± 4.3 | 23.1 ± 4.3 * |
| Race (%) | | |
| White, non-Hispanic | 65 | 34 |
| Hispanic | 16 | 42 |
| African-American | 5 | 24 |
| Other | 14 | - |
| Weight (kg) (Mean $\pm$ SD) | 60.9 ± 10.5 | 72.8 ± 17.6 * |
| Body Mass Index (kg/m$^2$) (Mean $\pm$ SD) | 22.0 ± 3.1 | 28.3 ± 7.3 * |

* Mean estimates for low-income women are significantly different from corresponding means for college women.

Inclusion criteria for the cross-validation sample in Study 2 were African-American, Hispanic or non-Hispanic White ethnicity; eligibility for Medicaid (=185 % of the poverty guidelines); ability to speak, read and write English; and absence of pregnancy abnormalities and chronic health conditions. It should be noted that this instrument was designed for those who are literate in English. Populations who reside in the southwestern United States and do not speak English may have food habits that are quite divergent from those of persons who have been acculturated into our society. Nonetheless, the food frequency questionnaire has been translated into Spanish and back-translated into English, and is available upon request. At present, it is unknown what proportion of potential minority participants were eliminated by the English literacy criterion.

Valid completion of food frequency questionnaires was indicated by caloric intakes within a pre-defined range of 500 to 5000 kcals. This range was modified from the 500 to 3500 kcals range proposed by Willett (1998) for non-pregnant, non-lactating women. Although 5000 kcals may seem to be a high level of habitual caloric intake, equal or higher cut-off values have been used in studies that included ethnic minority populations (Kolonel et al. 2000, Kristal et al. 1997, Yanek et al. 2001). A lower cut-off of 4000 kcals would have excluded an additional 17% of the African-Americans, and < 6% of Hispanics and non-Hispanic whites. Differential exclusion rates among the ethnic groups would limit interpretation of the ethnic sensitivity of the questionnaire. Also, 58% of the women were overweight or obese by 6-months postpartum, suggesting excessive energy intakes.

Sixty-two women recruited until March 2002 were considered for the cross-validation study. Three women were excluded because they had fewer than 5 days of food record data and four subjects were eliminated due to inaccurate completion of the food frequency questionnaire, as indicated by a modified DietSys® edit-check system (Block et al. 1994). Five women were removed due to unreasonable caloric intakes (kcal>5000), resulting in a final sample of 50 subjects. The tri-ethnic sample ranged in age from 18 to 38 years. At 6 months postpartum, 22% of the low-income women were overweight (BMI = 25 and < 30) and 36% were obese (BMI > 30) (Table 2).

The studies were approved by the Institutional Review Board for Human Subjects of the University of Texas at Austin. Informed consent was obtained from each subject prior to participation

**Food frequency questionnaire**

The semi-quantitative food frequency questionnaire was created as a modification of the Health Habits and History Questionnaire (HHHQ) (Block et al. 1992). The modified questionnaire was based on a reference period of the previous six months. The original food list was revised extensively and updated to include ethnic foods from the southwestern United States, low-fat food choices, a greater selection of fast foods and restaurant food items, functional foods and nutritional supplements (Table 3). The updated food list was based on knowledge of the regional food supply, new products in the market, and previously developed and validated questionnaires (Block et al. 1995, Pillow et al. 1997, Stern et al. 1993).

Table 3: Examples of line items in the revised food list

| | |
|---|---|
| **Fruits and juices** | **Vegetables** |
| Mango, papaya | Asparagus |
| Pineapple | Avocado, guacamole |
| Raisins, figs | Beans: pinto, kidney, chili, lentils, black |
| **Breakfast foods** | Beans: refried, baked, dip |
| Breakfast tacos | Beets |
| Chorizo | Collard greens |
| Eggs, migas | Eggplant |
| Egg whites, egg substitutes | Peas, black-eyed |
| Grits, hominy | Peppers: green, red |
| Slim-fast®, breakfast shakes, Ensure®, Boost® | Peppers: jalapeno, green chillies |
| Sports bars, PowerBars, Cereal bars, granola bars | Mushrooms |
| | Nopalitos |
| **Breads/ Snacks/ Spreads** | Okra |
| Rice: Spanish, fried rice | Radishes |
| Nachos, potato skins with cheese | Sprouts: bean, alfalfa |
| Couscous, kasha, bulgar | Green chili sauce |
| Snacks: low-fat, baked, fat-free chips, popcorn | Other vegetables: jicama, Jerusalem artichokes, water chestnuts, others |

**Meat/fish/poultry/nuts/mixed dishes**

Cabrito, rabbit

Chicken fried steak

Fish, mixed dishes: gumbo, etoufee

Hamburgers, cheeseburgers, meatloaf, picadillo, meat sandwiches

Meat empanadas

Meat substitutes: tofu, veggie burgers

Egg rolls, taquitos, fried fajita pockets

Beef/bean burritos, soft tacos, fajitas

Cheese/ beef enchiladas, tamales

Chili relleno

Crispy tacos, chalupas

Menudo, posole soup

Tripas, tongue; stomach, intestine

Liver, pate, chicken livers, sweetbreads, brains

Pork and beef ribs

Seeds: sunflower/sesame/tahini/pine nuts

**Dairy products**

Cheese, hard: American, cheddar, Swiss

Cheese, low-fat/non-fat hard: American, cheddar, Swiss

Ice cream: cones, milkshakes, sundaes

Ice-cream, low-fat, non-fat

Yogurt, frozen yogurt: regular fat

Yogurt, frozen yogurt: low-fat/non-fat

**Sweets**

Candy, with nuts: Pralines, Snickers

Empanadas, pan dulce, conchas

Jell-O, sherbet

Sopapillas

Pies: pecan

Pies, other: cobblers, crisps

**Beverages**

Coffee (regular, decaffeinated)

Soft drinks, other: Gatorade, Snapple

Fruit drinks, Hi-C, Kool-Aid

The final instrument included 195 items, grouped into eight categories: fruits and juices; breakfast foods; breads, snacks, and spreads; vegetables; meat, fish, poultry and mixed dishes; dairy products; sweets; and beverages. Six nutrition professors, dietitians and nurses, who were familiar with the dietary patterns of the target population, confirmed face and content validity of the final foodlist and reviewed the drafts of the questionnaires. Early versions of the questionnaire were tested for ease of administration and comprehension in 50 college women, and revised.

The format for the frequency response section was identical to the HHHQ and consisted of nine possible categories, ranging from "never or less than once a month" to "2+ times per day." Options for portion sizes were: small, medium, large and extra-large. The use of an "extra-large" serving size option is consistent with observed trends towards the consumption of large food portions in the United States (Nielson and Popkin 2003). Medium serving sizes for newly added foods were derived from Pennington (1998), the Food Guide Pyramid (1992), and a consensus of a panel of nutrition experts.

Nutrient values for the added foods were derived primarily from the United States Department of Agriculture Nutrient Database for Standard Reference (U.S. Department of Agriculture 1998). Missing nutrient values were imputed from values for similar foods; values for multi-ingredient foods that were not available in the USDA database were calculated from the nutrient values of their individual components.

Dietary data from the food frequency questionnaire were analyzed using DietSys®, a software program developed by Block et al. (1994). This program was updated with the nutrient values and portion size information for newly added foods. Analysis options provided refinement of nutrient calculations based on participant responses to summary questions. For example, Fruit Adjust checks a summary question on frequency of consumption of fruits with the total of individual fruit items selected.

Options that were retained were Fruit Adjust, Vegetable Adjust, Eat Skin (on chicken), and Meat Fat (fat on meat). Those that were turned off were Dark question (dark meat) and Recalc (modification of portion size of energy intake outliers) (HHHQ-DIETSYS Analysis Software 1997, Subar et al. 2001). The analysis options used in the present study are consistent with those used by others (Subar et al. 2001, Vandenlangenberg et al. 1997).

**Reference Data**

The reference data for the measurement of nutrient intakes consisted of 3-day food records in college women, and 6-day diets (two 24-hour recalls and four food intake records) in the postpartal women. All college women provided three days of dietary data. In the 50 low-income postpartal women, 6-day diet records were collected from 46 women and 5-day diet records were obtained from four women. In general, dietary data were obtained in the ratio of two weekdays and one weekend day.

Stringent quality control procedures were applied during all phases of dietary data collection. Professors with expertise in nutrition instructed the college women on how to complete diet records accurately. The young women were encouraged to include details on foods, such as methods of preparation, brand names, and fat contents of meats and milk. Plastic cups, food models and beverage containers were used to facilitate estimation of portion sizes. On receipt, diet records were checked for accuracy and completeness.

Dietary data collection in the low-income postpartal women was carried out by individuals with post-baccalaureate training in nutrition or health sciences. Approximately 1.5 months following recruitment in the study, participating women visited the clinic site and received detailed written and oral instructions for accurate completion of food records. With the help of food models and measuring cups and spoons, participants were trained to estimate portion sizes correctly for the diet records. Subjects were given a set of plastic measuring cups and spoons to take home for use.

Prior to the 3- and 6-month visits, diet record forms and detailed written instructions for accurate food record completion were mailed to participants. Subjects were requested to complete the diet records and bring them in to the research site. At the 3- and 6-month postpartum visits, well-trained project staff reviewed food records for accuracy and completeness, and then conducted 24-hour dietary recalls. A dietitian created a standardized interview protocol, which is available upon request. This interview protocol, food models and memory prompts (measuring cups and spoons, and activities) were used in the administration of the diet recalls. Careful examination of the data revealed that the quality of the recalls and records did not decline between the 3- and 6-month postpartal visits.

Nutrient intakes from the 24-hour recalls in low-income women and the food records from both populations were calculated using Food Processor, version 7.4 (ESHA, OR 1999). This nutrient database contains information on over 18,000 foods (Bazzano et al. 2002). Graduate students majoring in human nutrition coded the dietary records and recalls. A standardized list of food codes was compiled and this list guided the substitution of food codes for any missing brands in the nutrient database. All data were checked methodically and errors corrected.

In college women, the mean of the three diet records was used in all analyses. In low-income women, paired samples t-test showed that there were no significant differences between nutrient means of the two 24-hour recalls and the mean of the 4-day diet records ($p>0.05$). Nutrient means from the recalls and diet records also were correlated significantly with each other ($p<0.01$); correlations exceeded 0.5 for total calories, protein, dietary fiber, vitamin C, calcium, iron and magnesium. Thus, the diet record and recall values of low-income women were combined and are referred collectively to as diet records in the remainder of this paper. Others have used this combination method (Block et al. 1992, Patterson et al. 1999).

**Statistical Analyses**

Data were analyzed using the Statistical Program for Social Sciences (SPSS) for Windows (SPSS 9.0, Chicago, Ill, 1998). Reliability of the FFQ was tested using Cronbach's alpha, a measure of internal consistency reliability. The method of Cronbach's alpha was an appropriate reliability measure for this study as the FFQ is composed of distinct food groups or domains, each with a number of related items (Pedhazur and Schmelkin 1991). Foods were categorized on the basis of the Food Guide Pyramid (1992), and internal consistency reliability was assessed within food groups. Cronbach's alpha has been used previously to estimate internal consistency reliability of dietary questionnaires (Murphy et al. 2001).

Estimates of absolute nutrient intake in both populations were obtained using descriptive statistics. Paired samples t-tests were used to analyze differences in nutrient means produced by the FFQ and the reference methods in both samples. Nutrients were natural-log or square-root transformed as needed, to increase the normality of their skewed distributions and Pearson's correlation co-efficients were calculated. Correlation co-efficients were de-attenuated to correct for within-person variation in diet records. The formula used was:

$$r_t = r_o \sqrt{(1+ \text{lambda}/n)}$$

where $r_t$ is the true correlation between the food frequency questionnaire and the diet records, $r_o$ is the observed correlation between methods, lambda is the ratio of the within-person variance to the between-person variance, and n is the number of replicate measures of dietary data (Liu et al. 1978). The within- and between-person variance components necessary for the above equation were calculated using analysis of variance. Correlation coefficients were not adjusted for energy intake in this study as the instrument is intended primarily for use in community health settings, where absolute intakes are of greater interest than energy-adjusted nutrient values. This is consistent with recent recommendations (Subar et al. 2001, Block 2001) that the use of calorie adjustment be governed by the intended application of the food frequency questionnaire. There are also concerns that energy adjustment might result in inflated correlation coefficients (Block 2001).

The ability of the FFQ to assign individuals correctly by quartiles of nutrient intake was evaluated using contingency tables. For this, nutrient intakes from the FFQ and the diet records were classified into quartiles, and percent agreement between the classifications produced by the two methods was determined. Individuals were deemed classified correctly if they were categorized into the same quartile or within one quartile by both methods. Cross-classification by quartiles was used as a criterion for evaluation since food frequency questionnaires are used frequently to study relationships between specific dietary variables and the incidence of disease. In these studies, inappropriate classification of subjects might be of greater consequence than over- or under-estimation of nutrient means (Thompson and Byers 1994).

**RESULTS**

The internal consistency of the FFQ as determined via Cronbach's alpha coefficients for each food group is illustrated in Table 4. The median Cronbach's alpha estimate for food groups was 0.77 in college women and 0.72 in low-income women.

Table 4: Internal consistency as determined via Cronbach's alpha within homogenous food groups of the food frequency questionnaire in college women and low-income women

| Food group | Number of items | Cronbach's alpha | |
|---|---|---|---|
| | | College women (n = 95) | Low-Income women (n = 50) |
| Fruits | 23 | 0.73 | 0.70 |
| Vegetables | 42 | 0.86 | 0.85 |
| Dairy products | 12 | 0.64 | 0.58 |
| Meat, fish and poultry | 49 | 0.80 | 0.84 |
| Grains | 19 | 0.66 | 0.66 |
| Foods with added fats and sugars | 22 | 0.82 | 0.74 |

The means and standard deviations of the various nutrients estimated from the diet records and the food frequency questionnaire in the two populations are shown in Table 5. In college women, nutrients that were significantly overestimated by the FFQ relative to diet records were protein, monounsaturated fat, vitamin B1, vitamin B2, vitamin B6, folate, vitamin C, calcium, magnesium, phosphorus, potassium, sodium, zinc and alcohol. Nutrients that were significantly overestimated in low-income women were saturated fat, monounsaturated fat, dietary fiber, vitamin A, beta-carotene, vitamin B1, vitamin B2, vitamin B6, folate, vitamin C, vitamin E, calcium, magnesium, phosphorus, potassium, and zinc. Only dietary fiber was underestimated with statistical significance in college women; none of the nutrients were significantly underestimated in low-income women ($p>0.05$). For energy and the major energy-yielding nutrients, the average overestimation bias was +5.1% for college women and +6.6% for low-income women.

Pearson's correlation coefficients for the nutrients assessed by the FFQ and the diet records also are shown in Table 5. In college women, de-attenuated Pearson correlations ranged from 0.24 for sodium to 0.65 for vitamin A, with a mean of 0.42. De-attenuated correlation coefficients in the sample of low-income women ranged from 0.28 for sodium to 0.59 for vitamin E, with a mean of 0.45.

Table 5: Comparison of nutrient values estimated via diet records and a semi-quantitative food frequency questionnaire in college women and low-income women

| | Nutrient Intakes (Mean ± SD) | | | | De-attenuated Pearson's r [a, b] | |
|---|---|---|---|---|---|---|
| | College women (n = 95) | | Low-Income Women (n = 50) | | College women (n =95) | Low-Income (n = 50) |
| | Diet Record | Food Frequency Questionnaire | Diet Record | Food Frequency Questionnaire | | |
| Energy (kcal) | 1811 ± 563 | 1872 ± 649 | 1983 ± 458 | 2092 ± 1032 | 0.53 ** | 0.58 ** |
| Carbohydrate (g) | 242 ± 82.2 | 233 ± 89.2 | 249 ± 64.6 | 241 ± 120 | 0.49 ** | 0.54 ** |
| Protein (g) | 71.3 ± 27.8 | 79.3 ± 31.9 † | 77.2 ± 24.8 | 83.4 ± 44.5 | 0.38 ** | 0.42 ** |
| Fat (g) | 61.8 ± 31.2 | 67.6 ± 29.5 | 77.3 ± 21.4 | 89.7 ± 48.5 | 0.52 ** | 0.46 ** |
| Saturated fat (g) | 20.4 ± 11.2 | 23.1 ± 10.6 | 26.8 ± 7.5 | 31.6 ± 17.1 † | 0.53 ** | 0.48 ** |
| Monounsaturated fat (mg) | 13.4 ± 9.3 | 25.5 ± 11.9 ‡ | 14.4 ± 7.5 | 34.5 ± 19.4 ‡ | 0.39 ** | 0.36 * |
| Cholesterol (mg) | 210 ± 160 | 232 ± 132 | 299 ± 151 | 305 ± 192 | 0.34 ** | 0.45 ** |
| Dietary Fiber (g) | 15.6 ± 6.4 | 13.7 ± 6.6 † | 11.7 ± 4.8 | 13.8 ± 8.6 † | 0.35 ** | 0.50 ** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Vitamin A (µg RE) | 1050 ± 799 | 949 ± 608 | 587 ± 411 | 861 ± 629 ‡ | 0.65 ** | 0.42 ** |
| Beta carotene (mg) | 2703 ± 3829 | 2266 ± 1935 | 962 ± 1704 | 1886 ± 1963 † | 0.56 ** | 0.38 ** |
| Vitamin B1 (mg) | 1.2 ± 0.6 | 1.7 ± 0.7 ‡ | 1.1 ± 0.45 | 1.7 ± 0.9 ‡ | 0.34 ** | 0.42 ** |
| Vitamin B2 (mg) | 1.5 ± 0.56 | 2.2 ± 0.91 ‡ | 1.3 ± 0.53 | 2.0 ± 1.1 ‡ | 0.40 ** | 0.48 ** |
| Niacin (mg) | 19.6 ± 9.7 | 21.7 ± 8.5 | 17.2 ± 6.5 | 20.2 ± 11.0 | 0.35 ** | 0.40 ** |
| Vitamin $B_6$ (mg) | 1.5 ± 0.6 | 1.9 ± 0.79 ‡ | 1.2 ± 0.51 | 1.7 ± 0.93 ‡ | 0.34 ** | 0.37 * |
| Folate (mg) | 260 ± 124 | 354 ± 172 ‡ | 182 ± 97.5 | 334 ± 201 ‡ | 0.38 ** | 0.41 ** |
| Vitamin C (mg) | 101 ± 65.1 | 138 ± 84.7 ‡ | 71 ± 55.3 | 118 ± 81.5 ‡ | 0.55 ** | 0.51 ** |
| Vitamin E (mg) | 8.3 ± 7.3 | 9.4 ± 4.7 | 6.2 ± 4.9 | 10.1 ± 7.3 ‡ | 0.28 * | 0.59 ** |
| Calcium (mg) | 774 ± 317 | 964 ± 439 ‡ | 632 ± 299 | 882 ± 599 ‡ | 0.58 ** | 0.57 ** |
| Iron (mg) | 13 ± 4.4 | 13.6 ± 5.3 | 12.0 ± 4.4 | 13.6 ± 7.2 | 0.32 ** | 0.41 ** |
| Magnesium (mg) | 213 ± 86.4 | 276 ± 112 ‡ | 159 ± 63.6 | 270 ± 160 ‡ | 0.32 ** | 0.50 ** |
| Phosphorus (mg) | 971 ± 392 | 1326 ± 519 ‡ | 868 ± 327 | 1277 ± 735 ‡ | 0.38 ** | 0.52 ** |
| Potassium (mg) | 2241 ± 767 | 2712 ± 1080 ‡ | 1747 ± 646 | 2669 ± 1451 ‡ | 0.45 ** | 0.52 ** |
| Sodium (mg) | 2913 ± 949 | 3446 ± 1435 ‡ | 2964 ± 1009 | 3480 ± 1998 | 0.24 * | 0.28 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Zinc (mg) | 7.9 ± 3.2 | 12.0 ± 5.5 ‡ | 8.9 ± 3.6 | 11.8 ± 6.4 ‡ | 0.25 * | 0.44 * |
| Alcohol (g) | 3.2 ± 8.6 | 6.8 ± 8.5 ‡ | 0.75 ± 3.4 | 1.06 ± 2.2 | 0.47 | 0.36 |

[a] Energy and nutrient values were square-root or log-transformed as needed to increase normality prior to calculation of correlation coefficients.

[b] All correlation coefficients were de-attenuated to adjust for within-person variance in diet records.

[†, ‡] Significantly different from diet records within each population, i.e. within college women and within postpartal women: [†] $p<0.05$, [‡] $p<0.01$.

[*, **] Correlations within each population were significant: [*] $p<0.05$, [**] $p<0.01$.

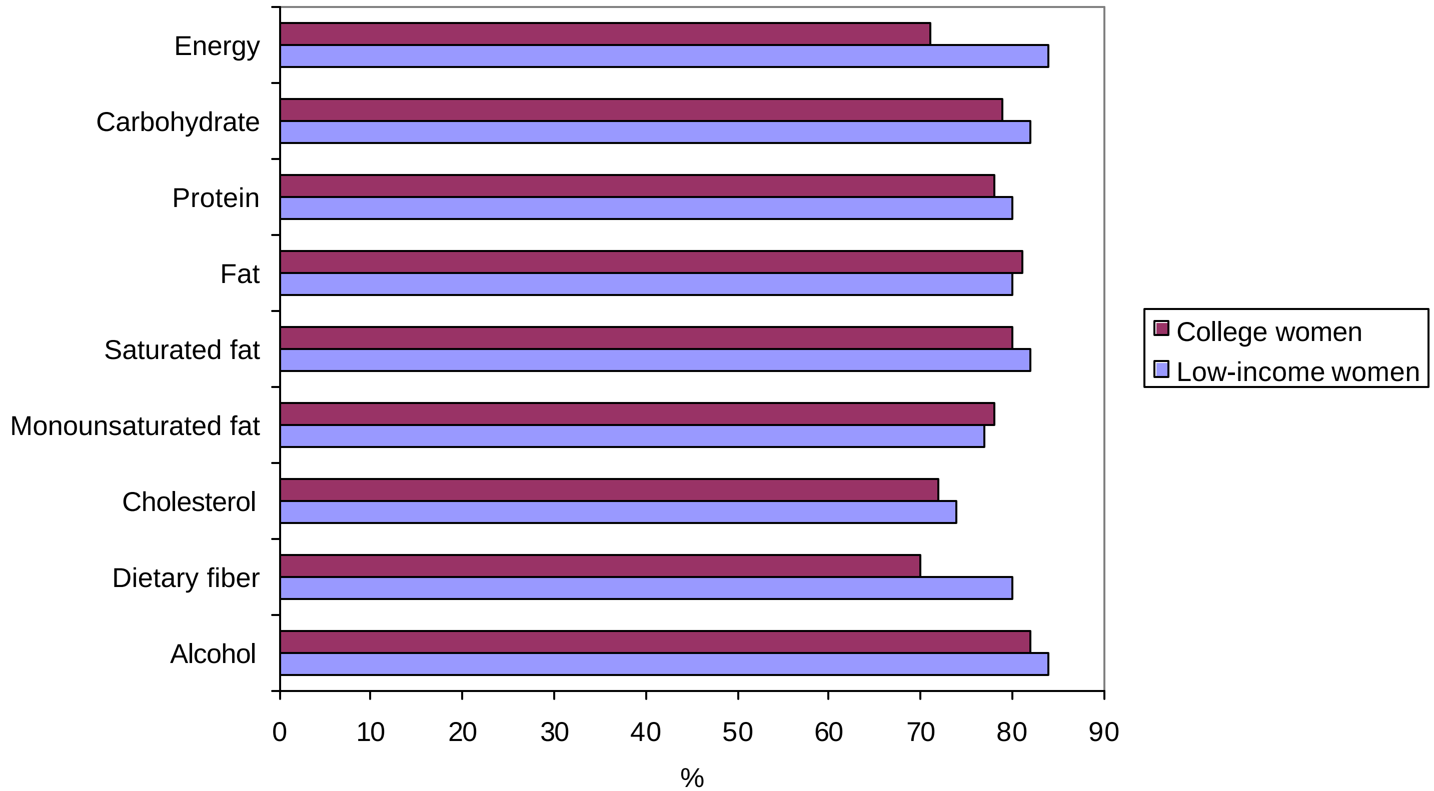


Figure 1: Proportion of women classified in the same quartile or within one quartile for energy, fats and energy yielding dietary components by the food frequency questionnaire and the diet records

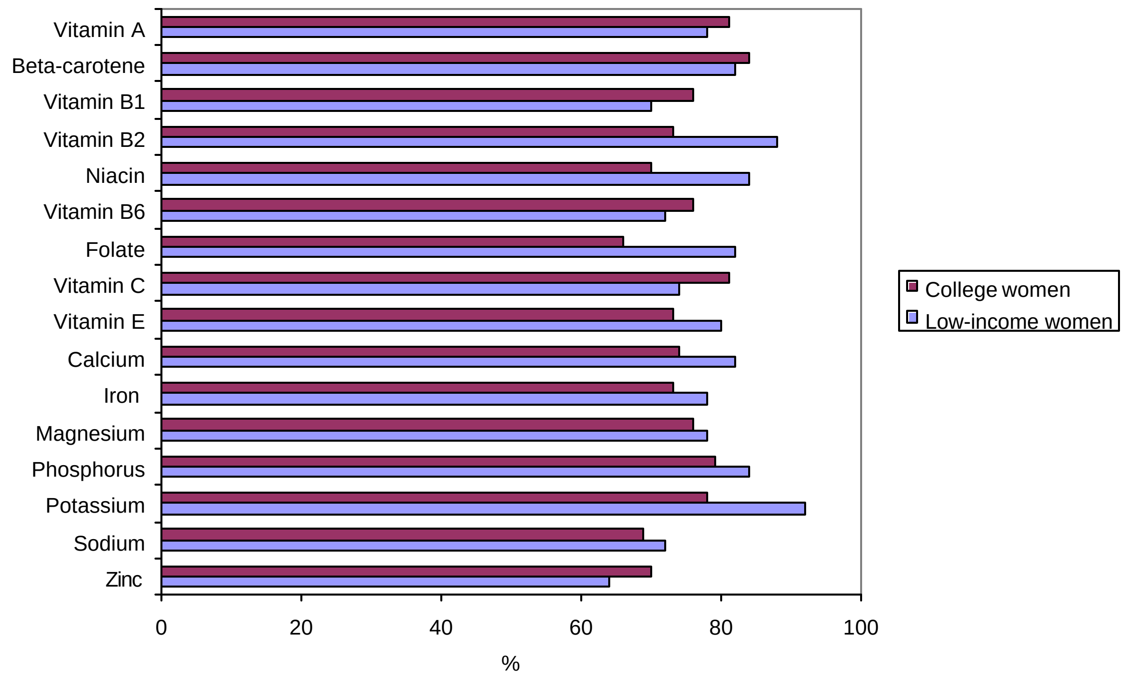


Figure 2: Proportion of women classified in the same quartile or within one quartile for vitamins and minerals by the food frequency questionnaire and the diet records.

Cross-classification of nutrient intakes into quartiles by the FFQ and the diet records are illustrated in Figures 1 and 2. This method resulted in 34% of college women being ranked into exactly the same quartile by both dietary methodologies. When considering all nutrients, 76% of college women were classified into the same or adjacent quartile. Individuals who were misclassified greatly, i.e., ranked in the first quartile with either the FFQ or the diet record, and in the fourth quartile with the other instrument, ranged from zero to 10%. The smallest degree of misclassification (0%) was seen for alcohol; the greatest degree of misclassification (10%) was for protein, iron and sodium. Among low-income women, exact concordance (agreement) between the rankings produced by the two methods averaged 39%. The mean percentage of low-income women classified into the same or adjacent quartile by the two methods was 79%. In low-income women, gross misclassification by the two methods ranged from 0% for dietary fiber, vitamin C, vitamin E and alcohol to 6% for total fat, vitamin A, iron, sodium and zinc.

## DISCUSSION

The results of this study suggest that the newly developed food frequency questionnaire is valid for its intended purpose. Mean estimates of internal consistency reliability (Cronbach's alpha) obtained in college women (0.75) and low-income women (0.73) were higher than those reported by Shannon et al. (1997) for a fat and fiber-related dietary questionnaire (0.53). The mean value obtained in this study also compares favorably with that reported previously by Murphy et al. (2001) (0.64) for a food behavior questionnaire in a convenience sample of 100 low-income women.

The ensuing sections on the validity of the food frequency questionnaire should be prefaced with the caveat that validation studies differ in terms of the demographic characteristics of their study populations, types of reference data used, sample sizes, lengths of questionnaires, and study designs (Subar et al. 2001). Hence, meaningful comparison of outcomes from multiple validation studies requires the examination of broad ranges, rather than specific values of validity coefficients and over/under estimation bias (Block et al. 1992). It is in this context that results from the present study are discussed.

Compared to the diet records in this study, the food frequency questionnaire over-estimated energy intake by 3.4% in college women and 5.5% in low-income postpartal women. Recent validation studies comparing food frequency questionnaires against diet records and recalls in U.S. women have reported biases in energy intake ranging from –3.4% (Subar et al. 2001). to +25% (Jones et al. 1997). The apparent differences among validation studies in the direction (over- or under-estimation of nutrient means) and degree of bias may be explained partly by variations in the number and specificity of items on the questionnaire (Warneke et al. 2001).

Research suggests that diet records and multiple 24-hour recalls may underestimate energy and nutrient intakes in females by as much as 10-46% (Hill and Davies 2001, Martin et al. 1996, Sawaya et al. 1996). This may be particularly true for obese subjects (Lichtman et al. 1992, Kretsch et al. 1999), and may explain the greater difference obtained between food frequency questionnaire and diet record estimates in the low-income postpartal women, 58% of whom were either overweight or obese (BMI>25). It may be plausible that the estimates obtained from the food frequency questionnaire are closer to the true intakes of the participants than those suggested by the diet records and recalls.

The majority of studies validating food frequency questionnaires against diet records and recalls have reported correlation coefficients ranging between 0.4 and 0.7 for nutrients (Willett 1998). Pearson’s validity coefficients obtained in the present study lie within this range. The mean de-attenuated correlation coefficient obtained in this study (0.42 among college women; 0.45 among low-income women) compares favorably with those reported by Subar et al. (2001) for the 126-item Willett food frequency questionnaire (0.33), and are slightly lower than mean coefficients obtained for the 106-item Block food frequency questionnaire (0.50) and the 124-item Diet History Questionnaire (0.54). The correlation coefficients between diet records and recalls in this study are similar to those obtained in other studies by Baumgartner et al. (1998) (0.47), Patterson et al. (1999) (0.47), Taren et al. (2000) (0.48) that evaluate multiple nutrients in southwestern populations. For certain nutrients (e.g. riboflavin and potassium), FFQ estimates in the present study were significantly different from those of diet records, even though estimates from the two methods were correlated significantly. It is plausible that although the food frequency questionnaire overestimated means for certain nutrients, it did so in a consistent manner. Although the FFQ demonstrated strong correlations for energy, carbohydrate, saturated fat, vitamin C, and calcium, the psychometric properties of the instrument may be less robust for certain nutrients such as monounsaturated fat, alcohol, vitamin B6 and sodium.

The average correlation obtained in the tri-ethnic sample of low-income postpartal women in this study (0.45) parallels that obtained in a validation study of a food frequency questionnaire vs. diet recalls in low-income pregnant women (0.47) (Wei et al. 1999). The mean correlation in the low-income women in the present study (0.45) compares favorably with that seen in the multi-ethnic sample by Kristal et al. (1997) (0.4) and the African-American sample by Yanek et al. (2001) (0.45), both of which included low-income women.

The mean percentage of subjects correctly classified in the same quartile by both the food frequency questionnaire and the diet records in this study (34% in college women; 39% in low-income women) was comparable to the 35% and 39% reported by Robinson et al. (1996) and Andersen et al. (1999), respectively, in evaluations of 100-item and 190-item food frequency questionnaires. The favorable correlations and quartile classifications that were obtained suggest that our instrument is suitable for ranking individuals according to their nutrient intakes.

The number of well-designed food frequency questionnaires developed for populations in the United States has increased in the past few years. Populations targeted were the general U.S. population (Vandenlangenberg et al. 1997, Hu et al. 1999, Flagg et al. 2000, Willett et al. 2001, Thompson et al. 2002) and specific sub-groups including Asians and Hawaiians (Kolonel et al. 2000), African-Americans (Yanek et al. 2001, Warneke et al. 2001, Resnicow et al. 2000, Kumanyika et al. 2003), Korean-Americans (Kim at al. 2002), Hispanics and non-Hispanic Whites (Baumgartner et al. 1998, Tucker et al. 1998), tri-ethnic samples of non-Hispanic Whites, African-Americans, and Hispanics (Kristal et al. 1997), and minority/multiethnic populations in the southwest (Pillow et al. 1997, Stern et al. 1993, Patterson et al. 1999, Jones et al. 1997, Baumgartner et al. 1998, McPherson et al. 1995, Foote et al. 2000). The present instrument builds upon previous food frequency questionnaires for the southwestern U.S. population by incorporating new foods available such as fat-modified foods and a wide variety of ethnic foods. It is essential to continually update food frequency questionnaires because of changing demographics and rapidly evolving food supplies.

Recent evidence suggests that food frequency questionnaires and other self-reported dietary measures, including diet records, may share certain person-specific biases or errors (Kipnis et al. 2001) such as misreporting of portion sizes. It is preferable that biases in the reference instrument are independent of those in food frequency questionnaires. One way to overcome this shared bias is to utilize biomarkers such as urinary nitrogen, serum nutrient levels or doubly labeled water (Kipnis et al. 2001, Livingstone and Black 2003). Although biomarkers may serve as useful reference instruments for food frequency validation, the cost involved and associated subject burden were outside the scope of this study.

In conclusion, this food frequency questionnaire may be used to identify areas of dietary concern in young adult women in order to better target nutrition interventions, and to examine relationships between dietary patterns and health outcomes.

# Chapter 3: Food Choices of Low-Income Women during Pregnancy and Postpartum

## INTRODUCTION

The periods of pregnancy and postpartum are significant life transition events for many women. This transition period may influence dietary behavior as women adapt to the maternal role (Devine et al. 2000), increased demands on their time (Devine and Olson 1992), alterations in taste preferences (Tepper and Seldner 1999), and the need to balance conflicting demands from family members and employment (Desai and Jann 2000, Peterson et al. 2002). Adjustment to the transition may be even more difficult for low-income women as they negotiate stresses arising from lack of finances, health insurance (Miranda et al. 2003), childcare (Friedman 2001), and transportation (Brown and Barbosa 2001).

Diminished intakes of nutrients, such as folate, zinc and vitamin B12 (Berg et al. 2001), changes in overall weight and dieting attitudes (Baker et al. 1999), and diet-related practices, such as increased snacking (Devine et al. 2000), have been observed from pregnancy to postpartum. Yet, data involving a detailed and comprehensive examination of how food choices change between pregnancy and postpartum in a single cohort of women is limited. The purpose of the present study was to examine longitudinal changes in dietary behavior from pregnancy to postpartum in a tri-ethnic sample of low-income women.

## METHODS

### Study Design

On 0-1 day following delivery of a singleton infant, 204 women in the hospital were recruited into a longitudinal cohort design. Information was obtained on socio-demographic variables and prepregnancy weight status. Subjects then visited the project site at 1.5- and 6-months postpartum; at these times food frequency questionnaires (FFQs) were administered that assessed diet during pregnancy and postpartum, respectively. Anthropometrics and method of infant feeding also were determined at these visits.

### Subjects

Subjects were drawn from a larger study on postpartal weight retention (Walker and Kim 2002). Inclusion criteria for the larger study were Medicaid-eligibility (income = 185 % of the Federal Poverty guidelines); age = 18 years; non-Hispanic White, African-American, or Hispanic ethnicity; delivery of a healthy and term (>37 weeks gestation) infant; fluency and literacy in English; and absence of pregnancy-related abnormalities and disease conditions. The study was approved by the Institutional Review Board of The University of Texas at Austin, and written informed consent was obtained from all participants. The final sample (n=156) ranged in age from 18 to 37 years, with a median of 22 years. Further details on the demographic characteristics are shown in Table 6.

Table 6: Demographic characteristics of participants by lactation status

| **Characteristic** | **Total (N = 156)** | **Lactating [a] (n = 28)** | **Non-lactating [b] (n = 128)** |
|---|---|---|---|
| Ethnicity (%) | | | |
| African-American | 23.1 [c] | 25.0 | 22.7 [c] |
| Anglo/Caucasian | 29.5 [d] | 32.1 | 28.9 [d] |
| Hispanic | 47.4 [c, d] | 42.9 | 48.4 [c, d] |
| BMI (kg/m$^2$) [e] | | | |
| Pre-pregnancy | 26.2 ± 0.50 [c] | 24.3 ± 1.0 [c] | 26.6 ± 0.56 [c] |
| Six months postpartum | 28.8 ± 0.57 [c] | 26.4 ± 1.0 [c, f] | 29.4 ± 0.64 [c, f] |
| Parity (%) | | | |
| ≤ 2 | 75.6 [c] | 92.9 [c, f] | 71.9 [c, f] |
| > 2 | 24.4 [c] | 7.1 [c] | 28.1 [c] |
| Education completed (%) | | | |
| ≤ Partial high school or less | 41.0 [c] | 25.0 | 44.5 [c] |
| High school graduate | 35.9 [d] | 35.7 | 35.9 [d] |
| ≥ Partial college | 23.1 [c, d] | 39.3 | 19.5 [c, d] |

[a] Breastfeeding at 6-months postpartum

[b] Bottlefeeding exclusively at 6-months postpartum

[c–d] Common superscripts within a column indicate significant differences, $p<0.05$

[e] Mean ± SEM

[f] Common superscripts within a row indicate significant differences, $p<0.05$

**Dietary Intake**

Food choices and energy and fat intakes during pregnancy and postpartum were assessed using a validated semi-quantitative food frequency questionnaire that reflected current dietary patterns of multiethnic populations in the southwestern United States (George et al. 2004). This FFQ was validated previously against the mean of two 24-hour recalls and four diet records in low-income multiethnic postpartum women. Reliability analyses revealed a Cronbach's alpha of 0.73 for food groups; Pearson's validity co-efficients centered at 0.45 for nutrients. Cross-classification of subjects into quartiles of nutrient intake resulted in 79% of postpartum women being classified into the same or adjacent quartile by the FFQ and the diet records (George et al. 2004).

The FFQ consisted of frequency and serving size options for 195 individual (e.g., flour tortillas) or closely related foods (e.g., Spanish and fried rice). The food frequency instrument also had separate questions that queried respondents on what percentage of their meals were prepared at home, restaurants, fast-food places, family and friends, and grocery carry-outs. The reference period for the questionnaire administered at 6-months postpartum was the previous six months. Nutrient and food choices during this period were converted into daily intakes.

Participants were given detailed instructions by nutritionists and/or nurses on how to estimate portion sizes of foods using food models and measuring cups and spoons, and to accurately complete the frequencies section. Questionnaires were self-administered by participants, reviewed by study staff for completeness, scanned via computer and verified. The purpose of the verification process, performed via TELEFORM, ensured that the questionnaires had been scanned accurately. Total energy and fat intake were estimated via DIETSYS, a computer program developed by Block et al. (1994) and modified to include low-fat, ethnic and southwestern foods. Examples of foods incorporated in the questionnaire included chorizo, menudo/posole soup (George et al. 2004).

Food frequency questionnaires were checked for accuracy and completeness using energy intake cut-offs. The lower limits for energy intakes in this study were 800 kcals during pregnancy, 500 kcals for non-lactating women during postpartum and 1000 kcals for lactating women in postpartum. This was based on the 500 kcals lower limit for energy intakes specified by Willett (1998) for non-pregnant, non-lactating women. As pregnancy requires an additional 300 kcal over non-pregnant levels, the lower limits for caloric intakes were specified at 800 kcal during pregnancy. While the lower cut-off for energy intake during postpartum was retained at 500 kcal for non-lactating women, a 1000 kcal limit was specified for breastfeeding women to reflect the 500 kcal increment in energy intake that is recommended during lactation.

The upper threshold was 5000 kcals during pregnancy and postpartum. Although this may seem high for habitual caloric intake, equal or higher cut-points have been used in other studies involving low-income, multiethnic or minority populations. The upper cut-off of 5000 kcal was used in African-American women by Yanek et al. (2001), and multiethnic women by Kristal et al. (1997) and Patterson et al. (2003). An even higher cut-off (5500 kcals) has been used in low-income African-Americans by Yaroch et al. (2000). Another reason for the higher cut-off was that 60% of the women were overweight or obese at 6-months postpartum, suggesting excessive energy intakes. For example, the highest postpartum weight retention observed from prepregnancy to six months postpartum was 57 lbs. Our cut-offs excluded 41 subjects whose caloric intakes were in excess and seven women whose intakes fell below the cut-offs, to result in a final sample of 156 women.

Foods were categorized into the major food groups of the Pyramid (The Food Guide Pyramid 1996) and/or foods containing added fat and added sugar. Consistent with Pyramid recommendations, dried beans and legumes were included into the vegetables, as well as the meat and meat alternatives group (Proposed Daily Food Intake Patterns 2003); these foods were not double-counted for total energy or fat intake as the DIETSYS program estimated these independently. Mixed dishes were disaggregated so that their individual ingredients could be classified into the appropriate food group (Cleveland et al. 1997). For example, pizza was divided into its grain, vegetable, and dairy components.

Serving sizes for individual foods were defined in terms of the following references: Food Guide Pyramid 1996; Dietary Guidelines for Americans 2000; and Bowe's and Church's Food Values of Portions Commonly Used 1998. For mixed dishes, appropriate portions were obtained from servings of disaggregated foods. Daily servings for individual foods were computed by multiplying the daily frequency of consumption by the number of servings. Total servings for a food group were obtained by summing across servings of individual foods in the pyramid food group.

Percentage of calories derived from fat was evaluated based on guidelines (< 30% kcals from fat) from the 2000 Dietary Guidelines for Americans (Dietary Guidelines for Americans 2000). Amounts of added sugar in foods was estimated from information found in Krebs-Smith (2001) and percent calories from added sugar were evaluated based on the Institute of Medicine recommendations (<25% kcals from added sugar) (Position of the American Dietetic Association 2004, Murphy and Johnson 2003). During pregnancy, Pyramid food group intakes were evaluated from guidelines of the American Dietetic Association (Position Paper of the American Dietetic Association 2002). During postpartum, diet was compared to Food Guide Pyramid recommendations (Food Guide Pyramid 1996).

**Demographic and anthropometric variables**

Sociodemographic data (such as ethnicity, parity, education and marital status) was collected via self-administered questionnaires at the hospital. Women were classified as lactating or non-lactating on the basis of their responses to a question on "method of infant feeding" at 6-months postpartum. Lactation was defined as exclusively breast-feeding, or using a combination of breast- and bottle-feeding at 6-months postpartum. Based on these criteria, 17.9% of new mothers were lactating and 82.1% were non-lactating at the 6-month time point. Within the non-lactating group, 91.4% were bottle-feeding exclusively by 3-months, and 74.2% by 6-weeks postpartum. These data suggest that the group classified as non-lactating at 6-months were bottle-feeding for the majority of the reference period of the 6-month food frequency questionnaire.

Height of participants was obtained at 1.5 months postpartum using a stadiometer. At delivery, participants self-reported their prepregnancy body weights; at 6 months postpartum, weight was measured. Although measurement of prepregnancy body weight is ideal, medical records were not available for this purpose. However, self-reported body weight has been shown to be related closely to actual weight in young adult women (Kuczmarski et al. 2001), and other investigators have used this method in studies of pregnant and postpartum women (Olson and Strawderman 2003, Linne and Rossner 2003, Gunderson et al. 2001, Kac et al. 2004). Moreover, the focus of this study was food choices and the calculated BMI was used only for sample descriptive purposes.

**Statistical Analysis**

Data were analyzed using the Statistical Program for Social Sciences (SPSS), version 9.0. Demographic (e.g., ethnicity, age) and dietary characteristics (e.g., food group, energy intake) of participants were defined in terms of frequencies, means, and standard errors of means. Standard errors of means were computed to quantify the accuracy of mean estimates.

Differences in the frequencies of persons classified into the categories of dichotomous demographic variables were tested using the binomial test; chi-square analyses were utilized for multinomial variables. Post-hoc differences among observed proportions of multinomial outcomes were examined using a log linear analysis with pairwise comparisons of proportions.

Differences in means of continuous variables (such as body mass index, daily servings of grains) between pregnancy and postpartum were tested using paired t-tests; lactating and non-lactating women were compared for continuous variables using independent samples t-tests. For the independent t-tests, the Levene's test for homogenous variances was estimated and if statistically significant, an adjusted t-test was used.

Chi-square, with follow-up tests of independent proportions, also was used to test significance of differences in groups of lactating and non-lactating women who met dietary recommendations. The McNemar test evaluated differences in adherence to Food Guide Pyramid guidelines during pregnancy and postpartum.

Within each food group, the top five foods most commonly consumed were identified by sorting the average number of servings for each food choice in Microsoft Excel. For each food, separate paired and independent samples t-tests were performed to determine significant differences. Level of significance for all statistical tests was set at $p<0.05$.

**RESULTS**

The transition from pregnancy to postpartum was associated with decreases in mean energy intakes (2660 vs. 2218 kcals, $p<0.001$) in the overall sample. When analyses were stratified by lactation status, mean caloric intakes decreased from gestation to after childbirth in both lactating (2615 vs. 2107 kcal, $p<0.02$) and non-lactating women (2669 vs. 2242 kcal, $p<0.001$).

In all subjects, daily servings of grains, vegetables, fruit and meat declined following childbirth, while % calories from fat and added sugar increased (Table 7). Women who were breastfeeding at six months postpartum had lower intakes during pregnancy of meat and percent calories from fat, and higher amounts of fruits than those who were bottle-feeding exclusively at the six month time point ($p<0.05$). In postpartum, lactating women consumed less added sugar than non-lactating women ($p<0.05$).

Table 7: Daily intakes of major food groups in low-income women during pregnancy and postpartum [a]

| Food group | Total (N = 156) | | Lactating women [b] (n = 28) | | Non-lactating women [c] (n = 128) | |
|---|---|---|---|---|---|---|
| | **Pregnancy** | **Postpartum** | **Pregnancy** | **Postpartum** | **Pregnancy** | **Postpartum** |
| Grains (servings/d) | 7.8 ± 0.38 [d] | 6.4 ± 0.34 [d] | 7.3 ± 0.93 | 6.5 ± 0.72 | 7.9 ± 0.41 [e] | 6.4 ± 0.38 [e] |
| Vegetables (servings/d) | 2.5 ± 0.16 [d] | 2.2 ± 0.14 [d] | 3.0 ± 0.51 | 2.7 ± 0.40 | 2.4 ± 0.16 | 2.1 ± 0.14 |
| Fruit (servings/d) | 3.7 ± 0.30 [d] | 1.8 ± 0.14 [d] | 5.2 ± 0.73 [e, f] | 2.3 ± 0.42 [e] | 3.4 ± 0.33 [f, g] | 1.7 ± 0.14 [g] |
| Dairy (servings/d) | 2.0 ± 0.13 | 1.7 ± 0.12 | 2.0 ± 0.30 | 1.8 ± 0.26 | 2.0 ± 0.15 | 1.7 ± 0.14 |
| Meat (servings/d) | 3.5 ± 0.16 [d] | 3.1 ± 0.16 [d] | 2.9 ± 0.25 [e] | 2.5 ± 0.31 | 3.7 ± 0.19 [e, f] | 3.2 ± 0.18 [f] |
| Total fat intake (% kcals) | 37.2 ± 0.48 [d] | 38.4±0.45 [d] | 34.0 ±1.1 [e, f] | 37.2 ± 1.3 [e] | 37.9 ± 0.52 [f] | 38.6 ± 0.47 |
| Added sugars (% kcals) | 14.6 ± 0.76 [d] | 16.6 ±0.86 [d] | 12.4 ± 1.8 | 12.8 ± 1.8 [e] | 15.0 ± 0.84 [f] | 17.4 ± 0.96 [e, f] |

[a] Mean ± SEM

[b] Breastfeeding at 6-months postpartum

[c] Bottlefeeding exclusively at 6-months postpartum

[d - g] Common superscripts within a row indicate significant differences, $p<0.05$.

Percentages of women who met dietary recommendations during pregnancy and postpartum are shown in Figure 3. The majority did not comply with dietary guidelines for grains, vegetables, dairy, fat, or added sugars ($p<0.05$) during or after pregnancy. Daily meat servings were adequate in 77.1% of women during gestation and 72.1% in the period following childbirth. Fruit intakes during pregnancy exceeded the recommended servings (>3 servings/d) in 64% of women who were breastfeeding at six months postpartum, as compared to 38% of those who were bottlefeeding exclusively. Lactating women more often reported total fat intakes within 30% of total calories than non-lactating women (29% vs. 7% during pregnancy; 18% vs. 3% in postpartum, $p<0.05$). Compliance with the recommendation for added sugar was 34% overall, and was greater during pregnancy than postpartum in women who were bottlefeeding exclusively at the six month time point (34% vs. 27%, $p<0.05$).

The ranking of use of items from the different food groups is shown in Table 8. White bread and flour tortillas were the most frequently consumed grain-based food items. Consumption of white bread was twice as high in non-lactating than lactating women; servings of flour tortillas eaten were similar for the two groups. Among the subjects, potatoes were the most habitually eaten vegetable, followed by corn, tomatoes and lettuce. The intake of French-fried potatoes and corn decreased from pregnancy to postpartum. Following childbirth, breast-feeding women had higher intakes of lettuce than those who bottle-fed exclusively ($p<0.05$). Fruit juice accounted for over 40% of total fruit intake and orange and apple juices were the most common fruit items for all subjects. The consumption of all juices declined from pregnancy to postpartum ($p<0.05$).

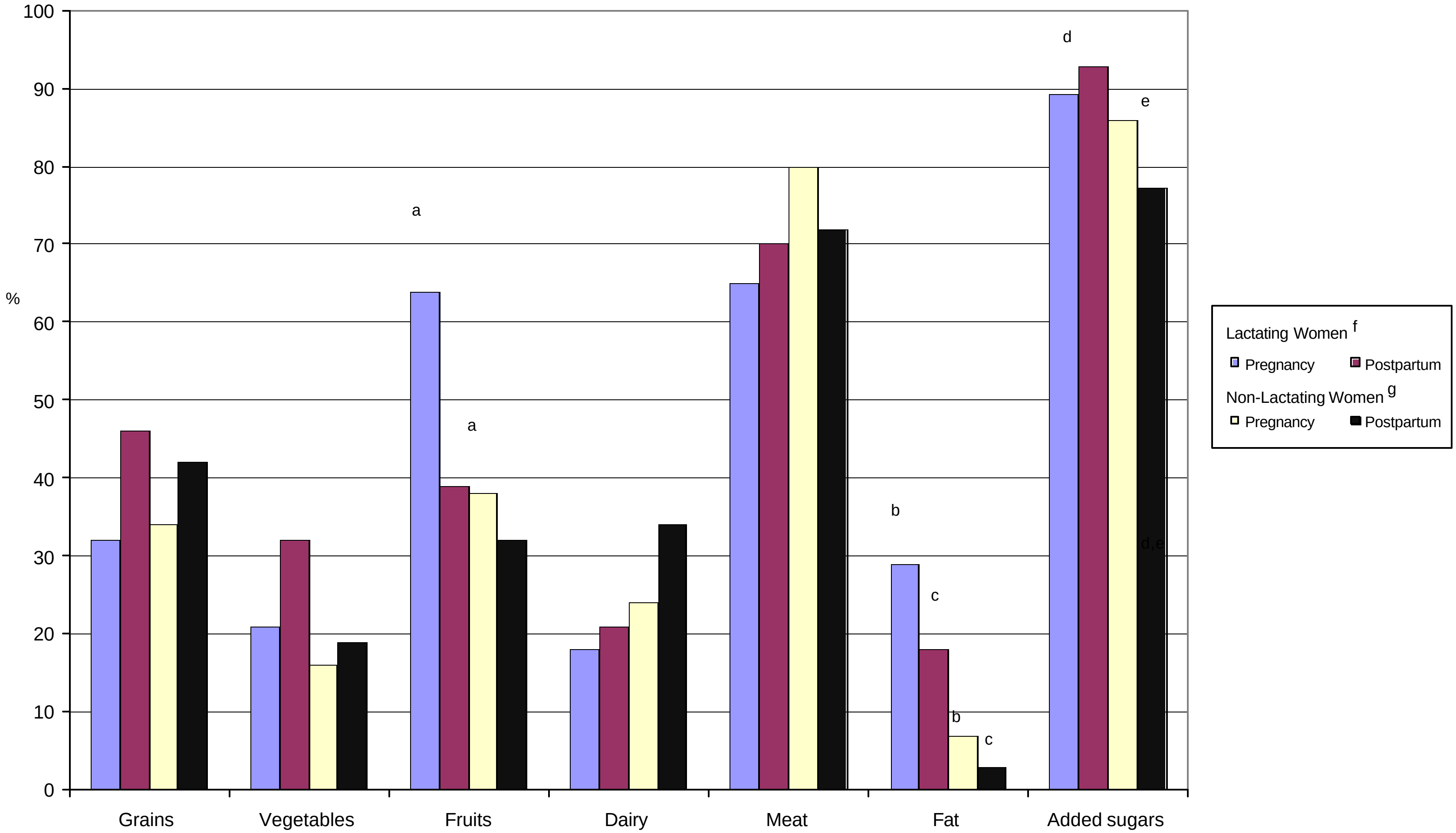


Figure 3: Percentage of women who met dietary recommendations during pregnancy and postpartum by lactation status at 6-months postpartum

Legend: [a-e] Common superscripts indicate significant differences ($p<0.05$). Adequate pyramid servings of food groups were defined during pregnancy as $\geq$9 servings of grains, $\geq$4 servings of vegetables, $\geq$3 servings of fruits, $\geq$2 servings of meat, $\geq$3 servings of dairy, total fat intakes $\leq$30% of total calories, and added sugar $\leq$10% of total calories. During postpartum, minimum recommended servings were $\geq$6 servings for grains, $\geq$3 for vegetables, $\geq$2 for fruits, $\geq$2 for meat and $\geq$3 for dairy for lactating; and $\geq$6 for grains, $\geq$3 for vegetables, $\geq$2 for fruits, $\geq$2 for meat and $\geq$2 for dairy for non-lactating women.

[f] Breastfeeding at 6-months postpartum

[g] Bottlefeeding exclusively at 6-months postpartum

Table 8: Foods selected from food groups ranked in order of highest number of mean ± SEM daily servings reported during pregnancy and postpartum

| | **Total (N = 156)** | | | | **Lactating women [a] (n = 28)** | | | | **Non-lactating women [b] (n = 128)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Pregnancy** | | **Postpartum** | | **Pregnancy** | | **Postpartum** | | **Pregnancy** | | **Postpartum** | |
| | **Rank** | **Servings** | **Rank** | **Servings** | **Rank** | **Servings** | **Rank** | **Servings** | **Rank** | **Servings** | **Rank** | **Servings** |
| **Grains** | | | | | | | | | | | | |
| White bread (French, Italian, sourdough) | 1 | 1.09 ± 0.10 | 1 | 1.00 ± 0.11 | 3 | 0.53 ± 0.16 [c] | 2 | 0.48 ± 0.12 [d] | 1 | 1.21 ± 0.12 [c] | 1 | 1.11 ± 0.14 [d] |
| Flour tortillas | 2 | 0.42 ± 0.05 | 2 | 0.45 ± 0.06 | - | 0.41 ± 0.12 | - | 0.36 ± 0.09 | 2 | 0.43 ± 0.05 | 2 | 0.47 ± 0.07 |
| Cheerios, Rice Krispies | 3 | 0.41 ± 0.05 [c] | - | 0.19 ± 0.03 [c] | 2 | 0.55 ± 0.14 [d] | - | 0.22 ± 0.06 [d] | - | 0.38 ± 0.05 [e] | - | 0.18 ± 0.03 [e] |
| Whole / variety grain breads | 3 | 0.41 ± 0.08 | 3 | 0.35 ± 0.08 | 1 | 0.74 ± 0.25 | 1 | 0.77 ± 0.23 [c] | - | 0.34 ± 0.07 | 3 | 0.26 ± 0.08 [c] |
| Sugared cereals | - | 0.40 ± 0.05 [c] | - | 0.18 ± 0.02 [c] | - | 0.24 ± 0.09 | - | 0.15 ± 0.05 | 2 | 0.43 ± 0.05 [d] | - | 0.19 ± 0.03 [d] |
| Corn tortillas | - | 0.28 ± 0.07 | - | 0.26 ± 0.06 | - | 0.41 ± 0.22 | 3 | 0.38 ± 0.13 | - | 0.26 ± 0.07 | - | 0.23 ± 0.06 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vegetables** | | | | | | | | | | | | |
| French fried potatoes, hash browns | 1 | 0.26 ± 0.02 [c] | 3 | 0.20 ± 0.02 [c] | 1 | 0.27 ± 0.05 [d] | - | 0.14 ± 0.04 [d] | 1 | 0.26 ± 0.03 | 2 | 0.21 ± 0.02 |
| White potatoes, baked/ boiled | 2 | 0.25 ± 0.02 | 1 | 0.22 ± 0.02 | 2 | 0.26 ± 0.06 | - | 0.20 ± 0.03 | 2 | 0.25 ± 0.02 | 1 | 0.22 ± 0.02 |
| Corn | 3 | 0.22 ± 0.02 [c] | - | 0.16 ± 0.02 [c] | - | 0.18 ± 0.05 | - | 0.14 ± 0.03 | 3 | 0.23 ± 0.02 [d] | - | 0.17 ± 0.02 [d] |
| Tomatoes | - | 0.20 ± 0.03 | 1 | 0.22 ± 0.03 | 2 | 0.26 ± 0.06 | 2 | 0.28 ± 0.05 | - | 0.19 ± 0.03 | 3 | 0.20 ± 0.03 |
| Lettuce | - | 0.18 ± 0.02 | - | 0.17 ± 0.02 | - | 0.24 ± 0.06 | 1 | 0.32 ± 0.07 [c] | - | 0.17 ± 0.02 [d] | - | 0.14 ± 0.01 [c d] |
| Kidney beans | - | 0.15 ± 0.02 | - | 0.15 ± 0.02 | - | 0.23 ± 0.06 | 3 | 0.26 ± 0.06 | - | 0.13 ± 0.02 | - | 0.13 ± 0.02 |
| **Fruits** | | | | | | | | | | | | |
| Orange juice | 1 | 0.60 ± 0.07 [c] | 1 | 0.29 ± 0.03 [c] | 1 | 0.87 ± 0.19 [d] | 1 | 0.33 ± 0.07 [d] | 1 | 0.54 ± 0.07 [e] | 1 | 0.29 ± 0.03 [e] |
| Apple juice | 2 | 0.40 ± 0.06 [c] | 2 | 0.18 ± 0.03 [c] | 2 | 0.58 ± 0.14 [d] | 2 | 0.22 ± 0.06 [d] | 2 | 0.35 ± 0.06 [e] | 2 | 0.17 ± 0.03 [e] |
| Bananas | 3 | 0.29 ± 0.04 [c] | 3 | 0.16 ± 0.02 [c] | - | 0.39 ± 0.10 [d] | 3 | 0.20 ± 0.05 [d] | 3 | 0.27 ± 0.04 [e] | 3 | 0.15 ± 0.02 [e] |
| Other real fruit juices | - | 0.25 ± 0.04 [c] | - | 0.11 ± 0.03 [c] | 3 | 0.55 ± 0.14 [d e] | - | 0.19 ± 0.07 [d] | - | 0.19 ± 0.04 [e f] | - | 0.10 ± 0.03 [f] |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dairy** | | | | | | | | | | | | |
| Whole milk | 1 | 0.69 ± 0.08 [c] | 1 | 0.44 ± 0.06 [c] | 1 | 0.60 ± 0.17 | 1 | 0.40 ± 0.13 | 1 | 0.71 ± 0.09 [d] | 1 | 0.45 ± 0.07 [d] |
| Hard cheeses | 2 | 0.31 ± 0.03 | 2 | 0.35 ± 0.05 | 2 | 0.30 ± 0.08 | 2 | 0.28 ± 0.07 | 2 | 0.31 ± 0.03 | 2 | 0.36 ± 0.06 |
| Chocolate milk | 3 | 0.17 ± 0.02 | - | 0.13 ± 0.02 | - | 0.15 ± 0.06 | - | 0.22 ± 0.08 | 3 | 0.17 ± 0.03 [c] | - | 0.11 ± 0.02 [c] |
| 2% milk | 3 | 0.17 ± 0.04 | 3 | 0.16 ± 0.03 | 3 | 0.25 ± 0.10 | 3 | 0.24 ± 0.10 | - | 0.16 ± 0.04 | 3 | 0.14 ± 0.03 |
| **Meat** | | | | | | | | | | | | |
| Hamburgers, cheeseburgers, meatloaf, picadillo | 1 | 0.29 ± 0.03 | 1 | 0.25 ± 0.02 | - | 0.15 ± 0.03 [c] | - | 0.13 ± 0.03 [d] | 1 | 0.32 ± 0.03 [c] | 1 | 0.28 ± 0.02 [d] |
| Broiled, roasted or stewed chicken, turkey or duck | 2 | 0.27 ± 0.03 [c] | - | 0.19 ± 0.02 [c] | 1 | 0.32 ± 0.07 | 1 | 0.24 ± 0.06 | 3 | 0.26 ± 0.04 | - | 0.18 ± 0.02 |
| Beef steaks, roasts, brisket, carne asada | 3 | 0.24 ± 0.02 | 2 | 0.24 ± 0.04 | - | 0.14 ± 0.04 [c] | - | 0.11 ± 0.03 | 2 | 0.26 ± 0.03 [c] | 2 | 0.27 ± 0.04 |
| Beef/ bean burritos, soft tacos, fajitas | - | 0.21 ± 0.03 | 3 | 0.20 ± 0.02 | 3 | 0.18 ± 0.05 | 2 | 0.21 ± 0.05 | - | 0.21 ± 0.04 | 3 | 0.19 ± 0.02 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eggs, migas | - | 0.18 ± 0.02 [c] | - | 0.13 ± 0.02 [c] | 2 | 0.20 ± 0.05 | - | 0.11 ± 0.03 | - | 0.18 ± 0.02 | - | 0.14 ± 0.02 |
| Beef cheese enchiladas, tamales | - | 0.13 ± 0.01 | - | 0.13 ± 0.02 | - | 0.09 ± 0.02 | 3 | 0.14 ± 0.05 | - | 0.14 ± 0.02 | - | 0.13 ± 0.02 |
| **Foods/added fat** | | | | | | | | | | | | |
| Potato and corn chips | 1 | 0.52 ± 0.06 | 1 | 0.51 ± 0.07 | 1 | 0.45 ± 0.13 | 1 | 0.47 ± 0.13 | 1 | 0.54 ± 0.06 | 1 | 0.51 ± 0.08 |
| Butter | 2 | 0.27 ± 0.03 [c] | 2 | 0.37 ± 0.04 [c] | - | 0.20 ± 0.05 | 3 | 0.28 ± 0.08 | 2 | 0.28 ± 0.03 [d] | 2 | 0.38 ± 0.05 [d] |
| French fried potatoes, hash browns | 3 | 0.26 ± 0.02 [c] | - | 0.20 ± 0.02 [c] | 2 | 0.27 ± 0.05 [d] | - | 0.14 ± 0.04 [d] | 3 | 0.26 ± 0.03 | - | 0.21 ± 0.02 |
| Chocolate candy | 3 | 0.26 ± 0.03 | - | 0.23 ± 0.03 | 3 | 0.25 ± 0.05 | 2 | 0.30 ± 0.05 | 3 | 0.26 ± 0.04 | - | 0.21 ± 0.03 |
| Margarine | - | 0.21 ± 0.03 | 3 | 0.26 ± 0.03 | - | 0.20 ± 0.07 | - | 0.21 ± 0.06 | - | 0.22 ± 0.03 | 3 | 0.26 ± 0.05 |
| **Foods/added sugar** | | | | | | | | | | | | |
| Coke, Sprite | 1 | 1.68 ± 0.17 [c] | 1 | 2.04 ± 0.18 [c] | 1 | 1.20 ± 0.35 | 1 | 0.87 ± 0.17 [d] | 1 | 1.78 ± 0.19 [e] | 1 | 2.30 ± 0.21 [d, e] |
| Fruit drinks: Hi-C, Kool-Aid | 2 | 0.52 ± 0.06 | 3 | 0.35 ± 0.05 [c] | 3 | 0.34 ± 0.12 | - | 0.19 ± 0.07 | 2 | 0.57 ± 0.07 [d] | 2 | 0.38 ± 0.06 [d] |
| Gatorade, Snapple | 3 | 0.51 ± 0.10 | 2 | 0.36 ± 0.07 | 2 | 0.76 ± 0.28 | 2 | 0.46 ± 0.17 | 3 | 0.45 ± 0.10 | 3 | 0.34 ± 0.07 |
| Sugar, syrup, jams | - | 0.25 ± 0.05 | - | 0.24 ± 0.04 | - | 0.29 ± 0.14 | 3 | 0.30 ± 0.09 | - | 0.24 ± 0.05 | - | 0.22 ± 0.04 |

[a] Breastfeeding at 6-months postpartum

[b] Bottlefeeding exclusively at 6-months postpartum

[c-f] Common superscripts within a row indicate significant differences, $p<0.05$

Whole milk was consumed at least once per week by over 60% of the sample. Two percent milk was used weekly by less than 26% of the overall sample, and 1% or skim milk, by less than 10%. The likelihood of consuming low fat forms of milk (<2% fat) did not change significantly from the period of gestation to the time following childbirth in lactating (25% vs. 28.6% for 2% milk, and 14.3% vs. 7.1% for 1% milk, respectively) or non-lactating women (24.4 vs. 24.2 for 2% milk and 7.4% vs. 9.4% for 1% milk, respectively).

Hamburgers and other ground beef were the most popular meats, closely followed by broiled, roasted or stewed poultry and beef steaks and roasts. The intake of fish was low. Use of broiled, roasted or stewed poultry and eggs decreased from pregnancy to postpartum ($p<0.05$). Consumption of eggs did not differ among lactating and non-lactating women ($p<0.05$). Women who bottlefed exclusively at six months postpartum ate less chicken and more beef during pregnancy as compared to those who breastfed for six months or more following childbirth (15.1% vs. 1.2%, $p<0.05$).

The most habitually eaten foods with added fat were potato and corn chips. The consumption of butter ranked higher than margarine, and increased from gestation to postpartum ($p<0.05$). Soft drinks contributed the most added sugar to the diet, and intakes increased following childbirth. The likelihood of having had at least one serving of soda/day increased from pregnancy to postpartum in lactating (17.9% to 25%, $p<0.05$), as well as non-lactating women (39.1% to 53.1%, $p<0.05$).

Sources of meals are presented in Table 9.

Table 9: Source of meals in low-income women during pregnancy and postpartum [a]

| Place | Total (N = 156) | | Lactating women [b] (n = 28) | | Non-lactating women [c] (n = 128) | |
|---|---|---|---|---|---|---|
| | Pregnancy | Postpartum | Pregnancy | Postpartum | Pregnancy | Postpartum |
| | | | % | | | |
| Home | 51.9 ± 2.1 [d] | 56.1 ± 2.1 [d] | 59.3 ± 5.4 [e, f] | 71.8 ± 3.9 [f, g] | 47.3 ± 2.4 [e, h] | 52.3 ± 2.2 [g, h] |
| Fast foods | 20.5 ± 1.3 [d] | 17.9 ± 1.4 [d] | 17.1 ± 3.5 | 13.4 ± 2.7 | 20.1 ± 1.4 | 18.4 ± 1.5 |
| Restaurants | 13.8 ± 1.1 | 13.5 ± 1.0 | 10.4 ± 1.6 | 9.5 ± 1.3 [d] | 13.8 ± 1.2 | 14.3 ± 1.1 [d] |
| Family/ friends | 8.5 ± 0.93 | 7.3 ± 0.76 | 7.5 ± 3.0 | 3.4 ± 1.2 [d] | 8.2 ± 0.86 | 8.5 ± 0.85 [d] |
| Grocery carry-outs | 5.6 ± 0.76 | 5.1 ± 0.69 | 2.1 ± 0.90 [d] | 2.0 ± 0.73 [d] | 6.1 ± 0.84 [e] | 5.8 ± 0.79 [e] |

[a] Mean ± SEM

[b] Breastfeeding at 6-months postpartum

[c] Bottlefeeding exclusively at 6-months postpartum

[d - h] Common superscripts within a row indicate significant differences, $p<0.05$.

From pregnancy to postpartum, the median percentage of meals prepared at home increased from 50% to 60% ($p<0.05$), while those eaten at fast-food places decreased ($p<0.05$). Lactating women prepared more food at home than non-lactating women ($p<0.05$).

## DISCUSSION

These results indicate that the transition from pregnancy to postpartum is associated with changes in food choices that can lead to a less healthy diet. Furthermore, the majority of low-income women in this study did not meet the dietary guidelines of the Food Guide Pyramid during pregnancy and postpartum for vegetables, dairy, total fat and added sugar. In addition, lactating women tended to have higher fruit and lower meat intakes during pregnancy than non-lactating women. These women also reported lower intakes of total fat during pregnancy and added sugars in postpartum than bottle-feeding women.

During pregnancy, mean daily servings of food groups for the overall sample were similar to those reported for a national sample of 332 low-income pregnant women for grains (7.8 vs. 7.3) and vegetables (2.5 vs. 2.3) but higher for fruits (3.7 vs. 2.0) and meat (3.5 vs. 2.1), and lower for dairy (2.0 vs. 2.9) (Mardis and Anand 2001). The average percent calories from fat during pregnancy in the present study (37%) was identical to that seen in other samples of low-income pregnant women (Giddens et al. 2000; Swensen et al. 2001).

In postpartum, intakes were higher for grains (6.4 vs. 5.9), fruit (1.8 vs. 1.2) and dairy foods (1.7 vs. 1.3), but lower for vegetables (2.2 vs. 3.0) and meat (3.1 vs. 4.0) than those recorded in the CSFII 1994-1996 survey of 675 females aged between 20 and 29 years (Pyramid Servings Intakes by U.S. Children and Adults 1994-96 1998). Daily servings for fruits and vegetables during postpartum also were similar to those observed by Quan et al. (2000) in 150 low-income women (mean = 1.8 vs. 1.9 for fruits and 2.2 in both samples for vegetables). In the present study, a significant proportion of added sugar came from soft drinks during pregnancy (46.3%) and postpartum (50.3%). Energy from daily soft drink consumption in this study was higher than that seen in a national sample of adults from the Continuing Survey of Food Intake by Individuals (160 vs. 107 kcals) (Chanmugam et al. 2003).

Food choices within the major food groups tended to be high in total calories and/or fat. Examples include french fried potatoes within vegetables, pizza, cookies/cakes/doughnuts within grains, whole milk and hard cheese within dairy, and fried dishes within meats. In a study with 2247 low- and middle-income pregnant women, Siega-Riz et al. (2002) also found that high fat biscuits/muffins, French fries/fried potatoes and whole milk were consumed frequently. The finding that fruit juices account for a large proportion of fruit intake in low-income women is consistent with reports by Quan et al. (2000).

One possible reason for food choices high in fat and calories in these low-income women may be their low cost (Drewnowski 2003, French 2003). Darmon et al. (2002) showed that the imposition of cost constraints on a computer simulated food budget resulted in food choices that were more energy-dense and nutrient poor. Food choices are also influenced by other factors, including palatability, nutrition knowledge, availability, and social marketing campaigns (Glanz et al. 1998, American Dietetic Association 2002, Dwyer et al. 2003). For example, the popularity of milk and cheese within dairy, and orange and apple juices within fruits may be related to the free distribution of vouchers for these foods by the Special Supplemental Program for Women, Infants and Children (WIC) (WIC Approved Food Brochures 2003). Examples of social marketing campaigns include "Got Milk?" and "5-A-Day for Better Health" (American Dietetic Association 2002).

The greater self-care demonstrated by women during pregnancy with their selection of healthful foods parallels the adherence to healthful norms during this time described by Baric and MacArthur (1977). These authors postulated that societal expectations and knowledge regarding pregnancy results in the formation of generally accepted practices or norms. The adoption of these norms by women guides their health-related behaviors, including those relating to diet. Greater concern for diet during pregnancy also has been described by Guendelman and Abrams (1994) who found that Mexican-American women had higher milk intakes, and non-Hispanic white women had more fruits and vegetables, during pregnancy than in postpartum.

Certain changes in food choices between pregnancy and postpartum may be attributed to food related cravings and aversions. For example, the increased consumption of fruit during pregnancy might be due to documented cravings for fruit and fruit juices (Bayley et al. 2002). However, the intake of other foods reportedly craved (sweets, chocolates and desserts) or avoided (meat products) during pregnancy (Bayley et al. 2002) did not change.

The prevalence of eating food prepared away-from-home in both pregnancy (34.3%) and postpartum (31.4%) in this study is greater than that reported in the 1995 CSFII survey (27%) (French et al. 2000). A study by French et al. (2000) noted that fast food restaurant use was higher among those with limited incomes and in ethnic minorities. Increased incidence of eating away-from-home has been associated with higher intakes of calories, total fat, and saturated fat in national samples of U.S. adults (McCrory et al. 2002, Paeratakul et al. 2003).

The finding that lactating women in this study had more positive dietary behaviors than non-lactating women is similar to that found by Walker and Freeland-Graves (1998). They found that breast-feeding women were more likely than bottle-feeding women to have lower fat intakes, and healthier overall lifestyles. The association between breastfeeding in postpartum and positive dietary behavior may reflect a clustering of positive health behaviors that has been described previously (Kahn et al. 2002). The fact that lactating women in this study had lower caloric intakes than non-lactating women is corroborated by results from a study by Olson et al. (2003) that showed that women who consumed less food breastfed until one year postpartum.

A possible limitation of the study is the assessment of pregnancy-related diet at 1.5-months postpartum. However, Bunin et al. (2001) found that women are able to recall diets during past pregnancies with reasonably high levels of accuracy. Dietary intakes recorded via a retrospective food frequency questionnaire administered 3-7 years following childbirth showed good correlations (mean = 0.49) and quintile agreements (69% - 79%) with dietary intakes recorded during the index pregnancy (Bunin et al. 2001).

The postpartum period constitutes an excellent opportunity when women might be highly receptive to nutrition messages as a result of weight concerns (Peterson et al. 2002). The findings of the present study suggest that the nutrition education component of programs targeted towards low-income women, such as the Special Supplementary Food Program for Women, Infants and Children (WIC) might be strengthened to inform women of the need for wise food choices during pregnancy as well as during postpartum. Furthermore, guidelines pertaining to the recommended servings from Pyramid food groups during pregnancy need to be publicized (Position of the American Dietetic

Association 2002, Dietary Guidelines for Americans 2000, The Food Guide Pyramid 1996).

## APPLICATIONS

Currently, many state and national food and nutrition programs that target low-income women focus their attention more towards the child, rather than the mother due to limited resources. The results of this study suggest that a greater emphasis on the nutritional needs of the mother should be incorporated into programs for postpartal women.

It is encouraging to note that lactating women had better diets than those who did not breastfeed. Thus, women who bottlefeed may need additional nutritional counseling. Areas of focus should include the expansion of selection of healthful foods, such as fruits, vegetables and dairy, and reduction in intakes of fats and added sugars.

# Chapter 4: Weight Retention at 1 Year Postpartum is Associated with Lower Calcium, Vitamin A and Dairy Intake in Low-income Women

## INTRODUCTION

Obesity has assumed epidemic proportions in the United States and its prevalence is increasing worldwide (Tanasescu et al. 2000). The Centers for Disease Control reported that 62% of U.S. women are overweight or obese (BMI$\geq$25) (Centers for Disease Control 2001). Obesity is a major public health problem due to its association with hypertension, stroke, type 2 diabetes, coronary heart disease, gallbladder disease, osteoarthritis, respiratory problems, and certain types of cancer (Healthy People 2010).

The childbearing years mark a critical risk period for weight gain and excess weight retention in adult U.S. women (Rooney and Schauberger 2002, Williamson et al. 1994). An association between postpartum weight retention and increased risk of obesity 8-10 years later has been established (Rooney and Schauberger 2002). Furthermore, weight retention during postpartum is higher among those with low incomes and in ethnic minorities (Williamson et al. 1994). Thus, it is important to identify dietary factors that may be associated with weight gain following childbearing in low-income multiethnic women. The purpose of this study was to examine associations between dietary factors and weight retention at one year postpartum in a tri-ethnic sample of low-income women.

## METHODS

### Subjects and Study Design

At the hospital 0-1 days following childbirth, a demographic questionnaire that assessed prepregnancy weight and sample descriptives, such as age, parity and educational status, was administered. Subjects then visited the clinic site at 1.5 months and 1 year postpartum; heights were determined at 1.5-months. At 1 year postpartum, weights were measured and a food frequency questionnaire was administered.

Inclusion criteria included Medicaid-eligibility (=185% of the poverty guidelines); African-American, Hispanic or Anglo-Caucasian ethnicity; delivery of a healthy, singleton, term (>37 weeks gestation) infant; fluency and literacy in English; age =18 years; and absence of pregnancy abnormalities and chronic disease conditions. The study was approved by the Institutional Review Board of The University of Texas at Austin, and written informed consent was obtained.

Complete data on key study variables were obtained from 170 non-lactating women; 21 subjects were excluded due to caloric intakes >4500 kcals, and five subjects due to energy intakes <500 kcals. The final sample consisted of 144 women, with a mean age of 22.2 ± 3.7 years. The demographic characteristics of the sample in relation to percent weight retained at 1 year postpartum are shown in Table 10.

Table 10: Mean weight retention at 1 year postpartum by categories of demographic and anthropometric variables in non-lactating low-income women (N=144)

| Demographic Variable | Total Sample | Weight retained at 1-year (%) [a] | |
|---|---|---|---|
| | | Mean ± SEM [b, c] | *P value* |
| *Race* | | | |
| White, non-Hispanic | 31.9 | 7.1 ± 1.9 | 0.060 |
| African-American | 29.9 | 12.7 ± 1.4 | |
| Hispanic | 38.2 | 12.7 ± 2.1 | |
| *Education completed* | | | |
| ≤ Partial high school | 38.2 | 14.3 ± 2.1 [d] | 0.030 |
| High school graduate | 39.6 | 9.9 ± 1.4 | |
| ≥ Partial college | 22.2 | 6.8 ± 2.1 [d] | |
| *Weight classification at 1 year postpartum* [f] | | | |
| Underweight | 4.9 | -3.1 ± 3.3 [d] | 0.001 |
| Normal weight | 32.6 | 3.9 ± 1.3 | |
| Overweight | 25.7 | 10.8 ± 1.6 [d] | |
| Obese | 36.8 | 19.0 ± 1.9 [d] | |

| | | | |
|---|---|---|---|
| *Gestational weight gain* | | | |
| < 30 lbs | 42.0 | 4.2 ± 1.3 [d] | 0.001 |
| $\geq$ 30 lbs | 58.0 | 15.8 ± 1.4 [d] | |

[a] [(Weight at 1 year postpartum in kgs. - prepregnancy weight in kgs.)/Prepregnancy weight in kgs.)] x 100

[b] SEM = Standard error of the mean

[c] Means compared by one-way analysis of variance or independent samples t-tests

[d, g-j] Common superscript letters indicate statistically significant differences within sub-groups as indicated by post-hoc Scheffe's test (p<0.05) for multinomial variables and independent samples t-tests for dichotomous variables.

[e] Weight classification based on prepregnant body mass index calculated from self-reported prepregnancy weight and measured height at 1.5 months postpartum.

[f] Weight classification based on body mass index calculated from measured weight at 1 year postpartum and measured height at 1.5-months postpartum.

## Instruments and Measures

### *Food Intake Measures*

Food choices and nutrient intakes were assessed via a food frequency questionnaire (FFQ) tailored for multiethnic populations in the southwestern United States (George et al. 2004). This 195-item instrument was modified from the Health Habits and History questionnaire (Block et al. 1992) and has been validated in a similar sample of low-income women (George et al. 2004). The time period covered the previous six months and response options for the frequency section varied from "never/less than once a month" to "two or more times a day." Energy and nutrient intakes from the questionnaire were calculated using DIETSYS, a computer program originally developed by Block et al. (1994) and modified by us to include nutrient values for the new, ethnic and southwestern foods. The software program also had multiple adjustment questions that permitted refinement of nutrient calculations.

At the 1-year postpartum visit, trained nutritionists or nurses provided detailed oral and written information on completing food frequency questionnaires. Plastic food models, and measuring cups and spoons were used for estimation of portion sizes. Study staff reviewed questionnaires for accuracy and completeness.

### *Anthropometric measures*

Self-reported prepregnancy weights were collected as these have been used in recent studies of pregnant and postpartum women (Kac et al. 2004, Lederman et al. 2002, Linne and Rossner 2003) and acceptable correlations exist between actual and self-reported weight (Kuczmarski et al. 2001, Yu and Nagey 1992). Heights were measured without shoes to the nearest 0.1 cm via a stadiometer (Perspective Enterprises, Portage, MI). At the 1-year postpartum visit, measured weight was determined to the nearest 0.1

kg using an electronic scale (Fairbanks Scales, St. Johnsbury, VT). Weight retention was expressed in terms of % weight retained from prepregnancy to 1 year postpartum. The 1-year time point was chosen because weight retention at this time is predictive of weight gain in future pregnancies (Linne and Rossner 2003). Subjects were divided into those gaining by 1 year postpartum < or ≥ 10% of prepregnancy weight.

### Statistical Analyses

Data were analyzed using the Statistical Program for Social Sciences (SPSS 9.0, Chicago, Ill, 1998). Weight retained was defined as a continuous or a categorical variable, depending upon the objective of the analysis. For descriptive purposes, analyses of variance with post-hoc Tukey tests were used to examine differences in percent weight retained at 1-year postpartum by categories of demographic variables. Independent samples *t*-tests were used to determine differences in nutrient intakes and food group servings among those retaining <10% or ≥10% of their prepregnancy weight at 1 year. The level of statistical significance for all tests was set at $p<0.05$.

## RESULTS AND DISCUSSION

The average weight retained at 1 year postpartum was 7.4 ± 0.74 kg, or 10.9 ± 1.09% of prepregnancy weight. The weight retention was higher in those with <partial high school education, and with gestational weight gains >30 lbs. The finding that postpartal weight retention may be associated with weight gain during pregnancy is similar to that reported by others (Linne and Rosner 2003, Olson et al. 2003, Soltani and Fraser 2000). The lack of an association between prepregnancy weight status and weight retention at 1 year postpartum observed in the present study is similar to that observed in primarily white U.S. postpartum women (Rooney and Schauberger 2002) and in Swedish Caucasian women (Linne and Rossner 2003).

Mean intakes of dairy foods were higher in those who had retained a lower proportion of their prepregnancy weight at 1 year postpartum (Table 11). Women whose weights at 1 year postpartum were within 10% of their prepregnancy weights reported greater consumption of hard cheeses than those in whom weight retention exceeded 10% of prepregnancy weight ($0.73 \pm 0.07$ vs. $0.57 \pm 0.06$, $p<0.08$). Servings of grains, vegetables, fruit, and meat did not differ by categories of % weight retained. Total calories, fat, protein and carbohydrates also did not differ between the two weight retention categories (Table 12). However, women whose weights at 1 year postpartum were within 10% of their prepregnancy weight had higher intakes of calcium and vitamin A than those who retained over 10%.

The association between dietary calcium and dairy foods and lower postpartum weight retention observed in the present study parallels research by Jacqmain et al. (2003) that showed a positive relationship between low calcium ingestion and increased adiposity in 20-65 year old women. Inverse relationships between dietary calcium and percent body fat or body weight were observed also in pre-schoolers (Carruth and Skinner 2001), and in older Caucasian (Skinner et al. 2003) and Puerto Rican (Tanesescu et al. 2000) children. Based on the results of the CARDIA study, Pereira et al. (2002) reported an inverse association between dairy foods and all components of the metabolic syndrome, including body mass index, in overweight adults aged 18-30 years. Similarly, Zemel et al. (2004) showed that diets high in calcium and dairy foods accelerated loss of weight and fat in obese adults, with dairy exerting a stronger effect than supplemental calcium alone.

Table 11: Mean daily food group intakes in non-lactating low-income women by categories of weight retention at 1 year postpartum (N=144)

| Food item | Categories of weight retention at 1 year postpartum | | |
|---|---|---|---|
| | < 10% | $\geq$ 10% | *P* value |
| Grains | 6.07 ± 0.32 | 5.68 ± 0.43 | 0.478 |
| Vegetables | 2.02 ± 0.16 | 1.76 ± 0.16 | 0.251 |
| Fruits | 1.51 ± 0.15 | 1.61 ± 0.25 | 0.739 |
| Dairy * | 1.52 ± 0.12 [a] | 1.19 ± 0.11 [a] | 0.043 |
| Meat | 2.87 ± 0.18 | 2.88 ± 0.18 | 0.972 |

[a] Common superscript letters in a row indicate statistically significant differences (p<0.05).

* Includes milk, yogurt and cheese. Excludes foods containing added sugars (pudding, ice-cream) and fats (butter, cream, ice-cream, and sour cream)

Table 12: Mean daily intakes of energy, macronutrient distribution and dairy associated nutrients in non-lactating low-income women by categories of weight retention at 1 year postpartum (N=144)

| Food item | Categories of weight retention at 1 year postpartum | | |
|---|---|---|---|
| | < 10% | $\geq$ 10% | P value |
| Total Calories, kcal | 2162 ± 92.07 | 2039 ± 103.3 | 0.377 |
| % Fat | 39.4 ± 0.63 | 38.1 ± 0.77 | 0.193 |
| % Carbohydrates | 45.2 ± 0.69 | 46.7 ± 0.81 | 0.166 |
| % Protein | 15.6 ± 0.31 | 15.5 ± 0.35 | 0.814 |
| Dietary fiber, g | 13.3 ± 0.74 | 12.6 ± 0.73 | 0.537 |
| Calcium, mg | 899 ± 45.6 [a] | 773 ± 44.3 [a] | 0.049 |
| Phosphorus, mg | 1291 ± 59.0 | 1161 ± 59.2 | 0.123 |
| Iron, mg | 14.0 ± 0.67 | 13.1 ± 0.72 | 0.395 |
| Sodium, mg | 3822 ± 181 | 3430 ± 184 | 0.132 |

| | | | |
|---|---|---|---|
| Potassium, mg | 2664 ± 116 | 2482 ± 121 | 0.283 |
| Zinc, mg | 13.3 ± 0.89 | 11.9 ± 0.82 | 0.258 |
| Vitamin A (RE), mcg | 946 ± 58.3 [a] | 772 ± 57.2 [a] | 0.035 |
| Beta-carotene, mcg | 2070 ± 214 | 1636 ± 143 | 0.094 |
| Vitamin B1, mg | 1.76 ± 0.10 | 1.58 ± 0.10 | 0.201 |
| Vitamin B2, mg | 2.12 ± 0.10 | 1.88 ± 0.10 | 0.109 |
| Niacin, mg | 21.4 ± 1.1 | 20.1 ± 1.2 | 0.432 |
| Folate, mcg | 338 ± 19 | 316 ± 20.7 | 0.451 |
| Vitamin B6, mg | 1.8 ± 0.10 | 1.6 ± 0.10 | 0.159 |
| Vitamin C, mg | 107.2 ± 6.7 | 109.8 ± 8.9 | 0.818 |
| Vitamin E, mg | 9.8 ± 0.41 | 9.7 ± 0.58 | 0.919 |

[a] Common superscript letters within a row indicate significant differences ($p<0.05$).

The mechanism by which dairy foods regulate body weight may involve intracellular levels of Ca2+ ions within adipocytes. High dietary intakes of calcium are associated with a decrease in intracellular levels of calcium ions, greater lipolysis of triacylglycerol and inhibition of lipogenesis within adipocytes. It has been proposed that dietary calcium reduces lipid accumulation within adipocytes and may minimize weight gain (Xue et al. 1998, Zemel 2003). In addition, Heaney (2003) postulated that calcium intakes in the United States at DRI levels could result in a 60-80% decrease in obesity prevalence rates. Other components of dairy foods, such as branched chain amino acids (Layman 2003) and whey peptides (Teegarden and Zemel 2003) also may play a role in the anti-obesity effect of dairy products.

The levels of calcium observed in this study (834 mg/d) are below current recommendations for adults, 19-30 years of age (1000 mg/d) (Institute of Medicine 2000). However, these values are higher than that seen in multiethnic U.S. women (687 mg/d) (Arab et al. 2003), African-American women (660 mg/d) (Huang et al. 2002) and obese women (500-600 mg/d) (Zemel et al. 2004), but similar to that reported by Huang et al. (2002) for Caucasian (825 mg/d) and Hispanic (792 mg/d) women.

Although dairy products are often avoided with dieting (Teegarden 2003), the results of this study suggest that dairy foods, calcium, and vitamin A may be associated with lower weight retention in postpartum. Thus, public health programs that target low-income women in postpartum should promote a greater inclusion of dairy products in postpartum diets.

# Chapter 5: Compliance with Dietary Guidelines and Relationship to Psychosocial Factors in Low-Income Women in Late Postpartum

## INTRODUCTION

The Dietary Guidelines for Americans were created to provide nutritional guidance to promote health and to reduce the risk of chronic disease (Dietary Guidelines for Americans 2000, McMurry 2003). Unhealthful diets may be prevalent during postpartum as women adapt to the maternal role and face increased demands on their time (Devine et al. 2000). Low-income mothers, especially, may face unique stresses relating to finances (Beck 2001) and childcare (Hersey et al. 2001) during this time. Thus, assessment of compliance with dietary guidelines in low-income women during late postpartum would help identify nutritional concerns.

The postpartum period may be characterized by rapidly changing life events that may influence psychosocial factors, such as neglect of self-care (Troy and Dalgas-Pelish 2003), weight-related distress (Walker 1998), stress (Albers and Williams 2002, Groer et al. 2002), depressive symptoms (Beck 2001), negative body image (Strang and Sullivan 1985, Baker et al. 1999) and a greater need for social support (Gill 2001, Logsdon and Usui 2001). For example, Horowitz et al. (2001) reported that mild to moderate depressive symptoms may be seen in over 25% of postpartum women. It is plausible that psychosocial variables may impact compliance with dietary recommendations.

Several indices that measure dietary quality and dietary behavior exist, including those that are exclusively nutrient- (Davis et al. 2000, Fitzgerald 2002, Packard and Krogstrand 2002) or food- (Kant et al. 2000, Gillman et al. 2001) based, or both (Kennedy et al. 1995, Haines et al. 1999, Bodnar and Siega-Riz 2002, Harnack et al. 2002, McCullough et al. 2002, Kim et al. 2003). The dietary guidelines index (Harnack et al. 2002) was chosen for this study because it measures multiple aspects of diet and is based on lifestyle factors that are determined easily in low-income women.

The purpose of this research was to evaluate compliance with dietary guidelines in late postpartum in low-income women. A secondary purpose was to examine the impact of psychosocial variables on this dietary behavior.

## METHODS

### Study Design

A tri-ethnic sample of low-income women was recruited 0-1 days following delivery in the hospital. Information was obtained on sociodemographic (income, ethnicity, education) status. Anthropometric data (height, weight and body mass index) were obtained at delivery and at one-year postpartum. At 1 year postpartum, participants also completed a food frequency questionnaire of foods eaten during the previous six months, and a variety of instruments that measured psychosocial factors. These included the Self-Care Inventory (neglect of self-care), Weight Related Thoughts and Feelings (weight-related distress), Stress, Center for Epidemiological Studies - Depression (CES-D) (depressive symptoms), Body Cathexis (body image), Postpartum Social Support, and Decisional Balance (pros and cons towards weight loss) scales.

### Subjects

Participants were healthy, Medicaid-eligible women who were not lactating at one year postpartum. Details on subject inclusion criteria have been described previously (George et al. 2004). Complete data on demographic, psychosocial and food frequency questionnaires were obtained from 172 women. Twenty-one subjects were excluded as their caloric intakes exceeded 4500 kcals; five subjects were excluded due to low energy intakes (<500 kcals). The final sample was 146 women (31.5% Caucasian, 30.1%

African-American and 38.4% Hispanic), with a mean age of 22.2 ± 0.31 years (mean ± SEM). Parity >2 was reported by 64.4% of the sample and 61.6% had graduated high school. The Institutional Review Board of the University of Texas at Austin approved study procedures, and all subjects gave informed consent

**Constructs and Instruments**

***Food frequency questionnaire***

Food choices and nutrient intakes were measured via a semi-quantitative food frequency questionnaire tailored for multicultural populations in the southwestern United States (George et al. 2004). The questionnaire contained 195 individual (e.g. bananas) or closely related food items (e.g. oranges, tangerines). It was based on the Block-NCI Health Habits and History Questionnaire, and was modified to incorporate southwestern, new, and ethnic food products. Examples of foods included were chorizo, chicken fried steak, and sopapillas. The reference period for the questionnaire was the previous six months. This instrument has been validated recently in an ethnically diverse sample of low-income postpartal women. Mean coefficients were 0.73 for reliability and 0.45 for validity (George et al. 2004).

Subjects were shown food models and measuring cups and spoons to enable accurate estimation of portion sizes. Portion size options were small, medium, large and extra-large; frequency options varied from "never or less than once a month" to "2+ times per day." Participants were given written and oral instructions by nutritionists and/or nurses on accurate completion of the instrument. All questionnaires were reviewed for missing items and ambiguous responses were clarified.

Dietary intake from the food frequency questionnaire was analyzed in terms of foods and nutrients via DIETSYS ®, a computer program developed by Block et al.

(1994) that we modified to incorporate nutrient values for the added foods. Sample nutrients calculated by the program included total fat, saturated fat, cholesterol and sodium intake. Analysis options in the DIETSYS program enabled fine-tuning of nutrient calculations based on responses of participants to summary questions. For example, the Vegetable Adjust option tallied the total of individual vegetable items selected with a summary question on how often vegetables were consumed.

Dietary behavior was defined in terms of the dietary guidelines index (Harnack et al. 2002), a composite measure of compliance with the 2000 Dietary Guidelines (USDA and US Department of Health and Human Services 2000). This index has nine components that reflect each of the major recommendations in the guidelines. Certain index components, such as those relating to adherence to Food Guide Pyramid, dietary variety and fat intake were divided into sub-components (Table 13). Total possible scores on this index range from 0 to 18, and higher scores indicate greater compliance with the dietary guidelines (Harnack et al. 2002). The choice of this multidimensional index reflects the suggestion that diet should be examined in terms of overall dietary patterns, rather than in terms of individual nutrients or food groups (Coulston 2001, Gerber 2001, Guthrie and Smallwood 2003).

***Self-Care Inventory***

The tendency of participants to neglect self-care by engaging in negative health behaviors such as inadequate sleep, unhealthy dietary practices and substance abuse, was assessed via this 40-item measure (Pardine 1983). Two questions on use of alcohol were added (Walker et al. 1999). The items on this questionnaire had a 4-point Likert format, with responses ranging from "rarely/never" to "very often." Higher scores indicate greater neglect of self-care. The Cronbach's alpha ranged from 0.76 in a sample of pregnant women (Walker et al. 1999) to 0.85 in the present study. Construct validity for this instrument was demonstrated by significant positive relationships between neglect of self-care scores and the presence of illness (path coefficient = 0.33, $p<0.01$) (Weibe and McCallum 1986).

***Feelings and Thoughts about Weight Scale***

This 14-item scale measured weight-related distress in postpartum, with higher scores indicating greater weight related distress (Walker 1999). Responses were coded on a 7-point Likert scale, ranging from “disagree strongly” to “agree strongly.” Internal consistency reliability was 0.94 at 1 year postpartum.

***Stress Scale***

An 11-item scale measured stress experienced from different sources, such as financial or family problems, or the presence of a young infant (Curry et al. 1994). The likert-type scale had responses ranging from 1 (no stress) to 4 (severe stressor/hassle). The internal consistency reliability in this sample was 0.8 at 1 year postpartum.

***Depressive Symptoms Scale***

Depressive symptoms were assessed via the Center for Epidemiological Studies-Depression Scale (CES-D) (Radloff 1977). This 20-item instrument has been used previously to measure depression in postpartum women (Campbell and Cohn 1991, Carter et al. 2000, Wilcox et al. 1998). Responses to questions 4, 8, 12 and 16 were reverse-coded prior to the calculation of total scale scores. Cut-offs on total scores that indicate mild and severe depression were 11 and 16, respectively (Bozoky and Corwin 2002). The Cronbach alpha value for the CES-D scale in this sample of 146 women was 0.92.

### *Body Cathexis Scale*

This 30-item instrument that measured dissatisfaction with specific parts (e.g. waist, hips, face) or functions (e.g. digestion) of the body was an abbreviated version of the original scale developed by Secord and Jourard (1953) (Walker and Freeland-Graves 1998). The validity of the scale was established as scale scores were related to self-esteem measures and to weight loss in expected ways (Walker and Freeland-Graves 1998). The Cronbach alpha value in the present study was 0.97 at 1 year postpartum.

### *Social Support Scale*

This six-item scale measured the degree of support a new mother receives from her family, primarily her partner. This instrument is tailored to the postpartum context and had a Cronbach's alpha value of 0.90 in the present sample.

### *Decisional Balance Inventory*

This 20-item measure evaluated the predisposition of participants towards weight loss. The "pro" subscale identified the degree to which participants desired to lose weight; "con" queried on perceived barriers to weight loss. Cronbach alpha values for this scale in the present study were 0.94 for the "pro" subscale and 0.91 for the "con" subscale.

## Statistical Methods

Descriptives such as ranges and means were used to describe characteristics of participants with respect to demographics and components of the diet guidelines index. Frequencies were computed to estimate the number of persons who complied with each of the dietary guidelines.

In order to establish construct validity, analysis of variance with post-hoc Scheffe tests were used to test for significant differences in nutrient intakes and Food Guide

Pyramid patterns among persons classified into different tertiles of diet index scores. Chi-square analyses with follow-up via tests of independent proportions were conducted to determine statistically significant differences among tertiles for categorical variables. This method of construct validity was utilized previously to demonstrate the usefulness of the diet guidelines index in a sample of older women (Harnack et al. 2002). Internal consistency reliability of psychosocial instruments was evaluated using Cronbach's alpha.

Variations in psychosocial factors across tertiles of the diet guidelines index were examined using analysis of variance with post-hoc Scheffe tests. Associations between individual items on the psychosocial scales and overall diet index scores were assessed via Pearson correlation coefficients.

**RESULTS**

Compliance with the dietary guidelines index was less than optimal in this sample of low-income women (Table 13). Weight recommendations were not followed by the majority of the sample, as 37.7% were obese (BMI >30) and 25.3% were overweight (BMI >25 and BMI <30). Over 75% of the sample did not engage in vigorous physical activity often or fairly often. Conformity with guidelines for food groups such as grains, vegetable, fruit, and dairy was low (<25%). Yet, over 60% of the sample did meet the recommendations for the meat, fish, poultry, dry beans, eggs and nuts group. In terms of variety, vegetables had the greatest diversity, with 35% of the sample consuming at least seven different items each week. The least variety was found for fruits, with only 25.3% of the subjects consuming >five types/week. The average percentage of total calories from fat was 38.8 ± 0.52%, ranging from 19.2 to 54.4%. Mean daily intakes of saturated fat and cholesterol were 13.6 ± 0.19% of total calories and 325.1 ± 16.9 g, respectively.

Table 13: Compliance with dietary guidelines recommendations in low-income women at 1 year postpartum (N=146)

| **Index component** | **Recommendation** | | **Score** | |
|---|---|---|---|---|
| | **Criteria** | **Compliance, %** | **Possible Range [a]** | **Mean ± SEM** |
| **Aim for fitness** | | | | |
| Weight | BMI < 25 | 37.7 | 0 - 2 | 0.99 ± 0.07 |
| Physical activity | Often / Fairly often | 21.3 | 0 - 2 | 0.27 ± 0.05 |
| **Build a healthy base** | | | | |
| Food Guide Pyramid recommendations | _ | | | |
| Breads, grains, cereal, rice and pasta | ≥ 6 servings/d | 23.3 | 0 - 0.4 | 0.09 ± 0.01 |
| Vegetable | ≥ 3 servings/d | 16.4 | 0 - 0.4 | 0.07 ± 0.01 |
| Fruit | ≥ 2 servings/d | 25.3 | 0 - 0.4 | 0.10 ± 0.01 |
| Milk, yogurt and cheese group | ≥ 2 servings/d | 19.9 | 0 - 0.4 | 0.08 ± 0.01 |

| | | | | |
|---|---|---|---|---|
| Meat, fish, poultry, dry beans, eggs and nuts | ≥ 2 servings/d | 65.1 | 0 - 0.4 | 0.26 ± 0.02 |
| Variety of grains and whole grains | | | | |
| Grains | ≥ 4 different types of grain items/wk | 35.0 | 0 - 1 | 0.25 ± 0.03 |
| Whole grains | > 1 servings/d | 14.4 | 0 - 1 | 0.08 ± 0.02 |
| Variety of fruits and vegetables | | | | |
| Fruits | ≥ 5 different types of fruits/wk | 25.3 | 0 - 1 | 0.21 ± 0.03 |
| Vegetables | ≥ 7 different types of vegetables/wk | 35.0 | 0 - 1 | 0.25 ± 0.03 |
| **Choose sensibly** | | | | |
| Amounts and types of fat | | | | |
| Total fat | ≤ 30% calories from fat/d | 6.8 | 0 - 0.67 | 0.05 ± 0.01 |
| Saturated fat | ≤ 10% calories from saturated fat/d | 6.2 | 0 - 0.67 | 0.04 ± 0.01 |
| Cholesterol | ≤ 300 mg cholesterol/d | 58.9 | 0 - 0.67 | 0.39 ± 0.03 |

| | | | | |
|---|---|---|---|---|
| Sweets and sugar-sweetened beverages | < 2 servings/d | 28.8 | 0 - 2 | 0.95 ± 0.07 |
| Sodium | ≤ 2400 mg sodium/d | 22.6 | 0 - 2 | 0.45 ± 0.07 |
| Alcoholic beverages | ≤ 1 drink/d | 97.9 | 0 - 2 | 2.0 ± 0.02 |
| **Total score** | - | - | 0-18 | 6.5 ± 0.17 |

[a] Failure to meet stated criterion for an index component results in a score of zero.

Use of alcoholic beverages was not prevalent in this population, as < 3% drank > 1 alcoholic beverage each day.

Construct validity for the dietary guidelines index was provided by expected variations of index scores with dietary variables (Table 14). Those classified into the highest tertile of compliance consumed more servings of vegetables, fruits and less cholesterol, sodium and alcohol than those in the lowest tertile. Dietary variety of grains, vegetables and fruits also was greater in those with higher scores on the dietary guidelines index.

Table 15 shows psychosocial scale scores across tertiles of the dietary guidelines index. Greater compliance with dietary guidelines was associated with lower neglect of self-care, weight-related distress, stress, depressive symptoms and perceived barriers to weight loss (decisional balance - con scale), and less negative body image ($p<0.05$). Surprisingly, social support did not vary across tertiles of diet index scores.

Individual items on the psychosocial questionnaires that showed highly significant relationships with diet index scores are shown in Table 16. Specific items that showed the strongest associations with dietary guidelines compliance were substituting junk foods for a meal, drinking a lot of coffee or cola, and lack of respect and feeling like a failure due to weight.

Table 14: Parameters of dietary behavior according to tertiles of diet index scores in low-income women at 1 year postpartum (N=146)

| **Dietary Parameters** | **Range** | **Tertiles of dietary guidelines index scores †** | | | ***P* value** |
|---|---|---|---|---|---|
| | | **1 (Lowest)** | **2** | **3 (Highest)** | |
| **Food categories** | | | | | |
| Grains (servings/d)* | 0 - 16.2 | 4.3 ± 0.40 [a] | 4.7 ± 0.36 [a] | 4.7 ± 0.42 [a] | 0.724 |
| Vegetables (servings/d)* | 0 - 7.7 | 1.4 ± 0.12 [a] | 1.9 ± 0.16 [ab] | 2.5 ± 0.25 [c] | 0.001 |
| Fruits (servings/d)* | 0 - 14.3 | 0.89 ± 0.13 [a] | 1.5 ± 0.18 [ab] | 2.6 ± 0.37 [c] | 0.001 |
| Dairy (servings/d)* | 0 - 6.2 | 1.5 ± 0.18 [a] | 1.3 ± 0.12 [a] | 1.2 ± 0.11 [a] | 0.273 |
| Meat (servings/d)* | 0.4 - 7.2 | 2.9 ± 0.20 [a] | 3.1 ± 0.21 [a] | 2.8 ± 0.24 [a] | 0.598 |
| Sweets and sugar-sweetened beverages (servings/d)* | 0 - 24.1 | 5.5 ± 0.63 [a] | 3.3 ± 0.30 [b] | 2.5 ± 0.28 [bc] | 0.001 |
| **Dietary variety** | | | | | |
| Grains (servings/wk)* | 0 - 11 | 2.5 ± 0.20 [a] | 2.8 ± 0.28 [a] | 4.0 ± 0.38 [b] | 0.001 |

| | | | | | |
|---|---|---|---|---|---|
| Vegetables (servings/wk)* | 0 - 18 | 3.5 ± 0.40 [a] | 5.3 ± 0.51 [a] | 7.7 ± 0.67 [b] | 0.001 |
| Fruits (servings/wk)* | 0 -19 | 1.9 ± 0.41 [a] | 2.8 ± 0.35 [a] | 5.6 ± 0.56 [b] | 0.001 |
| **Nutrient intakes** | | | | | |
| Total fat (g/d)* | 20 - 196 | 100.9 ± 6.0 [a] | 89.4 ± 5.5 [a] | 84.1 ± 5.6 [a] | 0.088 |
| Saturated fat (g/d)* | 7.2 - 75.3 | 35.9 ± 2.2 [a] | 31.2 ± 2.0 [a] | 29.7 ± 2.1 [a] | 0.073 |
| | | <------------------------------------ | % | -----------------------------------> | |
| Cholesterol >300 mg/d | 44.7 – 1321 | 52.1 [a] | 44.9 [a] | 26.5 [a] | 0.031 |
| Sodium >2400 mg/d | 822 – 8339 | 87.5 [a] | 81.6 [a] | 63.3 [a] | 0.013 |
| Alcohol >1 drink/d | 0 - 2 | 6.3 [a] | 0.0 [a] | 0.0 [a] | 0.045 |

† Indicates compliance with dietary guidelines as measured by the diet index score (Harnack et al. 2002)

* Mean ± standard error of the mean

[a, b, c] Different superscript letters indicate significant differences in anthropometric and dietary variables among tertiles of diet index scores as indicated by the post-hoc Scheffe test for continuous variables, and by the test of independent proportions for categories, $p \leq 0.05$.

Table 15: Distribution of psychosocial scale scores by tertiles of diet index scores in low-income women at 1 year postpartum (N = 146).

| **Scale** | **Scores** | | | | |
|---|---|---|---|---|---|
| | **Range** | **Tertiles of dietary guidelines index scores** | | | ***P* value **** |
| | | **1 (Lowest)** | **2** | **3 (Highest)** | |
| Neglect of self-care *****† | 7-72 | 40.9 ± 2.1[a] | 33.4 ± 1.5[b] | 30.4 ± 1.3[b] | 0.001 |
| Weight related distress *****† | 14-96 | 52.4 ± 3.1[a] | 39.8 ± 2.5[b] | 42.6 ± 2.9[ab] | 0.006 |
| Stress scale *****† | 11-38 | 22.9 ± 0.89[a] | 19.2 ± 0.78[b] | 20.3 ± 0.70[ab] | 0.009 |
| Depressive symptoms *****† | 0-50 | 21.2 ± 1.9[a] | 15.1 ± 1.6[ab] | 15.0 ± 1.5[b] | 0.020 |
| Negative body image *****† | 30-132 | 83.9 ± 3.6[a] | 72.1 ± 3.3[a] | 73.9 ± 3.5[a] | 0.041 |
| Social support ***** | 6-54 | 32.9 ± 1.8[a] | 35.1 ± 1.9[a] | 34.7 ± 2.0[a] | 0.753 |
| Decisional balance inventory | | | | | |
| Pro subscale *****‡ | 10-50 | 32.0 ± 1.6[a] | 25.8 ± 1.6[a] | 28.1 ± 1.7[a] | 0.059 |

| | | | | | |
|---|---|---|---|---|---|
| Con subscale *• | 10-48 | 24.8 ± 1.3[a] | 20.3 ± 1.3[a] | 20.3 ± 1.3[a] | 0.039 |

* Mean ± SEM

** Analysis of variance used to determine statistically significant differences among tertiles.

† Higher scores indicate greater negativity in psychosocial factors.

‡ Higher scores indicate greater disposition towards weight loss.

• Higher scores indicate greater disinclination towards weight loss.

[a, b] Different superscript letters (a, b) indicate significant differences in psychosocial variables across tertiles of diet index scores as indicated by the post-hoc Scheffe test.

Table 16: Relationships between selected significant items on psychosocial questionnaires and diet index scores in low-income women at 1 year postpartum (N=146)

| **Selected items on questionnaires** | **Mean score ± SEM** | **Relationship to Dietary Guidelines Index Score** | |
|---|---|---|---|
| | | **Pearson's Correlation (r)** | ***P* value*** |
| **Self-Care Inventory (neglect of self-care)** | | | |
| How often did you substitute junk food for a regular meal? | 1.46 ± 0.08 | -0.303 | 0.001 |
| How often did you drink a lot of coffee or cola beverages in one day? | 1.27 ± 0.09 | -0.223 | 0.008 |
| How often did you take time to perform exercises that enhance muscle tone (yoga, running in place, calisthenics/weight training)? | 0.62 ± 0.07 | 0.192 | 0.021 |
| How often did you eat a nutritious breakfast? | 1.20 ± 0.07 | 0.187 | 0.025 |
| **Weight Related Distress** | | | |
| I feel like a failure when I think about my weight | 2.72 ± 0.15 | -0.212 | 0.011 |

| | | | |
|---|---|---|---|
| I feel ashamed of myself because of my weight | 2.79 ± 0.16 | -0.203 | 0.015 |
| I prefer to wear clothes that hide my weight | 3.82 ± 0.17 | -0.182 | 0.029 |
| **Stress Scale** | | | |
| Degree of stress from work or school problems such as being laid off, failing a class, etc. | 1.59 ± 0.08 | -0.183 | 0.028 |
| Degree of stress from money problems such as paying bills | 2.77 ± 0.08 | -0.181 | 0.029 |
| **Center for Epidemiological Studies Depression Scale (CES-D)** | | | |
| I felt that I could not shake off the blues even with help from my family or friends | 0.81 ± 0.09 | -0.197 | 0.018 |
| I thought my life had been a failure | 0.53 ± 0.07 | -0.177 | 0.034 |
| **Body Cathexis Scale (Body Image)** | | | |
| Negative feelings about health | 2.34 ± 0.10 | -0.188 | 0.024 |
| Negative feelings about age | 2.02 ± 0.09 | -0.176 | 0.035 |
| Negative feelings about weight | 3.00 ± 0.12 | -0.166 | 0.046 |

| | | | |
|---|---|---|---|
| **Decisional Balance Inventory** | | | |
| Others would have more respect for me if I lost weight | 1.98 ± 0.11 | -0.222 | 0.008 |
| I would be able to accomplish more if I carried fewer pounds | 2.72 ± 0.13 | -0.173 | 0.038 |

***** Correlations are significant at $p<0.05$.

## DISCUSSION

Compliance with the dietary guidelines recommendations in late postpartum was less than expected. Specifically, these low-income women were not in compliance for guidelines related to weight, physical activity, grains, vegetables, fruit, dairy, and dietary variety. A significant proportion of the sample also reported excessive intakes of total fat, saturated fat, sweets/sugar-sweetened beverages and sodium.

Adherence to the weight guideline in the present study (37%) was lower than that seen in a national sample of 20-34 year old women from the 1999-2000 National Health and Nutrition Examination Survey (Center for Disease Control 2003) (48.5%), and in low-income women in the same age group by Gibson (2003) (50.4%). The lower proportion of healthy weight persons in the present sample may reflect the large proportion (>60%) of minority women who exhibit higher rates of postpartum weight retention than Caucasians (Peterson et al. 2002). The high degree of non-compliance with the weight guideline is of concern as overweight increases risk for diseases (type 2 diabetes, hypertension, coronary heart disease, gallbladder disease, osteoarthritis, sleep apnea, and certain cancers) and impacts negatively quality of life (USDA Dietary Guidelines for Americans 2000).

The frequency of vigorous physical activity in this cohort is lower than that seen by Hinton and Olson (2001) in 622 socio-economically diverse women at 1 year postpartum. In their study, 42% of participants exercised regularly and 15% reported doing so often. Our lower figures may be due to differences in ethnic and socioeconomic composition, or a limited ability to capture physical activity adequately. The minimal physical activity seen in the present sample is problematic as Rooney and Schauberger (2002) found that participation in aerobic exercises during postpartum was associated with less weight gain 8-10 years later. Postpartum physical activity also has been linked with improved overall fitness, serum lipid profiles, insulin sensitivity and psychological well-being (Larson-Meyer 2001). Reasons for limited exercise in this group of low-income postpartum women may include the responsibility of caring for a newborn infant; lack of time, financial resources and transportation (Hinton and Olson 2001); negative body image; lack of easy access to exercise facilities; safety concerns; and social isolation (Kieffer et al. 2002).

The percentage of women meeting recommendations for specific food groups was lower than those reported in a national sample of 20-29 year old women (Pyramid Servings Intakes by U.S. Children and Adults 1994-96 1998) for grains (23.3% vs. 32%) and vegetables (16.4% vs. 35%), but higher for fruits (25.3% vs. 18%), dairy (19.9% vs. 17%) and meats (65.1% vs. 29%). The proportions of our low-income women consuming at least five different fruits (25.3% vs. 63.6%) or seven vegetables (35% vs. 63.2%) weekly were less than those observed in postmenopausal women of primarily high socioeconomic status (Harnack et al. 2002).

In late postpartum, our women had high intakes of fat, saturated fat, and cholesterol, which increase the risk of cardiovascular and other chronic diseases. The percentage of calories from fat in the present study (38.8%) was slightly higher than that seen in other samples of low-income postpartal women (32-37%) (Morin et al. 1999), as well as U.S. women >20 years of age (32.4%) (Dixon and Ernst 2001.)

Reasons for compromised dietary behavior in women of limited economic means may include lower costs of high fat foods and higher expense for more nutritious foods such as fruits and vegetables (French 2003); economic constraints (Keenan et al. 2001); insufficient food shopping (Hersey et al. 2001) and cooking (Dibsdall et al. 2002, McLaughlin et al. 2003) skills; and lack of nutrition knowledge (Hanss-Nuss et al. 2003).

Recent evidence also suggests that foods containing sugar and fat are highly preferred by adults in general (Drewnowski and Levine 2003). Dietary practices during postpartum may be influenced further by insufficient time (Devine et al. 2000), weight concerns (Stein and Fairburn 1996), disinterest in eating, and meal skipping followed by the consumption of high fat snacks (Morin et al. 1999).

The psychosocial variables measured in this study were associated with lower compliance with dietary guidelines at 1 year postpartum. Previously, depression and environmental stresses have been reported to influence health behaviors during pregnancy (Walker et al. 1999). It is interesting to note from the present study that the influence of psychosocial factors on dietary behavior continues into postpartum.

The association of lower dietary compliance with inattention to taking care of oneself is not surprising. The majority of these low-income women was overweight or obese, and did not exercise on a regular basis. The relationship between eating at fast food places and lower dietary compliance in our study parallels that of a national sample of 17,370 by Paeratakul et al. (2003) who showed associations between fast food consumption and poor quality diets.

Weight-related distress was associated with low compliance with dietary guidelines in the present sample. Feelings of inadequacy relating to weight may accompany overweight status (Walker 1998). In a cohort of 622 women at 1 year postpartum, Hinton and Olson (2001) found that 56% reported dissatisfaction with body weight and/or shape. Previous studies also have shown that feelings of shame and guilt relating to weight may result in attempts by participants to avoid social activities (Walker 1999) and to lose self-esteem (Friedman et al. 2002). These feelings also were associated with lower adherence to nutrition recommendations in the present research.

We found that degree of stress from work or school problems, and financial issues such as paying bills, was associated with limited compliance with dietary guidelines. Dixon et al. (2001) also observed that economic hardship negatively impacted dietary quality.

A high incidence of depressive symptoms among low-income minority women has been reported (Logsdon et al. 2000, Miranda et al. 2003). In the present study, we found an inverse association between depression and dietary quality in these women. Previously, depression has been linked with lower intakes of fruits and vegetables (Lytle et al. 2003) and reduced physical activity (Schmitz et al. 2002) in adolescents; increased diabetes risk in persons with low education levels (Carnethon et al. 2003); diminished quality of life in patients with chronic disease (Ruo et al. 2003); and folate deficiency (Morris et al. 2003), weight gain and cardiovascular disease in the general population (Miller et al. 2003). To the best of our knowledge, the present study is the first to explore the relationship between depressive symptoms and dietary behavior in a low-income postpartal sample.

In summary, compliance with dietary guidelines was minimal in our low-income women. Psychosocial variables, such as neglect of self-care, weight-related distress, body image, stress and depressive symptoms were associated significantly with this compliance at 1 year postpartum. Thus, programs that target diet-related behavior change in low-income women might be improved by inclusion of psychosocial assessment and counseling components.

**APPLICATIONS**

Significant proportions of low-income women may not comply with dietary guideline recommendations for weight, physical activity, grains, vegetables, fruits, dairy foods, fats and added sugar in late postpartum. Programs and policies are needed to improve these specific areas of diet and lifestyle in low-income postpartal women.

Nutrition professionals should be aware that psychosocial factors such as neglect of self-care, weight-related distress, negative body image, stress and depressive symptoms may be associated with lower compliance with dietary guidelines in late postpartum. Research, policy and clinical efforts that target dietary behavior in low-income postpartal women should consider the inclusion of psychosocial components.

# Chapter 6: Summary and Conclusions

The first contribution of this research is the development and validation of a food frequency questionnaire (FFQ) for young adult women in the southwestern United States (chapter 2). The instrument was validated against 3-day diet records in 95 college women, and cross-validated against the mean of two 24-hour recalls and 4-day food records in 50 low-income postpartal women. Internal consistency reliability averaged 0.75 for food groups in college women and 0.73 in low-income women. De-attenuated Pearson's correlations centered at 0.42 among college women, and at 0.45 among low-income women. Cross-classification of participants into quartiles of nutrient intake resulted in 76% of college women and 79% of low-income women being classified correctly. The results indicate that the FFQ is suitable for the identification of areas of dietary concern and the examination of relationships between dietary patterns and health outcomes in young adult women from the southwestern United States.

The second aspect of this research was an examination of dietary behavior during and after pregnancy in a tri-ethnic sample of low-income women (chapter 3). From pregnancy to postpartum, % calories from fat (delta = +1.1%, $p<0.05$) and added sugar (delta = +2.0%, $p<0.05$) increased. A greater percentage of lactating than non-lactating women (64% vs. 38%, $p<0.05$) met recommendations for fruits during pregnancy. In addition, compliance with guidelines for total fat during pregnancy and postpartum was higher in women who breastfed at 6 months postpartum than in those who bottle-fed exclusively. Furthermore, the women in this study did not meet the dietary guidelines of the Food Guide Pyramid during pregnancy and postpartum for vegetables, dairy, and total fat. These findings suggest that governmental programs that target low-income postpartal women should include a greater emphasis on the nutritional needs of women during postpartum. Areas of focus should include the expansion of selection of healthful foods, such as fruits, vegetables and dairy, and reduction in intakes of fats and added sugars. It is encouraging to note that lactating women had better diets than those who did not breastfeed. Women who bottle-feed may need additional nutritional counseling, as they may represent a segment of the population that is at great nutritional risk.

The third facet of this dissertation was an examination of the relationship between dietary behavior and weight status (chapter 4). Weight retention at 1 year postpartum was related inversely to calcium ($p<0.049$), vitamin A (0.036) and dairy (0.043) intakes in low-income women. Furthermore, the ingestion of calcium was below current DRI recommendations (834 mg/d vs. 1000 mg/d) (Institute of Medicine 2000). The present study suggests that low-income women should be encouraged to consume larger amounts of calcium and dairy to minimize postpartum weight retention. Greater inclusion of dairy in diets could be accomplished through social marketing campaigns, augmentation of the nutrition education component of programs such as WIC, and increased provision of low-fat dairy foods to women on governmental food assistance initiatives.

The fourth contribution of this research was an evaluation of compliance with dietary guidelines at one year postpartum, and its association with psychosocial factors (chapter 5). In terms of dietary compliance, 60% met guideline recommendations for meat, but only 25% had adequate intakes of grains, vegetables, fruits, and dairy foods. Healthy weights (BMI<25) were observed in 37% of the sample. Women in the highest tertile of dietary compliance had a more positive body image ($p<0.041$) than those in the lowest tertile, and less neglect of self-care ($p<0.001$), weight-related distress ($p<0.006$), stress ($p<0.009$), depressive symptoms ($p<0.020$), and perceived barriers to weight loss ($p<0.039$). These results suggest that significant proportions of low-income women may not be in compliance with certain dietary guidelines. Furthermore, programs that target diet-related behavior change in low-income women might be improved by the inclusion of psychosocial assessment and counseling components.

The postpartum period represents an excellent opportunity for change when women might be highly receptive to adopting healthful behaviors (Morin et al. 2002) as a result of weight concerns (Hiser 1986, Peterson et al. 2002). Moran et al. (1997) showed that the areas in which postpartum women sought the most information were exercise, diet and nutrition. Interventions that educate women about nutrition in postpartum should be incorporated into programs that target low-income populations. Emphasis should be placed on the expansion of selection of healthy foods in postpartum, and the reduction in intakes of fats. The applications of the present study include a greater understanding of dietary behavior in low-income women of diverse ethnicities in the first postpartal year, and its psychosocial and body weight correlates.

Limitations of this research include the absence of a biomarker for the validation of the food frequency questionnaire, assessment of pregnancy-related diet at 1.5 months postpartum, and the use of self-reported prepregnancy weight. Biomarkers may serve as superior reference methods for validation of food frequency questionnaires, as sources of error in biomarkers vary from those in FFQs. However, the use of biomarkers was outside the scope of this research. The measurement of diet during pregnancy at 1.5 months postpartum could be criticized. Yet, Bunin et al. (2001) showed that dietary intakes recorded via a retrospective food frequency questionnaire administered 3-7 years following childbirth showed good correlations (mean = 0.49) and quintile agreements (69% - 79%) with dietary intakes recorded during the reference pregnancy.

Although measurement of weight would be ideal, self-reported pregravid weights have been used in several recent studies of postpartum women (Olson and Strawderman 2003, Linne and Rossner 2003, Gunderson et al. 2001, Kac et al. 2004). Furthermore, self-reported weights are related closely with actual weights in adult women (Kuczmarski et al. 2001).

Future directions include the development of interventions for multiethnic populations that include psychosocial assessment and counseling components. Other psychosocial variables such as self-efficacy may be studied together with those included in the present research as potential correlates of dietary behavior in postpartum.

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