FRUIT AND VEGETABLE INTAKES AND BODY MASS INDEX OF PRIMARILY LOW-INCOME AFRICAN AMERICAN CHILDREN LIVING IN RURAL ALABAMA

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IN RURAL ALABAMA

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VITA

Nicole Renee Schier, daughter of Mary and Jim Schier, was born January 24, 1981, in Bradenton, Florida. She graduated from Manatee High School in 1999. She attended Auburn University and graduated cum laude with a Bachelor of Science degree in Nutrition and Food Science in August, 2003. She entered Graduate School in August, 2003 at Auburn University.

THESIS ABSTRACT

FRUIT AND VEGETABLE INTAKES AND BODY MASS INDEX OF PRIMARILY LOW-INCOME AFRICAN AMERICAN CHILDREN LIVING IN RURAL ALABAMA

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Fruit and vegetable intakes among primarily low-income African American elementary school-aged children living in three rural counties in Alabama were examined. Data were collected from 253 children in the fall 2002 and 310 children in the spring 2003. In the fall, 49.8% of the children were classified with a normal BMI, 16.2% were classified as at risk, and 34.0% were classified as overweight using CDC growth charts and classification guidelines. In the spring, 51.6% were classified with a normal BMI, 16.5% were classified as at risk, and 31.9% were classified as overweight using CDC growth charts and classification guidelines. In the fall, servings of fruits differed significantly between the at risk and overweight children, with the overweight children consuming significantly more fruits than the at risk. Fruit intake did not differ significantly among groups in the spring, however. Fruit intake averaged about one and one quarter servings per day with only 23% of children meeting minimum recommended intakes. About 7% of the children failed to consume any fruits. No significant differences were found among groups for servings of vegetables consumed in the fall or spring. Vegetable intake averaged about one and one quarter servings per day. About 9% of children met the minimum recommendations for vegetable intake; about 5% of the children failed to consume any vegetables. No significant correlations were found between change in servings of vegetables and change in BMI or weight from fall to spring or between change in serving of fruits and change in BMI or weight from fall to spring. Folate intake as a percent of the Recommended Dietary Allowances (RDA) was below recommendations at 80% for all children. Intakes of potassium were also below the adequate intake at 46%. Intakes of vitamin C exceeded the RDA at 291%. The percent of children not ingesting two-thirds of intake recommendations for folate was 46%, for potassium was 80%, and for vitamin C was 21%. The at risk children had significantly lower potassium intake than the normal and overweight children in the fall but not spring. The at risk children consumed significantly less folate than the overweight children in the fall. No significant correlations were found between BMI and intakes of potassium, vitamin C, folate and beta carotene. Children consumed about 28% of energy from sugars. Significant negative correlations were found between servings of fruit and percent of energy as sweets and percent of energy as fat. These findings suggest that this population is not consuming adequate daily servings of fruits and vegetables nor adequate recommended amounts of folate and potassium.

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CHAPTER I

INTRODUCTION

The prevalence of overweight among children and adolescents in the United States has been steadily increasing over the past four decades (Troiana and others 1995). Childhood obesity has been associated with an increased chance of severe obesity in adulthood as well as hypertension, dyslipdaemia, chronic inflammation, increased blood clotting tendency, and hyperinsulinaemia (Ebbeling and others 2002).

Overweight and obesity does not affect all segments of the population equally. Several factors put populations at higher risks. African Americans children and adolescents have higher incidences of obesity when compared to white children and adolescents (Hedley and others 2004). Along with ethnicity, low socioeconomic status is associated with a higher incidence of obesity. Children of lower socioeconomic status are at a higher risk of becoming overweight when compared to children of higher socioeconomic status (Strauss and Knight 1999, Wang 2001).

The prevalence of obesity also differs based on the geographical region and setting (urban versus rural) in the United States. Individuals living in rural areas have higher occurrences of obesity than those living in other areas of the country. In a study set in North Carolina rural children had about a 55% increased risk for developing obesity compared with children in an urban setting (McMurray and others 1999). In rural areas significantly more women lived in poverty, reported poorer health quality, and had a greater incidence of obesity than in urban areas (Ramsey and Glenn 2002). Also, southern regions of the United States have higher rates of obesity compared to other regions of the country. Alabama has the highest prevalence of obesity in the United States according to a 2003 survey (CDC-BRFSS 2003). Alabama's overall health status of children ranks among the lowest in the country (47^{th}) (Alabama Kids Count 1998).

Several factors contribute to inadequate energy expenditure and excessive energy intake; both of which contribute to weight gain and obesity. Children today are engaged in increased amounts of sedentary leisure time behavior such as television watching, computer play, and video game playing and less time spent doing more physical activities and thereby expending energy. In addition to decreased physical activity and more inactive leisure activities, obesity can be caused from an increased energy intake. Several factors influence energy intake. These factors include foods away from home, portion sizes, meal pattern and frequency, and overall diet quality.

Many children are not meeting the recommendations set by the USDA's Food Guide Pyramid nor are they meeting the US dietary guidelines. For example, boys and girls living in a rural Appalachian Kentucky community have been shown to consume inadequate amounts of both protein and fiber, but consume fat (both total and saturated) in amounts above recommendations (Crooks 2000). In a national sample of high school students 76.1% of the students did not consume the recommended 5 servings of fruits and vegetables a day (Lowry and others 2002).

Lower food expenditures, low fruit and vegetable consumption, and overall low diet quality are results of poverty and food insecurity (Drewnowski and Specter 2004).

Thus, children from limited resource families living in rural Alabama are at high risk for poor quality diets. Although childhood obesity is on the rise which may lead us to believe that children are over nourished this does not appear to be the case. Children's consumption of low-nutrient/high energy dense foods may be contributing to a society of overweight and undernourished children. Although several studies have examined children's dietary habits, this study is among the first to examine body mass index along with fruit and vegetable consumption and selected nutrient intakes in a high risk population of primarily low income African American children in rural Alabama.

CHAPTER II

LITERATURE REVIEW

The literature review addresses the following: prevalence and cost of obesity, health consequences, definitions of obesity and overweight, and populations at risk. Several causes of obesity are discussed including decreased energy expenditure as well as increased energy intake which consists of foods eaten away from home, portion sizes, meal pattern and frequency and poor diet quality.

Prevalence and Cost of Obesity

Nearly two-thirds or 129.6 million Americans are overweight and nearly one-third or 61.3 million Americans are obese (Flegal and others 2002, NIH 2003). Obesity directly affects a large portion of the United States population. Moreover, incidences of obesity have increased rapidly from previous years. In comparing the results from the NHANES II (1976 to 1980) and NHANES III (1988 to 1994) rates of obesity in adults increased by 8% (Kuczmarski and others 1994). From 1960 to 2000, the prevalence of overweight (BMI $\geq$ 25 to < 30) increased from 31.5% to 33.6% in U.S. adults aged 20 to 74 years (NIH 2003). The prevalence of obesity (BMI $\geq$ 30) during this same time period more than doubled from 13.3% to 30.9%, with most of this rise occurring in the past 20 years (Flegal and others 2002) From 1988 to 2000, the prevalence of extreme obesity (BMI $\geq$ 40) increased from 2.9% to 4.7%, up from 0.8% in 1960 (Flegal and others 2002).

While obesity directly affects more than 60% of the adult population, the costs of obesity affect a much larger portion of the population. Annual obesity-related hospital costs increased more than threefold, from $35 million during 1979 to 1981 to $127 million during 1997 to 1999 (Wang and Dietz 2002). In 2000, the direct cost (health care costs) of obesity-related disease was estimated at $61 billion. Indirect costs (lost wages, etc) were estimated at $56 billion (Anderson and others 2003).

Obesity is not just affecting the adult population. The prevalence of obesity in children is also at an all time high. In 1999 to 2000, more than 15% of 6- through 19-year-olds were overweight (Ogden and others 2002). An additional 15% of children and 14.9% of adolescents were at risk for overweight (BMI for age between the 85th and 95th percentile) (NIH 2003). The percentage of children (6 to 11 years) with a body mass index greater than the 95th percentile increased from 7.5% to 10.7% between the years 1980 to 1990. The percentage of teens (12 to 17 years) in the same category increased from 5.7% to 10.8% (Troiana and others 1995). Overweight has increased by 5% among 12- through 19-year-olds from 10.5% to 15.5% between NHANES III and NHANES 1999 to 2000 (Ogden and others 2002). Between 1986 and 1998, the National Longitudinal Survey of Youth (n=8270) showed that overweight increased significantly and steadily among African American, Hispanic, and White children aged 4 to 12 years (Strauss and Pollack 2001).

There was a significant increase in overweight among non-Hispanic black and Mexican-American adolescents between NHANES III and NHANES 1999 to 2000 (Ogden and others 2002). The prevalence (95% confidence interval) of overweight for non-Hispanic black adolescents increased from 13.4% (10.8% to 16.0%) to 23.6% (19.4% to 27.8%) between 1988 to 1994 and 1999 to 2000 (Ogden and others 2002).

Health Consequences

Obesity has become one of the major public health concerns in western society. Obesity has been linked to many conditions including type 2 diabetes, cardiovascular disease, hypertension, stroke, and cancer. An estimated 300,000 deaths each year are credited to obesity, second only to smoking-related deaths in respect to preventable deaths (Anderson and others 2003, Dishman 2000). Researchers have found that obesity may cause 14% of all cancer deaths in men and 20% of all cancer deaths in women (Friedrich 2003). It is estimated that 90,000 cancer deaths each year could be prevented if a healthy weight was maintained (Calle and others 2003). A study found that people whose BMI was 40 or more had death rates from cancer that were 52% higher for men and 62% higher for women than rates for normal-weight men and women (Huang and others 1997).

Adults are not only seeing the health consequences of being obese, children are also experiencing the risks of this lifestyle. Childhood obesity has been associated with an increase chance of severe obesity in adulthood as well as hypertension, dyslipidaemia, chronic inflammation, increased blood clotting tendency, and hyperinsulinaemia (Ebbeling and others 2002, Ferraro and others 2003). For example, overweight children were 2.4 times as likely to have high blood cholesterol, 4.5 times as likely to have high systolic blood pressure, 7 times as likely to have high blood triglyceride concentrations, and 12.6 times as likely to have hyperinsulinemia during fasting (Freedman and others

1999). Almost 60% of the overweight children studied in the Bogalusa Heart Study had at least one cardiovascular disease risk factor (Freedman and others 1999).

Definitions of Obesity and Overweight

Obesity can be defined as the state in which a person has an excess amount of body fat. Obesity can be assessed by calculation of the body mass index (BMI). The BMI is used as an index of body fat and is calculated by dividing a person's weight in kilograms by the square of their height in meters. For adults "normal weight" equates with a BMI between 18.5 to 24.9 kg/m^2, "overweight" equates with a BMI between 25.0 to 29.9 kg/m^2, and an adult is considered "obese" with a BMI of 30 kg/m^2 or greater (CDC 2003a). The term "obese" is not used to classify excess weight in children. In children, BMI is plotted on age and gender specific growth charts. A BMI between the 5^{th} and 85^{th} percentile for age and gender is considered "normal". A BMI between the 85^{th} and 95^{th} percentile is considered "at risk for overweight", while a BMI greater than or equal to the 95^{th} percentile is considered "overweight" (CDC 2003).

Populations at Risk

Different segments of the American population have a higher occurrence of overweight and obesity. African Americans, individuals of low socioeconomic status, individuals living in rural areas, and those living in the south have been reported as having higher incidences of obesity.

Obesity occurs at a higher rate in African-Americans than in whites, especially in African-American women (Mokdad and others 1999). Middle-aged African American women have among the highest incidences of obesity of any segment of the population.

In US children aged 6 to 18 years, data from NHANES III (n=6110) showed ethnicity was a significant risk factor for obesity. Compared to Caucasians, African American (OR=1.2) and Mexican American children and adolescents were at a higher risk (OR=1.4) for obesity and overweight (95% CI) (Wang 2001). Data from the 1996 iteration of the Medical Expenditure Panel Survey, a nationally representative sample of the US civilian, non-institutionalized population, showed that in 1862 children aged 6 to 11 years Black (OR=2.26; 95%CI) and Mexican American (OR=1.99; 95% CI) children had a greater chance of being overweight compared with Caucasian children (Haas and others 2003). In the National Longitudinal Survey of Youth (n=8270) the number of children aged 4 to 12 years with a BMI greater than the 85th percentile increased significantly from 1986 to 1998 among African American and Hispanic children, but not significantly among Caucasian children (Strauss and Pollack 2001).

Low socioeconomic status is also associated with a higher incidence of obesity. For adults, there is an inverse relationship between level of education and the incidence of obesity (Cullen and others 2002, Mokdad and others 1999). Data from 499 adults participating in the Seasonal Variation of Blood Cholesterol Study (SEASONS), showed that higher education was significantly associated with lower risk of obesity; the odds ratio for subjects with at least a bachelor’s degree was 0.36 (95% CI), relative to those with a high school education or less (Yunsheng and others 2003). Obesity occurs at the highest rates in populations where poverty is high and education is low (Drewnowski and Specter 2004). In a study of 2791 children aged 8 to 16 years, family income was significantly higher among those in the nonoverweight group compared with the overweight group (Dowda and others 2001). Data from the 1996 Medical Expenditure Panel Survey, showed that 1862 children aged 6 to 11 years from families with lower parental educational attainment (OR=1.38; 95% CI) and from households with an income below 125% of the federal poverty level (OR=1.43; 95% CI) had a greater risk of overweight compared to those children that came from a more advantaged household (Haas and others 2003).

Individuals living in rural areas also may have higher occurrences of obesity than their urban and suburban counterparts. In general, rural communities have higher rates of chronic illness and disability and poorer overall health status than urban communities (NIH 2004). In a study looking at third and fourth grade children (n=2,113) in North Carolina and the effects of a rural versus urban setting, rural children had about a 55% increased risk for developing obesity compared with children in an urban setting (McMurray and others 1999).

The South also has a higher rate of obesity than other regions of the country. A study looking at the increase in overweight in a nation wide sample of children found that overweight increased the fastest with minorities and southerners (Strauss and Pollack 2001). In 2003 Alabama ranked first in the nation with the highest prevalence of obesity in adults (CDC 2004).

Clearly, individuals who are African American, of limited income, of limited education, and living in the rural south are at a seriously greater risk for obesity and ultimately obesity-related diseases as well as a lower quality of life than others who do not fall into one or all of these categories.

Causes of Obesity

There is no debate between professionals on children's need for adequate nutrition and an active lifestyle. So why are today's children becoming obese and at such alarming rates? To answer this question we need to determine what factors contribute to excessive energy intake and inadequate energy expenditure, each of which is discussed hereafter.

Decreased Energy Expenditure

Several studies show that children's level of physical activity has decreased as technology and automation have increased. Children today are engaged in increased amounts of sedentary leisure time behavior such as television watching, computer play, and video game playing and less time spent doing more physical activities and thereby expending energy. In a study involving 54 children aged 8 to 12 years in a rural Appalachian Kentucky community, overweight children reported significantly more episodes of video/computer play than non-overweight children (Crooks 2000). In this same study both overweight and nonoverweight children reported significantly more episodes of low-intensity activities compared to high-intensity activities (Crooks 2000).

According to NHANES III more than half of the children in the United States watch more than two hours of television a day (Crespo and others 2001). Television watching has been inversely related to obesity. Females aged 8 to 16 years (n=1455) who engaged in 4 or more hours of television watching per day were significantly more likely to be overweight than those females who watched less and children that watched less than one hour a day had the lowest incidence of obesity (Crespo and others 2001, Dowda and others 2001).

Parents have many influences over their children including their physical activity patterns. In a study that looked at the physical activity patterns of 428 children from lean and obese parents, children aged 4 to 5 years from obese/overweight families (n=200) preferred more sedentary activity and reported engaging in more sedentary activities than children from lean families (n=228) (Wardle and others 2001). Children with an overweight father and/or an overweight mother were significantly more likely to be overweight than those children who had lean parents (Dowda and others 2001).

Physical activity and sedentary behaviors may also be related to a child's food choices. Children (n=498) aged 9 to 12 years who did more physical activity had significantly higher intakes of energy, calcium, iron, zinc and fiber than children who did less activity; however, these higher nutrient intakes were not associated with increased body weight (Johnson-Down and others 1997). Television watching is not only replacing a more active choice of leisure time activity, watching television may also be influencing American children to make poor food choices. A content analysis showed that food is the most advertised product during children's television programs (Coon and Tucker 2002). Fast food and highly sweetened products make up the majority of these food advertisements (Coon and Tucker 2002). There have been purchase request studies done on the time a child spends watching television and the amount of requests the child makes to the mother regarding specific food items. Positive correlations between the number of hours watching television and the number of food requests made to the mother along with the amount of those specific foods found in the house were found (Coon and Tucker 2002). In addition, the mother's increase in television watching increased the likelihood of compliance with her child's request (Coon and Tucker 2002).

Increased Energy Intake

In addition to decreased physical activity and more inactive leisure activities, obesity can be caused from an increased energy intake. Several factors influence energy intake. These factors include foods away from home, portion sizes, meal pattern and frequency, and overall poor diet quality.

Foods Eaten Away from Home

The lifestyle of the average family has changed over the last several decades. Families are eating more meals away from home. In 2004 Nicklas and others reported that children consume one-quarter of their meals away from home, and fast food restaurants accounted for more than one-half of the meals away from home. Data from the Bogalusa Heart Study (n=1584) showed that the percentage of children (10 years old) consuming dinner at home significantly decreased from 89% in 1973 to 1974 to 76% in 1993 to 1994 (Nicklas and others 2004b). Also, the percentage of children consuming dinner outside the home significantly increased from 5% to 19% over the same time period (Nicklas and others 2004b). Research has showed a connection between obesity and the source from which the food is obtained. Using data from the 1994 to 1996 CSFII (n= 16,103), Binkley and others (2000) found significant trends between obesity and increased consumption of foods away from home, particularly fast foods. Data from 499 adults participating in the SEASONS study showed that a higher proportion of breakfast eating away from home was significantly associated with an increase risk of obesity in adults (Yunsheng and others 2003). Those consuming breakfast out frequently had more than 2 times the risk of obesity than those individuals who rarely ate breakfast away from home (Yunsheng and others 2003). This same data also showed that both breakfasts and dinners eaten away from home were significantly higher in total energy, percentage of energy from total fat and percentage of energy from saturated fat and lower in percent of energy from fiber compared with breakfast or dinners eaten at home (Yunsheng and others 2003). Lunches eaten away from home were also significantly higher in total energy and percent of energy from total fat (Yunsheng and others 2003).

Portion Sizes

Increases in portion size and the concept of getting more for less also may be contributing factors to the increased prevalence of obesity. In 1957 a typical fast food hamburger contained about 1 oz of meat, while in 1997 burgers are weighing up to 6 ounces (Nicklas and others 2004a). With the increasing portion sizes being served Americans have demonstrated a relative inability to regulate the amount of food consumed. The American Institute for Cancer Research commissioned several surveys investigating consumers' perceptions of the portions they are served. The surveys found that 78% of the respondents believed that the type of food they eat is more important for weight management than the amount of food. In addition, 62% were unaware that portions served in restaurants have increased in size during the past 10 years and despite the amount served, 67% said they finish their entrees most of the time or always (Rolls 2003). Customers appreciate a good value and restaurants understand this and as a result offer more food for less money. Because food is only a small percentage of the cost of a restaurant meal, giving customers more food is an excellent economic strategy to increase total sales. Therefore "supersizing," is very common, especially in fast-food establishments. For example, when ordering a cheeseburger, spending $1.57 more can buy 600 extra calories; for French fries, 64 cents can buy 330 more calories; and for some soft drinks, 37 cents can buy 450 more calories (Rolls 2003). To discuss further, a traditional McDonald's meal that contains a hamburger, small French fries, and a 16 oz soft drink has 627 calories and 19 grams of fat. The McDonald's Big Extra with cheese, supersized soft drink, and French fries has 1805 calories and 84 grams of fat (Lieberman 2003).

Fast food restaurants are not the only ones increasing their portion sizes. Candy bars have tripled in size since the 1970s and an extra large movie theater popcorn with butter-flavored topping contains 1600 calories (Lieberman 2003). Larger portion sizes lead to increases in consumption. Research indicates that people will consume a larger portion of food or beverage from a "supersize" item particularly if they feel that the price per ounce is less (Wansink 1996).

Meal Patterns and Frequency

Changes in meal patterns and meal frequency in children such as increases in snacking and decreases in the frequency of the traditional family sit down meal also appear to be contributing to increases in childhood obesity (Nicklas and others 2004a). Data from the Bogalusa Heart Study (n=1584) found that the mean number of meals consumed per day significantly decreased from 3.01 to 2.81 in 10 year old children

(Nicklas and others 2004a). In an investigation of the effects of the frequency of feeding on the relationship between perceived hunger and subsequent food intake seven obese men were given 33% of each subjects' average daily energy requirement comprised of 70% carbohydrate, 15% protein, and 15% fat. The food was administered either as a single meal or divided evenly over 5 meals given hourly. Five hours after the first meal a test meal was given to determine differences in the amount of energy that was consumed between the two eating patterns. The subjects who received the single meal consumed significantly (27%) more energy in the test meal compared to the subjects that received the multiple meals. Although there was a difference in energy intake there were no significant changes in hunger ratings between the two test groups (Speechly and others 1999). Data from the SEASONS study involving 499 adults showed that the number of eating episodes was inversely associated with the risk of obesity (Yunsheng and others 2003). In comparison with subjects who reported 3 or fewer eating episodes per day, subjects who reported four or more eating episodes per day experienced a significant 45% lower risk of obesity (95% CI: 0.33, 0.91) (Yunsheng and others 2003).

Another pattern increasingly seen in children is skipping breakfast. Total amount of breakfast consumption has been negatively associated with obesity (Nicklas and others 2003). Data from the SEASONS study showed that skipping breakfast was associated with a significantly higher risk of obesity in adults. Subjects who regularly skipped breakfast had 4.5 times the risk of obesity than those who regularly consumed breakfast (95% CI: 1.57, 12.90) (Yunsheng and others 2003). This study also found that subjects who skipped breakfast at least once during the one year study had 1.34 times the risk of obesity than those who always consumed breakfast (95% CI: 0.81, 2.20) (Yunsheng and others 2003).

Poor Diet Quality

Several dietary practices are associated with increased energy intakes among children, including increased consumption of meals away from home, increased portion sizes, increased snacking and decreased frequency of the traditional family meals. While these dietary practices have promoted an increase in energy consumptions and are associated with an increase in the prevalence of overweight in children, they are also associated with detrimental effects on the quality of the diets of children. The food guide pyramid recommends 6 to 11 servings of grains, 3 to 5 servings of vegetables, 2 to 4 servings of fruits, 2 to 3 servings of dairy, 2 to 3 servings of meat, and recommends using fats, oils, and sweets sparingly. However, many children are not meeting these recommendations nor are they meeting the US dietary guidelines. For example macronutrient intakes and food consumption patterns were assessed in 54 children aged 8 to 12 years in a rural Appalachian Kentucky community. Both boys and girls were statistically significantly below the recommendation for intake of protein (13.46% kcal from protein) and above the recommendation for intake of fat (36.31% kcal from fat) including higher than recommended saturated fat intake (Crooks 2000). Fiber consumption for 54 children age 8 to 12 years was significantly below the recommendation with the children consuming only about half the recommended amount (Crooks 2000). Data from the Continuing Survey of Food Intake by Individuals conducted from 1994 to 1996 and the Supplemental Children's Survey conducted in 1998 demonstrated that fast-food consumption was significantly and inversely associated with children's consumption of fiber, milk, fruits, and nonstarchy vegetables (Bowman and others 2004). In a study of the comparison of 110 African American and Caucasian children aged 7 to 14 years from Birmingham, AL, average daily intake for all the food groups was below recommendations except for the grain group (Brady and others 2000). Only 20% of the children met US Food Guide Pyramid's recommendation for vegetables, 5% met the recommendations for fruit, 9% met dairy recommendations, and 26% obtained the recommended servings of meat (Brady and others 2000).

The food guide pyramid recommends that consumption of sugar and added fat should be limited because these compounds are low in nutritional value. US consumption of sweetener, including sugar, corn syrup, and dextrose, from the 1970s through 1990s has increased from 120 to more than 160 pounds/person/year (Lieberman 2003). Many children are eating excessive amounts of low-nutrient-dense foods that are high in sugar and fat. A nationwide survey reported that low nutrient dense foods contributed more than 30% of daily energy in the diets of 8 to 18 year old US children and adolescents (n=4852), with sweeteners and deserts together accounting for nearly 25% (Kant 2003). The average daily consumption of refined sugar was 120 g (22% of total energy from sugar) for 54 children aged 8 to 12 years in a rural Kentucky community (Crooks 2000). Cookies, quick breads, cakes, yeast breads and donuts are among the top ten sources of energy in the diet of US children (n=4008) aged 2 to 18 years as determined from the Continuing Surveys of Food Intakes by Individuals (CSFII) (Subar and others 1998). One study indicated that fat and added sugar combined to make up 46% of the total diet of 110 African American and Caucasian children aged 7 to 14 years from Birmingham, AL (Brady and others 2000). In the Bogalusa Heart study the total amount of food/beverage consumed, particularly from snacks and the total consumption of low quality foods were significantly positively associated ($r^2 = 0.04$) with overweight (Nicklas and others 2003). Furthermore, high consumption of sweets was significantly positively associated ($r^2 = 0.05$) with overweight (Nicklas and others 2003). Excess consumption of low-nutrient dense foods has been associated with decreased folate, vitamin B6, calcium, and magnesium intakes in children aged 8 to 18 years (Kant 2003).

While sugars and fats are being consumed in excess amounts by many children, fruits and vegetables are being consumed in quantities below recommendation (Brady and others 2000, Crooks 2000, Lee and Birch 2002). For example, in a national sample of high school students (n= 15,349) 76.1% of the students did not consume the recommended 5 servings of fruits and vegetables a day (Lowry and others 2002). Data collected from 194 fifth grade children (54% of this sample were either "overweight" or "at risk of overweight") in rural Mississippi showed that these children averaged one fruit serving and ½ vegetable serving per day (Davy and others 2004). Also, on the day of the 24 hour recall 45% of the children reported consuming no servings of fruits and 59% reported consuming no servings of vegetables (Davy and others 2004). Based on the 1999 to 2000 national average, Healthy Eating Index (HEI) component mean scores for children 7 to 10 years were 3.9 for fruits and 5.0 for vegetables. These scores are based on a scale of 0 to 10 with a score of 10 indicating that the recommended servings are met.

Poor diet quality, specifically inadequate fruit and vegetable consumption can lead to serious health implications. Diets rich in fruits and vegetables are associated with reduced risk of coronary heart disease (Hu and Willett 2002). In a large study with 84,251 women and 42,148 men, a significant inverse association between total fruit and total vegetable consumption, specifically green leafy vegetables and vitamin C rich fruits and vegetables, and coronary heart disease was reported (Joshipura and others 2001). Also, participants in the top quintile of fruit and vegetable intake had a 20% lower risk for coronary heart disease (multivariate relative risk, 0.80 CI) than did those in the lowest quintile (Joshipura and others 2001). A Finnish study found, in 5133 adults, an inverse association between vegetable consumption and coronary artery disease (CAD) (Knekt and others 1994). Fruit and vegetable consumption also has been shown to increase longevity in men (Rissanen and others 2003, Wright and others 2002). Diets that are low in whole grains, vegetables, and fruits are likely to contribute to overweight and obesity as well as cancer (James 2002).

The specific components found in fruits and vegetables responsible for the reductions in disease risk are unknown; however, suspected components include phytochemicals. Phytochemicals are chemicals that are produced by plants. Currently, the term is being used only for those plant chemicals that may have health-related effects but are not considered essential nutrients such as proteins, carbohydrates, fats, minerals, and vitamins**.** Research has shown that lignans, one of thousands of phytochemicals, may be associated with decreased risks of cardiovascular disease along with cancers such as breast, colon and prostate (Adlercreutz and Mazur 1997, van der Schouw and others

2002). Fruits and vegetables also contain vitamins, minerals, and fiber which are essential nutrients with many functions throughout the body. Many nutrients in fruits and vegetables, such as dietary fiber, folate, potassium, flavonoids, and antioxidant vitamins, have been associated with reduced risk for cardiovascular disease (Hu and Willett 2002).

Income has an affect on diet quality because the prices of foods and income of the individual affect the choices they make when purchasing food. Poverty and obesity may be connected in part by the low cost of energy dense foods and may be reinforced by the high palatability of sugar and fat (Drewnowski and Specter 2004). With a higher income one can choose higher quality foods. Two community based interventions studied the effects of price reductions on purchasing rates of targeted foods. In 12 worksites and 12 secondary schools price reductions of 10%, 25%, and 50% applied to lower fat food choices in vending machines resulted in increases in sales of 9%, 39%, and 93% respectively (French 2003). The results of the second part of that study found that a 50% price reduction in fresh fruit and baby carrots resulted in a four-fold increase in fresh fruit sales and a two-fold increase in baby carrot sales (French 2003).

Higher Healthy Eating Index (HEI) scores, which rate diet quality, have been associated with increased income and education; a higher score represents a better quality diet. African-Americans were found to have the lowest HEI score (Drewnowski and Specter 2004).

Food insecurity is often found in low income households. A study looking at household security and nutritional status of Hispanic children in fifth grade found that fruit, vegetables, and milk consumption were significantly lower in the food insecure households than in food secure households (Matheson and others 2002).

Lower food expenditures, low fruit and vegetable consumption, and overall low diet quality are results of poverty and food insecurity (Drewnowski and Specter 2004). In rural areas significantly more women lived in poverty, reported poorer health quality, and had a greater incidence of obesity (Ramsey 2002). Alabama's overall health status of children ranks among the lowest in the country (47^{th}). Alabama is 43^{rd} in percentage of children in single parent families, and 37^{th} in percentage of children in poverty (Alabama Kids Count 1998). Thus, children from limited resource families living in rural Alabama are at high risk for poor quality diets.

Justification

Although childhood obesity is on the rise which may lead us to believe that children are over nourished this does not appear to be the case. Children's consumption of low-nutrient/high energy dense foods may be contributing to a society of overweight and undernourished children. Although several studies have examined children's dietary habits, studies to date have not evaluated diet quality, specifically fruit and vegetable consumption and its relation to body mass and the development of obesity in a high risk population. The purpose of this study was to examine body mass index along with fruit and vegetable consumption and selected nutrient intakes in a high risk population of primarily low income African American children living in rural Alabama.

Research Hypotheses

1. There are significant differences in servings of fruit intake among normal weight, at risk of overweight, and overweight children.
2. There are significant differences in servings of vegetable intake among normal weight, at risk of overweight, and overweight children.
3. There is a significant correlation between BMI and serving of fruit intake.
4. There is a significant correlation between BMI and serving of vegetable intake.
5. There is a significant correlation between change in BMI from fall to spring and the change in servings of fruit intake from fall to spring.
6. There is a significant correlation between change in BMI from fall to spring and the change in servings of vegetable intake from fall to spring.
7. There is a significant correlation between change in weight from fall to spring and change in servings of fruit intake from fall to spring.
8. There is a significant correlation between change in weight from fall to spring and change in servings of vegetables from fall to spring.
9. There is a significant correlation between servings of fruit intake and % kcal from total fat intake.
10. There is a significant correlation between servings of vegetable intake and % kcal from total fat intake.
11. There is a significant correlation between % kcal as sweets and servings of fruit intake.

12. There is a significant correlation between % kcal as sweets and servings of vegetable intake.
13. There are significant differences in the intakes of energy, potassium, vitamin C, folate, and β-carotene among normal weight, at risk of overweight, and overweight children.
14. There are significant correlations between BMI and intakes of potassium, vitamin C, folate and β-carotene
15. There are significant correlations between % kcal as sweets and intakes of potassium, vitamin C, folate, and beta carotene.

CHAPTER III

FRUIT AND VEGETABLE INTAKES AND BODY MASS INDEX OF PRIMARILY LOW-INCOME AFRICAN AMERICAN CHILDREN LIVING IN RURAL ALABAMA

ABSTRACT

Fruit and vegetable intakes among primarily low-income African American elementary school-aged children living in three rural counties (Bullock, Macon, and Wilcox) in Alabama were examined. Data were collected from 253 children in the fall 2002 and 310 children in the spring 2003. In the fall, 49.8% of the children were classified with a normal BMI, 16.2% were classified as at risk, and 34.0% were classified as overweight using CDC growth charts and classification guidelines. In the spring, 51.6% were classified with a normal BMI, 16.5% were classified as at risk, and 31.9% were classified as overweight using CDC growth charts and classification guidelines. In the fall, servings of fruits differed significantly between the at risk and overweight children, with the overweight children consuming significantly more fruits than the at risk. Fruit intake did not differ significantly among groups in the spring, however. Fruit intake averaged about one and one quarter servings per day with only 23% of children meeting minimum recommended intakes. About 7% of the children failed to consume any fruits. No significant differences were found among groups for servings of vegetables consumed in the fall or spring. Vegetable intake averaged about one and one quarter servings per day.

About 9% of children met the minimum recommendations for vegetable intake; about 5% of the children failed to consume any vegetables. No significant correlations were found between change in servings of vegetables and change in BMI or weight from fall to spring or between change in serving of fruits and change in BMI or weight from fall to spring. Folate intake as a percent of the Recommended Dietary Allowances (RDA) was below recommendations at 80% for all children. Intakes of potassium were also below the adequate intake at 46%. Intakes of vitamin C exceeded the RDA at 291%. The percent of children not ingesting two-thirds of intake recommendations for folate was 46%, for potassium was 80%, and for vitamin C was 21%. The at risk children had significantly lower potassium intake than the normal and overweight children in the fall but not spring. The at risk children consumed significantly less folate than the overweight children in the fall. No significant correlations were found between BMI and intakes of potassium, vitamin C, folate and beta carotene. Children consumed about 28% of energy from sugars. Significant negative correlations were found between servings of fruit and percent of energy as sweets and between servings of fruits and percent of energy as fat. These findings suggest that this population is not consuming adequate daily servings of fruits and vegetables nor adequate recommended amounts of folate and potassium.

INTRODUCTION

The prevalence of overweight among children and adolescents in the United States has been steadily increasing over the past four decades (Troiana and others 1995). Childhood obesity has been associated with an increased chance of severe obesity in adulthood as well as hypertension, dyslipdaemia, chronic inflammation, increased blood clotting tendency, and hyperinsulinaemia (Ebbeling and others 2002).

Overweight and obesity does not affect all segments of the population equally. Several factors put populations at higher risks. African Americans children and adolescents have higher incidences of obesity when compared to white children and adolescents (Hedley and others 2004). Along with ethnicity, low socioeconomic status is associated with a higher incidence of obesity. Children of lower socioeconomic status are at a higher risk of becoming overweight when compared to children of higher socioeconomic status (Strauss and Knight 1999, Wang 2001).

The prevalence of obesity also differs based on the geographical region and setting (urban versus rural) in the United States. Individuals living in rural areas have higher occurrences of obesity than those living in other areas of the country. In a study set in North Carolina rural children had about a 55% increased risk for developing obesity compared with children in an urban setting (McMurray and others 1999). In rural areas significantly more women lived in poverty, reported poorer health quality, and had a greater incidence of obesity than in urban areas (Ramsey and Glenn 2002). Also, southern regions of the United States have higher rates of obesity compared to other regions of the country. Alabama has the highest prevalence of obesity in the United States according to a 2003 survey (CDC 2003). Alabama's overall health status of children also ranks among the lowest in the country (47^{th}) (Alabama Kids Count 1998).

Several factors contribute to inadequate energy expenditure and excessive energy intake; both of which contribute to weight gain and obesity. Children today are engaged in increased amounts of sedentary leisure time behavior such as television watching, computer play, and video game playing and less time spent doing more physical activities and thereby expending energy. In addition to decreased physical activity and more inactive leisure activities, obesity can be caused from an increased energy intake. Several factors influence energy intake. These factors include foods away from home, portion sizes, meal pattern and frequency, and overall diet quality.

Many children are not meeting the recommendations set by the USDA's Food Guide Pyramid nor are they meeting the US dietary guidelines. For example, boys and girls living in a rural Appalachian Kentucky community have been shown to consume inadequate amounts of both protein and fiber, but consume fat (both total and saturated) in amounts above recommendations (Crooks 2000). In a national sample of high school students 76.1% of the students did not consume the recommended 5 servings of fruits and vegetables a day (Lowry and others 2002).

Lower food expenditures, low fruit and vegetable consumption, and overall low diet quality are results of poverty and food insecurity (Drewnowski and Specter 2004). Thus, children from limited resource families living in rural Alabama are at high risk for poor quality diets. Although childhood obesity is on the rise which may lead us to believe that children are over nourished this does not appear to be the case. Children's consumption of low-nutrient/high energy dense foods may be contributing to a society of overweight and undernourished children. Although several studies have examined children's dietary habits, this study is among the first to examine body mass index along with fruit and vegetable consumption and selected nutrient intakes in a high risk population of primarily low income African American children in rural Alabama.

SUBJECTS AND METHODS

Subjects

About 700 primarily African American children aged 9 to 13 years from three rural Alabama counties (Macon, Bullock, and Wilcox) were given information about participation in this study. In Bullock County children were recruited from five classrooms in Notasulga Elementary School (n=34), one classroom in South Macon Elementary School (n=23), one classroom in St. Joseph Catholic Elementary School (n=10), five classrooms in Tuskegee Public Elementary School (n=94), and four classrooms in Washington Public Elementary School (n=94). In Wilcox County, children were recruited from four classrooms in Ervin Elementary School (n=91) and four classrooms in Hobbs Elementary School (n=83). The percentage of the population that was African Amercian in these schools ranged from 86% to 100%. A large percentage of children in these counties are from families of low income. These counties are above the state average for the percent of children in poverty (Bullock, 39.4%; Macon, 44.1%; Wilcox, 50.7%). In these counties the percentage of the population receiving food stamps ranged from 22.5% to 36.3%.

Children were recruited through oral announcements made in 4-H programs in these counties. Incentives (small toys) were provided for the children's participation. Children and parents filled out assent and consent forms respectively. The study was approved by the Institutional Review Board for the Use of Human Subjects in Research at Auburn University. Anthropometric, dietary, and lifestyle information was obtained. However, this study, as part of a larger study, only evaluated anthropometric and dietary assessments of the children.

Anthropometric Assessment

Heights and weights of each participant were collected twice throughout the project, at the beginning (October to November 2002) and at the end (April to May 2003), using standard techniques. Children's weights were measured in private without heavy shoes and clothing such as coats and sweatshirts. A medical scale with a fixed height rod (Detecto, Webb City, MO) was used to measure the children's weight and height. The heights and weights were used to calculate body mass index (BMI) of each child. The BMI was then used to classify each child as of normal weight, at risk for overweight or overweight using the National Center for Health Statistics gender specific BMI-for-age growth charts (CDC 2003).

Dietary Assessment

Diet quality was assessed using the Kids Food Questionnaire which was developed by Block Dietary Data System Berkley Nutrition Services (Berkley California). The Kids' Food Questionnaire is a self-administered food frequency questionnaire developed for children ages 8 to13 years. Diet quality was assessed twice throughout the project (Fall and Spring). This particular study used only the Kids Food Questionnaires for dietary assessment but 3-day diet records were also collected for use in the larger study and also to validate the Kids Food Questionnaire.

The Kids' Food Questionnaire assesses frequency of consumption of specific foods and the portion size of each food. Frequency was addressed, for example, by asking how many times a day/week do you consume a given food item. Children were asked to indicate their portion sizes as small, medium, or large based on pictures provided to the children as a visual reference. Researchers read the Kids Food Questionnaires aloud to the children and were available to assist and answer questions when needed.

Statistical Analysis

The completed Kids' Food Questionnaires were sent to Block Dietary Data Systems (Berkeley, CA) for analysis. Statistical analysis was conducted using JMP (SAS Institue Inc., Cary NC). Log transformation was applied to values if needed to normalize skewed distributions. Untransformed data are presented as mean ± standard error (SE) in tables.

Analysis of variance (ANOVA) was used to determine statistical differences in BMI, energy, servings of fruits, servings of vegetables, potassium, vitamin C, folate, and beta carotene among children whose BMI was classified as normal weight, at risk of overweight, and overweight. Statistically significant findings using analysis of variance were followed with a Tukey Multiple Comparisons Test. A p-value of <0.05 was used to indicate statistical significance. Correlations were used to determine associations between servings of fruits and vegetables and BMI, servings of fruit and vegetable and % kcal from fat, and servings of fruits and vegetables and % kcal as sweets. Correlations were also used to determine associations between potassium, vitamin C, folate, and beta carotene and % kcal as sweets; as well as between potassium, vitamin C, folate, beta carotene and BMI. In addition, correlations were used to determine associations between changes in children's weight and BMI from fall to spring and changes in the children's fruit and vegetable consumption between fall and spring.

RESULTS

Children aged 9 to 13 years old from nine schools in three rural Alabama counties (Bullock, Macon, and Wilcox) participated in the study. Income data were not available for participants; however, information documenting the percentage of children at each of the schools receiving free or reduced price lunches was obtained. In Bullock County, 93% of students at South Highland Elementary School received free or reduced price lunches. The percentage of students at DC Wolfe, Notasulga, South Macon, Tuskegee Public and Washington Public Elementary Schools in Macon County who received reduced priced or free lunches were 95%, 75%, 97%, 79%, and 92% respectively. Data for St. Joseph Catholic Elementary School are unknown. In Wilcox County, 99% of students at both Ervin and Hobbs Elementary Schools receive reduced priced or free lunches (Great Schools 2004).

In fall 2002, 253 food frequency questionnaires were analyzed for nutrient intakes. Of the 253 children with complete food frequency questionnaires, 126 (49.8%) children were classified with a normal BMI, 41 (16.2%) were classified as at risk, and 86 (34.0%) were classified as overweight using CDC growth charts and classification guidelines. Of the 253, 6 (2%) were Caucasian and 247 (98%) were African American; 114 (45.1%) were male and 139 (54.9%) were female. The mean (± SE) age of the children was 10.3 ± 0.1 years (range 9 to 13 years); mean age did not significantly differ among children when classified by BMI. BMI differed significantly ($p<0.0001$) among groups (normal weight 17.4 ± 0.3 kg/m^2, at risk 21.7 ± 0.5 kg/m^2, and overweight 28.8 ± 0.3 kg/m^2) as expected due to study design (Table 1).

In spring 2003, 310 food frequency questionnaires were analyzed for nutrient intakes. Of the 310 children with complete food frequency questionnaires, 160 (51.6%) were classified with a normal BMI, 51 (16.5%) were classified as at risk, and 99 (31.9%) were classified as overweight using CDC growth charts and classification guidelines. Of the 310 children, 7 (2%) were Caucasian and 303 (98%) were African American. Of the 310 children, 128 (41.3%) were male and 182 (58.7%) were female. The mean (± SE) age of the children was 10.7 ± 0.04 years (range 9 to 13 years); mean age did not significantly differ among children when classified by BMI. BMI differed significantly ($p<0.0001$) among groups (normal weight 17.8 ± 0.3 kg/m^2, at risk 22.3 ± 0.5 kg/m^2, and overweight 29.5 ± 0.5 kg/m^2) as expected based on study design (Table 2).

The mean (±SE) BMI of the children in each classification group are shown for the fall along with selective nutrient and food group data in Table 1 and for the spring in Table 2. Energy intake of at risk children was significantly ($p=0.004$) lower than that of the normal weight and the overweight children in the fall (Table 1). Energy intake did not differ significantly among classifications in the spring (Table 2).

Fruit and Vegetable Consumption

The children as a group did not meet the recommended two to four servings of fruits or three to five servings of vegetables. Servings of fruit averaged 1.3 ± 1.0 in the fall and 1.2 ± 1.1 in the spring. Servings of vegetables averaged 1.3 ± 1.3 in the fall and

1.2 ± 1.4 in the spring. Only 20% and 25% of the children met the recommended minimum fruit servings in the fall and spring, respectively and 7% and 10% of the children met the recommended minimum amount of vegetable servings in the fall and spring, respectively. In the fall 15 (6%) children reported consuming no servings of fruit and 12 (5%) reported consuming no servings of vegetables. In the spring 18 (6%) of the children reported consuming no servings of fruit and 22 (7%) reported consuming no servings of vegetables

Mean fruit and vegetable intakes in the present study were computed to Healthy Eating Index (HEI) component mean scores based on USDA's guidelines for The Healthy Eating Index: 1999 to 2000 (Basiotis and others 2002). HEI component scores range from 0 to 10 with 10 being the optimal value. The HEI component mean score for fruits was 4.8 and 4.4 in the fall and spring, respectively. The HEI component mean score for vegetables was 3.5 and 3.2 in the fall and spring respectively.

In the fall, serving of fruits differed significantly (p=0.006) between the at risk and overweight children, with the overweight children consuming significantly more fruits than the at risk (Table 1). Fruit intake did not differ significantly among groups in the spring, however (Table 2). No significant differences were found among groups for servings of vegetables consumed in the fall or spring (Tables 1 and 2).

A significant positive correlation was found between servings of fruit and BMI in the fall (r^2=0.02), but not the spring. No significant correlation was found between servings of vegetables and BMI.

Of the children that participated in the study, 164 children completed both fall and spring food frequency questionnaires. No significant correlations were found between change in servings of fruits and change in BMI from fall to spring, change in servings of vegetables and change in BMI from fall to spring, change in servings of fruits and weight change from fall to spring, or change in servings of vegetables and weight change from fall to spring.

Nutrient Intakes

Because fruits and vegetables are particularly good sources of some vitamins and minerals, selected nutrient intakes of the children as a group were compared with recommended intakes by the Food and Nutrition Board (FNB 1998, 2000). Folate intake as a percent of the Recommended Dietary Allowances (RDA) was below recommendations for fall (83% ± 45%) and spring (78% ± 43%) for all children. Intakes of potassium were also below the adequate intake recommendations for fall (44% ± 25%) and spring (47% ± 26%). Intakes of vitamin C exceeded RDA for fall (279% ± 212%) and spring (300% ± 255%). The percent of children not ingesting two-thirds of intake recommendations for folate was 43.1% in the fall and 48.7% in the spring, for potassium was 76.3% in the fall and 82.9% in the spring, and for vitamin C was 35.2% in the fall and 10% in the spring.

Tables 1 and 2 report selected nutrient intakes in the fall and spring, respectively. The at risk children had significantly lower ($p=0.006$) potassium intake than the normal and overweight children in the fall, but not spring (Tables 1 and 2). No significant differences were found among groups for intakes of potassium/100 kcal in the fall or spring. The at risk children consumed significantly less folate than the overweight children in the fall, but not the spring (Table 1). Intakes of vitamin C, vitamin C/100 kcal, folate/100 kcal, beta carotene, and beta carotene/100 kcal did not differ among groups in the fall (Table 1). In the spring, no significant differences were found among groups for intakes of potassium, potassium/100 kcal, vitamin C, vitamin C/100 kcal, folate, folate/100 kcal, beta carotene, and beta carotene/100 kcal.

Significant ($p<0.05$) negative correlations were found between potassium intake and % kcal as sweets in the fall ($r^2=0.02$) and spring ($r^2=0.02$). No other significant correlations were found between nutrients. No significant correlations were found between intakes of potassium, vitamin C, folate, or beta carotene and BMI in the fall or spring.

Fat and Sweet Consumption

The mean fat intake as a percent of total energy was 36% ± 7% in the fall and 35% ± 8% in the spring. The mean sweet intake as a percent of total energy was 27% ± 14% in the fall and 29% ± 15% in the spring.

No significant differences in % kcal from sweets were found among normal weight, at risk of overweight, and overweight children (Tables 1 and 2). The at risk children had significantly higher % kcal from fat than the normal weight and overweight children in the spring, but not the fall (Tables 1 and 2).

There was a significant negative correlation between servings of fruit and % kcal as fat in the fall ($r^2=0.03$) and spring ($r^2=0.08$). There was no significant correlation between servings of vegetable intake and % kcal as fat in the fall or spring.

Significant ($p<0.05$) negative correlations were found between servings of fruit and % kcal as sweets in the fall ($r^2=0.02$) and spring ($r^2=0.03$). Significant ($p<0.05$) negative correlations were also found between servings of vegetables and % kcal as sweets ($r^2=0.03$) in the fall, but not the spring. No significant correlations were found between % kcal as sweets and BMI or % of kcal as fat and BMI.

DISCUSSION

Poor diet quality, specifically inadequate fruit and vegetable consumption, can lead to serious health problems. Diets rich in fruits and vegetables are associated with reduced risk of coronary heart disease (Hu and Willett 2002). Other studies have noted an inverse relationship between fruit and vegetable consumption and coronary heart disease (Joshipura and others 2001, Knekt and others 1994). In 1997, an international review panel (World Cancer Research Fund–American Institute for Cancer Research) concluded that there was convincing evidence that high intakes of vegetables decreases the risk of certain cancers including those of the mouth and pharynx, esophagus, lung, stomach, colon, breast, and pancreas (World Cancer Research 1997). High fruit intake was also shown to decrease the risk of certain cancers (World Cancer Research 1997). Fruits and vegetables contain vitamins, minerals, and fiber which are essential nutrients with many functions throughout the body. Ingestion of many nutrients found in fruits and vegetables, such as dietary fiber, folate, potassium, flavonoids, and antioxidant vitamins, also has been associated with reduced risk for both cancer and cardiovascular disease (Hu and Willett 2002). Fruits and vegetables are crucial components of a child's diet.

Children's consumption of low-nutrient/high energy dense foods may be contributing to a society of overweight and undernourished children. Although several studies have examined children's dietary habits, studies to date have not evaluated diet quality and its relation to body mass index in a population with multiple risk factors for obesity. This study was among the first to examine body mass index along with fruit and vegetable consumption and selected nutrient intakes in a high risk population of primarily low income, African American children in rural Alabama.

Fruit and Vegetable Consumption

This population as a group consumed less than the recommended amounts of fruits and vegetables and excessive amounts of fats and sweets. Fruit intake averaged a little over 1 serving, and thus is below the food guide pyramid's minimum recommendation of 2 servings of fruits daily. Vegetable intake also averaged slightly over 1 serving, and below the food guide pyramid's minimum recommendation of 3 servings of vegetables daily. These findings are consistent with a study of 54 children ages 8 to 12 years from a rural Kentucky community which found that children consumed significantly fewer fruits (0.9 servings/day) and vegetables (1.8 servings/day) than recommended (Crooks 2000). A study of 194 fifth grade children in rural Mississippi reported similar findings with children consuming on average one fruit serving and ½ a vegetable serving per day (Davy and others 2004). The present study's findings are also consistent with a national sample of children and adolescents 2 to 19 years which reported that the mean daily servings from the fruit and vegetable groups were below minimum recommendations (Munoz and others 1997).

In the present study, 20% and 25% of the children met the recommended minimum fruit servings in the fall and spring, respectively, and 7% and 10% of the children met the recommended minimum vegetable servings in the fall and spring, respectively. These study percentages are below national averages for children 2 to 19 years of age. According to national findings, 30% of youth met fruit recommendations and 36% of youth met vegetable recommendations (Munoz and others 1997). However, the present study's findings are similar to those in a study of 110 children, 7 to 14 years old from Birmingham, AL, in which 20% of the children met recommendations for vegetables and 5% met recommendations for fruits in the Birmingham based study (Brady and others 2000).

Mean fruit and vegetable intakes in the present study were computed to Healthy Eating Index (HEI) component mean scores based on USDA's guidelines for The Healthy Eating Index: 1999 to 2000 (Basiotis and others 2002). HEI component scores range from 0 to 10 with 10 being the optimal value. The HEI component mean score for fruits was 4.8 and 4.4 in the fall and spring respectively. These scores exceed the 1999 to 2000 national average of 3.9 for children 7 to 10 years and 3.2 for children 11 to 14 years. The HEI component mean score for vegetables was 3.5 and 3.2 in the fall and spring, respectively. These values fall below the 1999 to 2000 national average of 5.0 for children 7 to 10 years and 4.9 for children 11 to 14 years.

In the present study, about 7% of children reported consuming no servings of fruit and about 6% reported consuming no servings of vegetables. These findings are lower than those reported for similar-aged children in Mississippi. Specifically, data collected from 194 fifth grade children (59% African American and 76% of children were eligible for free or reduced-cost breakfast and lunch) in rural Mississippi found 45% of the children consumed no servings of fruits and 59% reported consuming no servings of vegetables (Davy and others 2004).

Nutrient Intakes

Intakes of folate, and especially potassium were inadequate in this population. Mean folate intakes were greater than two-thirds, but less than 100%, of the RDA. Of the individual nutrients analyzed from the fall data, the normal weight and overweight children had significantly greater potassium intake than the at risk children; however, potassium intakes by all groups were less than 50% of the recommended amounts. Folate intake by the at risk children was also significantly less than that by the overweight children in the fall. Higher fruit intake by the overweight children versus the other children in the fall may partially explain this difference. Ingestion of other potassium rich foods also may have contributed to the difference. There were no significant differences among groups for intakes of vitamin C, folate, or beta carotene in the fall. There were no significant differences among groups for intakes of vitamin C, potassium, folate, or beta carotene in the spring. Other studies evaluating differences in nutrient intakes among children of varying body mass index have not been found in published literature.

Fruit and Vegetable Intakes and Relationship to Weight Gain and BMI

Fruit and vegetable consumption did not appear to be associated with weight gain and an excessive body mass index in this population. There were no significant differences in servings of vegetables among children with different BMI classifications during the fall or the spring and no significant correlation between vegetable intake and BMI. Similarly, no correlations were found between change in servings of vegetables and change in BMI or weight from fall to spring. There also were no significant differences in servings of fruits among children with different BMI classifications during the spring. However, while overweight children were found to consume significantly more servings of fruit than the at risk and a significant correlation was found between fruit intake and BMI in the fall, no significant correlations were found between BMI and fruit intake in the spring and no significant correlations were found between the change in servings of fruit and the change in BMI or weight from fall to spring. Only the Bogalusa Heart Study appears to have evaluated fruit consumption and weight in children. This study found consumption of fruits and fruit juices was negatively associated with overweight in 10 year old African American girls (Nicklas and others 2003).

Energy Intake and Fat and Sugar Consumption

While energy intake did not differ significantly among the normal, at risk and overweight children in the spring, energy intake by at risk children in the fall was significantly less than that of the overweight and normal weight children. This difference may be due to under reporting of intakes or may represent energy restriction (dieting) by the at risk children.

Fat and sweet intakes appear to be excessive for a majority of this population. Fat intake as a percent of total energy averaged about 36% which is above the recommendation of 25% to 35% of total energy as fat. A study of 54 children ages 8 to 12 years in a rural Kentucky community found similar results with the children consuming 36.3% of total energy as fat (Crooks 2000). These data are also consistent with data from a national sample of children and adolescents which reported that total fat averaged 35% of energy (Munoz and others 1997). Sugar intake averaged about 28% of energy in this study population. This value is also above recommendations which suggest <10% of total energy from sugars. These study findings for sugar intake also are consistent, but slightly higher than intakes of 22.5% of total energy intake from sweets for the 54 children in rural Kentucky (Crooks 2000). Study findings also are consistent with a national study which found children 8 to 18 years old received nearly 25% of daily energy from sweeteners and desserts (Kant 2003). When compared to another national sample of children 2 to 19 years old, the present study findings of about 28% of energy from sugars were above the 15% of energy from added sugars from the national sample (Munoz and others 1997). Other studies have supported that consumption of low nutrient dense foods are contributing excessive amounts of energy to children's diets. A national study reported that low nutrient dense foods contributed more than 30% of the daily energy of children 8 to 18 years old (Kant 2003). Moreover, in a study of 110 children 7 to 14 years based in Birmingham, AL, consumption of foods making up the "tip" of Food Guide Pyramid (including discretionary fat and added sugar) contributed 46% of total energy (Brady and others 2000).

Although sweets appear to make up a large portion of the children's diets in the present study, no associations between BMI and % kcal as sweets were found. Similarly no significant difference among groups (normal weight, at risk of overweight, and overweight) were found for % kcal from sweets. These findings are consistent with a study of children age 6 to 11 years from CSFII and NHANES which found no association between intake of added sugars and BMI (Storey 2003).

The relatively high intake of sugar in the diets of the children in the present study appears to be negatively impacting fruit and vegetable consumption. Significant negative correlations were observed between servings of fruit and percent of total energy as sugars in both the fall and spring. A significant negative correlation between servings of vegetables and percent of total energy as sweets also was observed in the fall, but not the spring. A national study of 8 to 18 year old children reported that mean intake of fruit and vegetable declined with increased amounts of low nutrient dense foods in both boys and girls (Kant 2003).

Although no significant correlation was found between % kcal as fat and BMI, fat intakes may have affected fruit consumption. Servings of fruit were negatively correlated with % kcal as fat. This finding is consistent with those of Lee and Birch (2002) who found that girls consuming 20 to 30% kcal from fat had diets that were higher in fruit than those consuming a diet higher in fats. In the spring, the at risk children had significantly higher % kcal from fat than the normal and overweight children. The at risk children also had significantly lower servings of fruit intake than the overweight children, however these results were found in the fall, but not the spring. No significant correlations were found between servings of vegetables and % kcal as fat.

Recommendations

African American children living in rural areas of Alabama are not meeting national recommendations for fruit and vegetable consumption. The inadequate intakes of fruits and vegetables may be compromising their nutrient status, particularly potassium and folate. This population is also consuming excessive amounts of their total energy from low nutrient dense foods, particularly those high in sugar and fat. It is crucial to teach children to make food selections that replace excessive fat and sugar in their diets with high nutrient dense foods, such as fruits and vegetables.

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Table 1: Energy, Fruit and Vegetable, and Selected Nutrient Intakes of Normal Weight, At Risk of Overweight, and Overweight Children in the Fall

	Normal (n=126)	At Risk (n=41)	Overweight (n=86)
Energy (kcal)	1702 ± 79[a]	1250 ± 139[b]	1802 ± 96[a]
% kcal from Sweets	28 ± 1	27 ± 2	26 ± 2
% kcal from fat	36 ± 1	36 ± 1	35 ± 1
Food Groups (Servings)			
Fruits	1.3 ± 0.1[ab]	0.9 ± 0.2[b]	1.6 ± 0.1[a]
Vegetables	1.3 ± 0.1	1.1 ± 0.2	1.5 ± 0.2
Nutrients			
Potassium			
mg	2161 ± 102[a]	1599 ± 180[b]	2288 ± 124[a]
mg/100 kcal	130 ± 3	125 ± 5	128 ± 3
% AI[d]	48 ± 2 [a]	36 ± 4 [b]	51 ± 3 [a]
Vitamin C			
mg	123 ± 9	104 ± 15	140 ± 10
mg/100 kcal	7.6 ± 0.5	8.1 ± 0.8	8.1 ± 0.6
% RDA[e]	273 ± 19	231 ± 33	312 ± 23
Folate			
µg	252 ± 12[ab]	202 ± 21[a]	263 ± 14[b]
µg/100 kcal	15.5 ± 0.5	16.4 ± 0.8	15.4 ± 0.5
%RDA[e]	84 ± 4[ab]	67 ± 7[a]	88 ± 5[b]
Beta Carotene			
mg	2540 ± 374	2988 ± 655	2800 ± 452
mg/100 kcal	148.0 ± 22.0	234.1 ± 38.7	153.9 ± 26.7

[a,b,c] Different letters in rows indicate significant ($p \le 0.05$) difference
[d] AI= Adequate Intake
[e] RDA= Recommended dietary allowance

Table 2: Energy, Fruit and Vegetable, and Selected Nutrient Intakes of Normal Weight, At Risk of Overweight, and Overweight Children in the Spring

	Normal (n=160)			At Risk (n=51)			Overweight (n=99)		
Energy (kcal)	1634	±	65	1538	±	115	1454	±	82
% kcal from Sweets	30	±	1	26	±	2	29	±	2
% kcal from Fat	35	±	1[b]	38	±	1[a]	34	±	1[b]
Food Groups (Servings)									
Fruits	1.2	±	0.1	1.4	±	0.2	1.2	±	0.1
Vegetables	1.4	±	0.1	1.2	±	0.2	1.1	±	0.1
Selected Nutrients									
Potassium									
mg	2055	±	89	2028	±	158	1866	±	113
mg/100 kcal	127	±	3	131	±	5	129	±	3
% AI[d]	46	±	2	45	±	4	41	±	3
Vitamin C									
mg	142	±	9	125	±	16	129	±	12
mg/100 kcal	9.0	±	0.5	8.0	±	0.9	8.6	±	0.6
% RDA[e]	316	±	20	277	±	36	287	±	26
Folate									
µg	247	±	10	232	±	18	214	±	13
µg/100 kcal	16.0	±	0.4	15.5	±	0.8	15.0	±	0.5
% RDA[e]	82	±	3	77	±	6	71	±	4
Beta Carotene									
mg	2612	±	313	1511	±	555	2088	±	398
mg/100 kcal	141	±	15.0	101.8	±	27.0	145	±	19.0

[a,b,c] Different letters in rows indicate significant ($p \leq 0.05$) difference
[d] AI= Adequate Intake
[e]RDA= Recommended dietary allowance

CHAPTER IV

SUMMARY OF FINDINGS

In the fall, servings of fruits differed significantly between the at risk and overweight children, with the overweight children consuming significantly more fruits than the at risk. Fruit intake did not differ significantly among groups in the spring, however. These findings partially support research hypothesis one.

No significant differences were found among groups for servings of vegetables consumed in the fall or spring. These findings do not support the second research hypothesis.

There was a significant positive correlation between BMI and serving of fruit intake in the fall but not the spring. This partially supports the third research hypothesis. There were no significant correlations between BMI and serving of vegetable intake in the fall or spring. This finding does not support research hypothesis four.

No significant correlations were found between change in servings of fruits and change in BMI from fall to spring, change in servings of vegetables and change in BMI from fall to spring, change in servings of fruits and weight change from fall to spring, or change in servings of vegetables and weight change from fall to spring. These findings do not support research hypothesis five, six, seven and eight.

There was a significant negative correlation between servings of fruit intake and % kcal from fat intake in the fall and spring. This finding supports research hypothesis nine. There were no significant correlations between servings of vegetable intake and % kcal from fat in the fall or spring. This finding does not support research hypothesis ten.

A significant negative correlation was found between servings of fruit and % kcal as sweets in the fall and spring. This finding supports research hypothesis eleven. A significant negative correlation was found between servings of vegetables and % kcal as sweets in the fall, but not the spring. Therefore, this finding partially supports research hypothesis twelve.

The at risk children had significantly lower potassium intake than the normal and overweight children in the fall but not spring. This finding supports research hypothesis thirteen. The at risk children consumed significantly less folate than the overweight children in the fall, but not the spring. Thus, this finding also supports research hypothesis thirteen. There were no other significant findings to support research hypothesis thirteen.

No significant correlations were found between BMI and intakes of potassium, vitamin C, folate and beta carotene. These findings do not support research hypothesis fourteen.

A significant negative correlation was found between potassium intake and % kcal as sweets in the fall and spring. This finding supports research hypothesis fifteen. No other significant correlations were found to support research hypothesis fifteen.

CHAPTER V

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CHAPTER VI

APPENDICES

APPENDIX A

PARENTAL INFORMED CONSENT FORM

Auburn University

Auburn University, Alabama 36849-5605
College of Human Sciences

Department of Nutrition and Food Science
328 Spidle Hall

Telephone: (334) 844-3261
FAX: (334) 844-3268

Parental Informed Consent for Diet Quality in Rural Alabama Children

You and your child are invited to participate in a study of the diets of children and the individuals that prepares their food to be conducted by Jean Weese. Ph.D., Associate Professor and Janet Johnson, graduate student in the Department of Nutrition and Food Science. We hope to record the type of food that is eaten by people living in rural Alabama. You are your child were selected because your child participates in the 4-H program

If you decide to participate, Jean Weese, Janet Johnson, and your county 4-H Leader will give your child a food frequency form and ask them to fill it out at school and one for you to fill out at home. This form asks how often you eat certain foods, like green beans, cornbread, or drinks such as colas and orange juice. After you and your child fill out the forms, this information will be sent to Auburn University to see what adults and children in rural Alabama eat. The form will take a few minutes to fill out.

Our goal is to learn what adults and children eat in Alabama. We will ask you to complete this form at the beginning and near the end of the school year. We will also ask your child to fill out a similar form at the beginning and near the end of the school year. Also we will ask your child out a form about their physical activity. For completing all the diet records and questionnaires, your child will be given a free pass for admission to the Montgomery Zoo in Montgomery, AL.

There are no risks to you or your child for participating in this research project. The information we gather will be kept completely confidential. We will assign a number to your child and to you to keep the information confidential. The information obtained in this research study will be used to develop nutrition education programs especially designed to meet the needs of children in the rural south. All information collected will be reported in a group format. For example, all the children in the south eat grits at least 4 times a week. No child will be singled out in the report but the information will go in as a group report.

____
Subject's initials

HUMAN SUBJECTS
OFFICE OF RESEARCH
PROJECT # 01-071 MR0106
APPROVED 6/14/01 TO 6/11/03

Page 2: Parental Informed Consent for Diet Quality in Rural Alabama

If you or your child chooses to participate in this research project you can withdraw at anytime and you may withdraw any information that has been collected from you and your child. Your decision to participate or not, will not jeopardize you relationship with the Alabama Cooperative Extension System or Auburn University.

If you have any questions, we will be glad to answer them at anytime no or later. Contact either Jean Weese, Ph.D. at jweese@aces.edu or Janet Johnson at johns16@aces.edu pr call (334) 844-4261. You may also ask any questions to you child's teacher or the 4-H leader. You will be provided a copy of this form to keep.

For information regarding your rights as a participant in this study you may contact the Office of Research Programs. Ms. Jeanna Sasser at (334) 844-5966 or sassejb@auburn.edu or Dr. Steve Shapiro at (334) 844-6499 or shapisk@auburn.edu

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU AND YOUR CHILD WILL PARTICIPATE IN THIS PROJECT. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______ I will participate in this study.

______________________________ ______________________

Parent's or Guardian's Signature Date

______ I consent for my child to participate in this study.

______________________________ ______________________

Parent's or Guardian's Signature Date

______________________________ ______________________

Investigator's Signature Date

HUMAN SUBJECTS
OFFICE OF RESEARCH
PROJECT # 01-071 MR 0106
APPROVED 6/14/01 TO 6/11/03

APPENDIX B

PARTICIPANT INFORMED ASSENT FORM

Auburn University

Auburn University, Alabama 36849-5605
College of Human Sciences
Department of Nutrition and Food Science
328 Spidle Hall
Telephone: (334) 844-3261
FAX: (334) 844-3268

Child Assent for Diet Quality of Rural Alabama Children

Dear Student:

Our names are Jean Weese and Janet Johnson. We work at Auburn Universtiy. We would like to ask your help in a study about what children eat in Alabama. We are asking you because you are in the 4-H program

If you decide to help us, we will give you two forms to fill out. One will ask you how often you eat certain foods. The second form will be about your physical activity. Last we would like to weigh you and see how tall you are. For completing these forms we will give you a free pass for admission to the Montgomery Zoo.

We won't tell anybody else how you answered the questions. Sometimes, reports are written so that other people like us can learn from our study. If we do that no person will be singled out in a report. Our study may help others to develop nutrition education programs that are good for kids living in the South.

If you choose to help us out with this study you can change your mind and stop at any time. You also don't have to answer any questions that you don't want to.

If you have any questions, we will be glad to answer them at anytime. You may ask any questions to you child's teacher or the 4-H leader. You can also have them call us so we can answer your questions.

If you have had your questions answered and would like to help us in this study, please sign your name below.

Participant's Signature ____________ Date ____________

Investigator's Signature ____________ Date ____________

HUMAN SUBJECTS
OFFICE OF RESEARCH
PROJECT # 01-071 MR0106
APPROVED 6/4/01 TO 6/11/03