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Resemblance in dietary intakes of snacks, sweets, fruit, vegetables, energy, macronutrients, and selected micronutrients among mother-child dyads from families with limited incomes

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RESEMBLANCE IN DIETARY INTAKES OF SNACKS, SWEETS, FRUIT, VEGETABLES, ENERGY, MACRONUTRIENTS, AND SELECTED MICRONUTRIENTS AMONG MOTHER-CHILD DYADS FROM FAMILIES WITH LIMITED INCOMES

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ABSTRACT

The objective of these studies was to determine the association between dietary intakes of selected food groups, macronutrients, and micronutrients in mother-child dyads. This was a secondary analysis of data on low-income Black, Hispanic, and White children 3-5 years-old (y) participating in Head Start (HS) (n=650), and their mothers. Mothers served as a proxy for their child, and self-reported intake during a multiple-pass 24-hour recall interview for one weekend day. One weekend day was chosen since children attended HS during the week, and mothers may not know what their children consumed outside the home. Data were collected on children's and mothers' intakes of servings of snacks, sweets, fruit, and vegetables, and amounts of energy, dietary fiber, vitamin D, calcium, potassium, added sugars, saturated fatty acids (SFA), trans fat, and sodium. Analysis of variance was conducted to determine differences in intakes by race. Pearson partial correlation coefficients were determined to assess the associations of intakes between children and mothers.

Both children and mothers met the recommendation for vegetables; however, they did not meet the recommendations for fruit, dietary fiber, vitamin D, calcium, or potassium. Further, they exceeded the recommendations for SFA and sodium. Intake of all food groups and nutrients in mothers was associated with intake of the corresponding food groups and nutrients in children ($p<0.0001$ for all). Nutrition professionals need to encourage mothers to consume healthy snacks, such as fruit and vegetables, and consume foods that are high in nutrients of public health concern, which include dietary fiber, vitamin D, calcium, and potassium. Nutrition professionals should also encourage mothers to consume low amounts of foods that are high in nutrients of overconsumption, which include added sugars, SFA, trans fat, and sodium. Modeling of these habits by mothers may encourage healthy eating habits in children.

CHAPTER 1

INTRODUCTION

Dietary habits begin early in life (1), and are influenced by the diets of parents (1,2-4), especially mothers (5). Strong relationships have been shown between the diets of preschool children 2-5 years of age (y) and mothers (6,7). However, preschool children did not meet the recommendations for some food groups (8) and nutrients (9), and exceeded recommendations for others (10). This may be related to poor intake in mothers. Additionally, preschool children of low socioeconomic status (SES) were less likely to meet recommended food group or nutrient intakes than their higher-income counterparts (8,11). This suggests that low-income mothers may be more likely to model poor eating behaviors to their children than higher-income mothers.

Parents, especially mothers, influence the diets of their young children (5). Parental food preferences affect parents' choices in food selection and in those foods made available to their children (1). Parents also serve as role models for their children's dietary behaviors (1,3). For example, preschool children imitated the diets of their parents (4,12) by choosing foods that they had seen their parents purchase (12). However, it is unclear if there are correlations in mother-child dyads between those foods thought to represent typical intake of preschool children. Those foods include snacks, sweets, fruit, and vegetables. Correlations in energy and nutrient intakes, including macronutrients, nutrients of public health concern, and nutrients of overconsumption, are also unclear.

Few studies have examined snacking in preschool children. One study that did look at this found that children consumed approximately 27% of their energy as snacks (13), although the energy needs of preschool children are low relative to their nutrient needs (14,15). However, snacking may also add nutrients to the diet that could not otherwise be consumed in sufficient

amounts during meals. Therefore, low energy, nutrient-dense snacks, such as fruit and vegetables (FV), may aid children in meeting their nutrient recommendations without contributing large amounts of energy.

Fruit and vegetable intake in preschool children was generally low (16). Mean intake in children 2-3 y met the recommendation for fruit but not for vegetables while mean intake in children 4-8 y did not meet the recommendation for fruit but did for vegetables (16). Additionally, mean intakes that did meet the recommendations for fruit or vegetables were at the lowest end of the recommended range (16). Intake of FV below recommended levels may result in under-consumption of certain nutrients as well.

The composition of snacks among adults is unclear as studies have shown mixed results (17,18). In one study, snacking in adults consisted primarily of salty snacks, chips, and nuts (17), all of which are energy-dense. However, another study showed that the number of self-reported snacking occasions was positively associated with energy and carbohydrate intake, but negatively associated with protein and fat intake (18). This suggests that snack intake consisted primarily of low-fat, carbohydrate-rich snacks. That study also found that snack intake was associated with nutrient intake, suggesting that snacks contribute nutrients to the diet (18).

Snacks may provide an opportunity for adults to increase their consumption of FV since they did not consume the recommended number of servings of FV (16). Consumption of FV at the recommended levels was inversely associated with risk of developing cardiovascular disease (CVD) (19) and type 2 diabetes (20). Additionally, because FV are nutrient-dense, under-consumption may also result in low intake of nutrients.

Nutrients of public health concern in the diets of children include dietary fiber, vitamin D, calcium, and potassium (21). Dietary fiber, vitamin D, and potassium were consumed by

preschool children in insufficient amounts to meet recommendations (9,10,15,22). In children, intake of dietary fiber and vitamin D below recommendations was associated with constipation (23) and rickets disease (24), respectively. A relationship between intake of potassium below the recommendation and children's health is unclear. Previous data showed that calcium was not a shortfall nutrient in preschool children, but was a shortfall nutrient in children 9 y and older (25). More recent data, however, showed that calcium intake in children 4-8 y was also below recommended levels (26).

In adult females, intake of dietary fiber, vitamin D, calcium, and potassium was below recommendations (15,22). Intake of calcium below recommended levels was associated with osteoporosis (27), and intake of potassium below recommended levels was positively associated with BP (15). Conversely, intake of dietary fiber, vitamin D, calcium, and potassium at recommended levels was associated with better gastrointestinal function (28), immune health (29), and bone health (15), and reduced risk of CVD (30), respectively.

Nutrients of overconsumption in the diets of preschool children include saturated fatty acids (SFA), trans fat, and sodium (21). A direct relationship between intake of SFA or trans fat and CVD risk during childhood is unclear. However, because nutrient intake tends to track beginning around preschool age (31), consumption of these nutrients in excess during childhood may also continue in adulthood. Sodium consumption in preschool children was positively associated with blood pressure (BP) (32). Since BP was also shown to track into adulthood (33), excessive consumption of sodium during childhood may be associated with excessive consumption of sodium (31) and high BP in adulthood (33).

In adults, nutrients of overconsumption, as defined by the 2010 Dietary Guidelines for Americans, include added sugars, SFA, trans fat, and sodium (21). Intake of those nutrients in

amounts that exceed recommendations may be associated with risk of type 2 diabetes (34) and CVD (35-37). Recommendations for added sugars and trans fat intake, however, are ambiguously defined. Currently, there are two recommendations for added sugars intake (15,38), and there is no exact recommendation for intake of trans fat (21). Therefore, it is unclear what defines excessive intake of added sugars or trans fat.

Income and diet are closely related (11). In comparison to families of high SES, families of low SES had poorer diet quality (11), consumed fewer servings of FV (39-41), and consumed more processed foods (42). Low-income families also consumed fewer than the recommended number of servings of whole grains (43) and dairy (44,45), and tended to choose high-fat meats over lean meats (46). Those dietary habits may be a result of the higher cost of nutrient-dense foods over energy-dense foods (42,46), reduced availability of nutrient-dense foods in low-income neighborhood stores compared with their higher-income counterparts (47-49), or lack of sufficient knowledge of nutrition (50).

Justification

Child diet may be influenced by maternal diet. Few studies have assessed the correlation between diets in mother-child dyads. Even fewer studies have assessed this in a low-income, multi-ethnic population. This study examined the correlation in snack, sweets, fruit, vegetable, energy, macronutrient, and selected micronutrient intake of low-income Black, Hispanic, and White mother-child dyads.

Objectives:

1. Determine the association between intakes of snacks, sweets, fruit, and vegetables of mothers and children 3 to 5 y participating in Head Start (HS).

2. Determine if energy, and macro- and micronutrient consumption between children and mothers is correlated.

Limitations

1. Data were obtained from a cross-sectional study; thus inferences cannot be drawn.
2. Twenty-four hour recalls may not be accurate since they rely on memory.
3. Parents may have over- or under-reported intake for themselves and their children.
4. These studies cannot be applied to populations other than low-income Black, Hispanic, and White mother-child dyads in the southern United States, participating in HS.

Assumptions

1. The sample size was sufficient to accurately determine intake in mother-child dyads.
2. One weekend day was sufficient to accurately report daily intake in mother-child dyads.

CHAPTER 2

REVIEW OF LITERATURE

The Association of Diet in Mother-Child Dyads

Children's eating patterns are initiated early in life, generally between 2 and 5 y, suggesting that the preschool period is a pivotal developmental time point during which healthful eating patterns may be fostered. However, the diets of preschool children have been understudied and dietary influences have not been well established. Parental influences are thought to play a major role in the diets of preschool children, but these have not been well studied, especially for foods associated positively or negatively with obesity or for nutrients of public health concern or nutrients of overconsumption.

Parents, especially mothers (5), have been shown to have a strong influence on their children's food intake (4). Parental modeling of food intake may contribute to this influence (1,3,5); however, studies have found mixed results when comparing the food intakes of children and mothers (7,51,52). A study of 560 children 5-6 y and parents (92% mothers; 8% fathers) found that parental modeling of diet did not predict the diet of the child. That study had significant differences with the two studies we conducted using HS mother-child dyads. Campbell's study used older children and did not compare mother-child dyads. Another study found a positive association between parental modeling and children's diets; however, results from that study were clouded since parents also intentionally exposed their children to new foods (52).

Parental modeling of healthy eating behaviors may have a greater influence on children's dietary intake than modeling of unhealthy eating behaviors (12,53); however, some studies did find positive correlations between children and mothers for intake of snacks, sweets, and energy-

dense foods (6,52,54). Other studies found stronger correlations between children's and mothers' FV (6,54) and snack intake (6) than sweets and candy intake (7,54). High FV consumption in mothers was more strongly correlated with child FV intake than was low FV consumption in mothers (53). Children whose parents purchased healthy foods were more likely to choose the foods they had seen their parents purchase than children whose parents purchased less healthy foods (12).

Some racial trends in diet correlations of mother-child dyads have been shown (54). Diet quality and soft drink intake of Hispanic mother-child dyads was more strongly correlated than diet quality and soft drink intake of Black or White mother-child dyads (54). A study of low-income, Black mother-child dyads found a strong correlation between the diets of children and mothers, but no correlation in dietary variety; however, that study was conducted in toddlers and adolescent mothers (6).

Studies that looked at differences in correlations by child age have found mixed results (6,7,54). One study found that the diets of older children and mothers were more strongly correlated than that of young children and mothers; however, young children categorized as being in the highest quintile of diet quality had stronger dietary correlations with mothers than older children and mothers (54). Another study found that the diets of preschool children 3-5 y and their mothers were more strongly correlated than that of older children (6) or adolescents (7) and mothers.

Diets of Preschool Children

<u>Snacks</u>

Preschool children commonly consume snacks. When snacking occasions were defined by parents, preschool children were shown to consume between 28% and 29% of their energy as

snacks (55). Some studies have shown a potential relationship between snacking and weight, depending on the type of snack food consumed (56-58). Data from the 2008 Feeding Infants and Toddlers Study showed that 86% of children 2-3 y consumed energy-dense, nutrient-poor foods such as sweetened beverages, desserts, sweets, and salty foods during snacking occasions (59). Between 82% and 89% of children 2-3 y consumed those foods on more than one occasion each day, although number of servings was not specified (59). Studies conducted in children 2-10 y showed that intake of large portions of energy-dense, nutrient-poor foods and low intake of FV during snacking occasions (56-58), combined with sedentary behavior (56) may contribute to high body mass index (BMI). One problem with these studies, and the studies done in adults is that "snack" does not have a standard definition; therefore, study participants or parents either self-define snacks, or the term is defined by the investigators. This makes it difficult to compare studies.

Fruit and Vegetables

Mean fruit consumption among children 1-3 y met the 2010 Dietary Guidelines for Americans (DGA) recommendation of 1-1.5 cups per day for children up to 3 y; however, vegetable consumption did not meet the 2010 DGA recommendation of 1-2 cups per day for children up to 3 y (16,21). Mean fruit intake in children 4-8 y did not meet their DGA recommendation of 1-2 cups per day, but did meet their DGA recommendation of 1.5-2.5 cups per day for vegetables (16,21). Among children 2-5 y, 50% and 78% were likely to consume less than the recommended number of servings of fruit and vegetables, respectively (8), and consumption of FV has been decreasing over the last 20 years (60,61). Because diet patterns tend to track into adulthood (62), children who do not consume the recommended number of

servings of FV may continue that pattern as adults. Because FV are nutrient-dense, under-consumption of FV may result in deficiencies or inadequacies of some essential nutrients.

Diets of Adult Females

<u>Snacks</u>

In the past 30 years, the prevalence of adults that snack has increased from 71% to 97% (17). The principal snack foods of adults were salty snacks, chips, and nuts (17). All of those are energy-dense, and salty snacks and chips are nutrient-poor (15). A previous study showed that consumption of energy-dense, nutrient-poor foods in adults was negatively associated with adequacy of food group intake, suggesting that those foods may have replaced nutrient-dense foods in the diet (63). However, consumption of nuts, which are nutrient-dense, had a protective effect against CVD and was inversely associated with risk of colon cancer in women and risk of gallstones in adults (64). Further, consumption of nuts had no association with weight (64). This evidence suggests that a relationship between snack intake and health in adults may be dependent on the type of snack food consumed.

<u>Fruit and Vegetables</u>

Adults consumed fewer than the recommended number of servings of FV (16). Consumption of the recommended number of servings of FV in adults was inversely associated with risk of developing CVD (19) and type 2 diabetes (20). Additionally, under-consumption of FV may coincide with under-consumption of some nutrients in adults, since FV are nutrient-dense.

Key Nutrients Identified by the 2010 DGA

The 2010 DGA identified dietary fiber, vitamin D, calcium, and potassium as nutrients of public health concern since those nutrients are thought to be inadequate in the diets of most

Americans. Nutrients of overconsumption were identified as added sugars, SFA, trans fat, and sodium. Dietary patterns that include underconsumption of the nutrients of public health concern, and overconsumption of the nutrients of overconsumption were associated with increased incidence of obesity and nutrition-related chronic disease (65).

Nutrients of Public Health Concern

Preschool Children

The adequate intake (AI) for dietary fiber in children 1-3 years is 19 grams (g)/day, and in children 4-8 y is 25 g/day (15). Mean intake of dietary fiber in children 2-5 y was between 10.5 and 11.3 g/day (22), which was less than the lowest recommendation. Fiber intake below the recommendation in children was associated with constipation (23). High intake of dietary fiber was shown to reduce low-density lipoprotein cholesterol (LDL-C) levels in children more than reducing intake of SFA (66,67). Additionally, intake of dietary fiber in children was negatively associated with weight (68).

Mean intake of vitamin D among children 2-5 y was 6.1-6.5 micrograms (μg)/day (22); however, the estimated average requirement (EAR) for vitamin D in children is 10 μg (15). Intake of vitamin D below the recommended level may result in vitamin D insufficiency (69). Severe deficiency in children is a known cause of rickets (24); however, a relationship between vitamin D insufficiency and health in children is unclear.

Calcium intake in children 2-5 y met the recommended dietary allowance (RDA) (10,22,25) of 700-1000 milligrams (mg)/day (15). Mean calcium intake was between 957 and 1009 mg/day (22). Data have shown that calcium became a shortfall nutrient at 9 y (25), but more recent data have shown that children as young as 4-8 y consumed less than the recommended intake level (26). Further, calcium intake may decrease as children progress into

adulthood; however, tracking of calcium intake is unclear as results have been inconsistent (70-72).

Intake of potassium in preschool children was below the AI of 3000-3800 mg/day (9,10,15,22). Mean potassium intake in children 2-5 y was between 1896 and 2050 mg/day (22). The relationship between inadequate potassium intake and health in children is unclear; however, a high sodium to potassium excretion ratio, which is indicative of sodium and potassium intake, was positively associated with CVD in adults (73). Therefore, intake of potassium below the recommended level, in combination with high intake of sodium, may put children at risk for developing CVD as they age into adults (32,74).

Adult Females

In adult females, mean dietary fiber intake was 14.3 g/day (22), which was less than the AI of 25 g/day for dietary fiber in all adults (15). In adults, adequate dietary fiber intake was associated with lower rates of diabetes than inadequate dietary fiber intake (75). High fiber intake was also associated with moderate weight loss (75), improved gastrointestinal function (28), and reduced risk of CVD (76).

Mean intake of vitamin D in adult females was 3.8 μg (22); however, the EAR for vitamin D in adults is 10 μg (15). Severe vitamin D deficiency in adults is a known cause of osteomalacia (24). Additionally, vitamin D was shown to play a role in maintaining immune health (29) and aid in the prevention of autoimmune diseases (77-79), cancer (80,81), and type 2 diabetes (82) in adults.

Adult females did not meet the RDA for calcium (15,22). Mean intake was 833 mg/day (22); however, the RDA is 1000 mg/day (15). In adult females, consumption of calcium below

the RDA is associated with risk of osteoporosis (27,83). In individuals with hypertension, consumption of calcium at or above the RDA resulted in reduced BP (84).

Mean potassium intake in adult females was 2290 mg/day (22). However, the AI is 4700 mg/day (15). In adults, intake of potassium below recommended levels was associated with high BP (15), while intake at or above the recommended level was associated with reduced risk of CVD compared with intake below the recommended level (30).

Nutrients of Overconsumption

Preschool Children

The 2010 DGA listed added sugars as a nutrient of overconsumption among children (21); however, added sugars intake by preschool children was shown to be within the Institute of Medicine (IOM) recommendation of no more than 25% of kilocalories (kcals) (15,85). However, some studies showed that intake of added sugars among children increased between 2 and 7 y (86) and continued to increase with age (38). Added sugars may replace more beneficial nutrients in the diet when comprising 25% or more of energy intake (15).

Mean SFA intake among children 2-5 y was between 20 and 20.8 g/day, which was approximately 12% of total kcals (22). The recommendation for SFA set by the IOM is consumption of the least amount of SFA practicable since exogenous SFA provides no nutritional benefit (15). The 2010 DGA recommended keeping SFA intake below 10% of total kcals since total elimination of dietary SFA is not feasible (21). Thus, children 2-5 y exceeded this recommendation (22). The relationship between SFA intake and health during childhood is unclear; however, due to tracking of eating behaviors (62), intake above the recommended level during childhood may continue into adulthood.

Mean trans fat intake among preschool children is unclear. The 2010 DGA and the IOM recommend that trans fat consumption be as low as possible (15,21), further compounding the problem of determining actual overconsumption in children. However, data from the 2001-2004 National Health and Nutrition Examination Survey (NHANES) showed that mean intake of solid fat, a major source of trans fat (21), among children 1-8 y was between 37.9 and 44.5 g/day (87), providing approximately 340-400 kcals/day. This exceeded the 2010 DGA recommendation for children 2-5 y of no more than 121-137 kcals/day provided by both solid fats and added sugars (21).

Sodium intake among preschool children (9,10,22) was higher than the tolerable upper level limit (UL) of 1,500-1,900 mg/day for children (15). Mean intake was between 2,189 and 2,265 mg/day (22). Sodium intake in children was positively associated with BP (32,74). Since nutrient intake (31) and BP (88) were shown to track into adulthood, consumption of sodium above the UL during childhood may increase risk for developing CVD during adulthood (74,89-91).

Adult Females

Among adult females, mean intake of added sugars was between 203 and 229 kcals/day (92). This did not exceed the IOM recommendation of less than 25% of energy as added sugars (15). In adults, intake of added sugars above this level was associated with low healthy eating scores (93) and diets that were deficient in essential micronutrients (94). Mean intake did exceed the American Heart Association (AHA) recommendation of no more than 100 kcals of added sugars/day in adult females (38); however, that recommendation was based on consumption of half of one's discretionary kcal allowance, based on the 2005 DGA, as added sugars (38).

Further, no evidence was found to substantiate benefits of consumption of added sugars below that level.

Among adult females, mean SFA intake was 22.3 g/day, which was approximately 11% of total kcals (22); however, the 2010 DGA recommend that SFA comprise no more than 10% of total kcals (21). Saturated fatty acid intake was shown to have a positive association with LDL-C levels (95-97). Low-density lipoprotein cholesterol levels are positively associated with risk of CVD (98-100). A positive association between SFA intake and CVD was also shown in some studies (35,101); however, another study found this link to be weak (102). Intake of SFA in adults was also positively associated with insulin resistance (34).

In adult females, median trans fat intake between 1994 and 2006 comprised 1.2% of total energy intake (103). Multiple studies have shown that trans fat intake had a positive association with LDL-C levels (104). Levels of serum LDL-C above 100 mg/deciliter (dl) are atherogenic and a major risk factor for CVD (105,106). Studies have also shown a negative association between trans fat intake and high density lipoprotein cholesterol (HDL-C) levels (104). Levels of serum HDL-C below 40 mg/dl are a risk factor for CVD while levels above 60 mg/dl are a negative risk factor for CVD (105,106). Trans fat intake was also shown to have a positive association with CVD (36, 107).

Mean intake of sodium among adult females was 2,884 mg/day (22), which was more than the UL of 2,300 mg/day for adults (15). Mean intake of sodium among Black adults was 3,270 mg/day, (22) which was far greater than the UL of 1,500 mg/day for their race/ethnicity (15). Black adults were shown to be more salt sensitive than adults of other races/ethnicities (108-110), and therefore, have a lower UL for sodium (15). Among adults, sodium consumption

above the UL is positively associated with hypertension (111), risk of CVD (37,112), and stroke (112,113).

Low Socioeconomic Status and Diet

Low SES has been shown to be associated with poor diets (11). Data from the 2007-2008 NHANES showed that children 2-5 y whose family income was less than 131% of the federal poverty threshold consumed more energy, dietary fiber, potassium, SFA, and sodium, and less vitamin D and calcium than those whose family income was greater than 185% of the federal poverty threshold (114). Adults 20 y and older with a family income less than 131% of the poverty threshold consumed less of all of those nutrients than adults with a family income greater than 185% of the federal poverty threshold (114).

Low-income families had poorer diet quality than high-income families (11). Socioeconomic status had an inverse association with FV intake (8). Among low-income children, 72% and 85% were likely to consume fewer than the recommended number of servings of fruit and vegetables, respectively (8). Children and women of low SES chose high-fat meats over lean meats (46) and consumed more processed foods (42) than their higher-income counterparts. Low SES children and women also consumed less than the recommended number of servings of whole grains (43) and dairy (44,45).

Low-income women had poorer diets than their higher income counterparts (115). A recent study assessed the diets of women of low and high SES and showed that energy density was inversely associated with diet cost. Diets that were low in energy were nutrient-dense. That study also found that women of high SES were more likely than women of low SES to consume a low energy, nutrient-dense diet (115). Another study that looked at grocery shopping behavior of low-income women found that the most commonly purchased foods were refined grains and

high fat meats (46). High fat meats are energy-dense, and are not considered nutrient-dense (21). That study also found that low-income women considered meat their most important food group, as it was central to breakfast, lunch, and dinner (46).

Differences in SES accounted for some of the differences in intake by race (116). A recent study found that Blacks consumed fewer servings of vegetables and fewer servings of FV than Whites, but the same number of servings of fruit as Whites (116). However, when that study controlled for SES, the disparity between consumption of FV among Blacks and Whites became insignificant, and Blacks consumed more fruit than Whites. Differences in vegetable consumption remained unchanged (116). Further, low-income Black families consumed fewer servings of dairy at dinner meals than low-income White families (44), suggesting that differences in SES may not account for differences in intakes of all foods by race.

Part of the association between income and poor diet may be explained by the higher cost of nutrient-dense foods when compared to energy-dense nutrient-poor foods (42,46) and the low availability of nutrient-dense foods in low-income area stores (47-49). Low-income women did not often purchase FV due to cost, but stated they would purchase more FV if they could afford them (46). Another study found that healthy food selection, such as large variety of FV, in grocery stores located in low-income neighborhoods was significantly poorer than those located in high-income neighborhoods (47). Diet quality was also associated with food selection in grocery stores (49).

Lack of sufficient nutrition knowledge may be another barrier to healthful eating patterns in low-income households (50). Low-income parents had less knowledge of the relationship between nutrition and chronic disease, healthful eating patterns, and food label use than high-income parents (50). Those with more nutrition knowledge than others were more likely to

engage in healthful dietary changes (117). However, some studies showed no association between improvements in nutrition knowledge and improvements in diet (118,119). These findings show that improving nutrition knowledge alone is not enough to change behavior.

Diet Assessment

The diet assessment method used in these studies was a 24-hour recall. One of the strengths of 24-hour recalls is accurate estimation of population intake (120-123). Multiple studies found that reported intake was within 10% of actual intake (121-123). Another strength of 24-hour recalls is the low burden on the respondent. Because recalls are conducted as interviews, respondents do not need to be literate (120). Additionally, no specific knowledge or training is needed for participation (120). Multiple-pass 24-hour recalls taken over a 3-day period that included both weekend and week days were the most accurate method of diet assessment when mothers reported intake for their young child (124). Single-day multiple-pass 24-hour recalls are also effective for estimating mean intake of a population (120).

In this study, mothers reported for themselves and served as a proxy for reporting child intake since children of this age cannot accurately report their own intake (125). This is not uncommon in those studies where parents reported child's intake (126-131). Limitations of proxy reporting of 24-hour recalls include parental overreporting (129,130,132) or underreporting (132-134). Mothers are also able to report accurately what the child consumed at home (132), but not outside the home (134); this can affect the accuracy of the recall. To mitigate this effect, one 24-hour recall from a weekend day was used in these studies.

Reporting errors could also have occurred in the mothers' recall. A study conducted in Jamaica showed that those of lower weight were more likely to overreport intake than those of higher weight (135). Overreporting was also negatively associated with age and level of

education (135). Underreporting was positively associated with weight in adults who self-reported intake (136). The same was also true in a population of low-income women (137). Underreporting among subjects of high BMI may be due to a desire to lose weight (138).

Head Start

Families in these studies participated in HS, a federally funded preschool program, available to young children from low-income families. The purpose of the program is to provide those children with basic academic knowledge prior to starting kindergarten (139). Head Start also provides low-income children with health care services (139) since many do not receive adequate health care (140,141). Head Start is a participant in the United States Department of Agriculture's Child Nutrition programs; the low-income children in HS qualify for free meals served at the center (139). In the HS programs used in these studies, children received breakfast, lunch, and at least one snack. These meals meet the requirements for the National Breakfast Programs and the National School Lunch Programs (139).

CHAPTER 3

RESEMBLANCE IN DIETARY INTAKES OF SWEETS, SNACKS, FRUIT, AND VEGETABLES AMONG MOTHER-CHILD DYADS FROM FAMILIES WITH LIMITED INCOMES

Introduction

Diets of low income children and adults rely heavily on nutrient-poor, energy-dense foods and individuals are not meeting the recommended number of servings of fruit and vegetables (FV). Snacking prevalence and the number of snacking events has increased in recent years. Diets of parents, especially mothers, likely influence those of preschool children; however, data on the association of food intake between mother-child dyads is limited.

In children and adults, the number of snacking episodes is high (55) and has risen in parallel with the prevalence of obesity (13); although a cause and effect relationship is lacking. Approximately 28% and 29% of energy intake in males and females 2-5 years of age (y), respectively, came from snacks. The prevalence of snacking in adults has increased over the past 30 years to 97%; and the total energy coming from snacks was 24% (17). The principal snack foods of children tended to be nutrient-poor, energy-dense, including desserts and sweetened beverages (13), whereas, adults tended to choose salty snacks, chips, and nuts, rather than sweet snacks (17). Both types of snacks tend to be nutrient-poor, energy-dense.

Fruit and vegetables are generally low in energy and saturated fatty acids and provide important vitamins, minerals, and phytochemicals. However, intake of FV has decreased in the past 20 years (60) and both are consumed below recommended levels by children and adults (16). A direct relationship between FV consumption in preschool children and in adulthood is unclear; however, eating patterns of children tend to track into adulthood (62). This suggests that preschool children with low intakes of FV may continue this pattern through adulthood.

Fruit and vegetable intake below recommended amounts may contribute to obesity if these foods are replaced in the diet by nutrient-poor, energy-dense foods (21), although the relationship between FV consumption and overweight/obese status has not been confirmed in either children or adults (142). Low intake of FV puts adults at risk for the development of chronic diseases including cardiovascular disease, type 2 diabetes, and cancer (21); thus, it is important to establish healthy eating patterns early in life. Based on the overall energy density and health benefits these foods provide, children and adults need to include more FV in the diet. Snacking on FV may be one way to increase intake of these foods; parental modeling may be another.

Mothers have been shown to serve as role models for their children's health related behaviors (3), including diet; and parental food preferences and behaviors have been shown to influence children's food preferences (1,3). The food preferences of parents have been shown to affect the foods they buy and consume, and, thus, those made available to their children (1). Young children imitate the diets of their parents (1,3,7); for example, preschool children have been shown to choose healthy foods they've seen their parents purchase (12,143). Children, 3-5 y, had a stronger positive correlation to the diets of their parents than older children (6) or adolescents (7). Stronger positive correlations have been shown between the diets of parents and daughters (7,144) than for parents and sons (7,54). Some food categories, such as FV (6,54) and snacks (6) have shown stronger correlations between mothers and children than others (7), such as sweets and candies (54).

No studies have assessed the resemblances in dietary intake of snacks, sweets, and FV among mother-child dyads from families with limited incomes. Therefore, the objective of this study was to determine the association between intakes of snacks, sweets, fruit, and vegetables of mothers and children 3 to 5 y participating in Head Start (HS).

Subjects and Methods

Study Participants

This was a secondary analysis of data collected on mother-child dyads from HS centers (n=57) in Alabama and Texas. Inclusion criteria were having a child enrolled in HS in his or her first year of participation and an income at or below 100% of the poverty index, and self-identifying race/ethnicity as Black, Hispanic, or White. The final sample included 650 mother-child dyads. Methodological details of the study have been published previously (44). The study was approved by the Institutional Review Board of the Baylor College of Medicine. Adults provided written informed consent for themselves and their children prior to entry into the study.

Anthropometric Assessment

Heights and weights of all mother-child dyads were measured twice (145) to determine the mean. Height was measured using a stadiometer (Shorr Productions Growth Unlimited, Olney, MD) and recorded to the nearest 0.1 cm. Weight was recorded to the nearest 0.1 kg and was measured on a scale calibrated to 500±0.5 kg (Befour Model PS-6600, Saukville, WI) with subjects wearing light clothing. Body Mass Index (BMI) was calculated as kilograms/meters^2 (146); and the weight status of mothers was reported as underweight <18.5; normal 18.5<24.9; overweight 25-29.9; obese >30 (147). The weight status of the child was determined by calculating BMI z-scores using BMI-for-age percentiles from the Reference Standards from the Centers for Disease Control and Prevention (148); weight status was reported as underweight (<5$_{th}$%), normal weight (5$_{th}$ to 84$_{th}$%), overweight (85$_{th}$ to <95$_{th}$%), or obese (>95$_{th}$%) (149).

Dietary Data

Twenty-four-hour recalls on participants were collected using a standard multiple pass method (122) for one weekend day. One weekend day was chosen, rather than consecutive day recalls, since mothers may not know what their children consume at day care or other venues outside the home (134). Mothers, grandmothers, or guardians (subsequently referred to as mothers) provided the recall for the child. Foods were grouped into categories (Table 1.1) for statistical analysis. Serving sizes for snacks and sweets were defined according to the Nutrition Data System for Research software (version 5.0_35, 2004, Nutrition Coordinating Center, University of Minnesota, MN). Serving sizes for FV were defined according to MyPyramid (now MyPlate) (150).

Statistical Analyses

Statistical analyses were run using the Statistical Analysis Software (SAS) (version 9.2, SAS Institute Inc, Cary, NC, 2008). Means ± standard deviations, as well as frequency distributions, of participant characteristics and intakes were calculated. Plots and histograms of residuals were used to investigate homogeneity of variance and normal distribution of variables. Analysis of variance was conducted to detect differences by race/ethnicity groups for continuous variables and Chi-square analysis was used for categorical variables. Statistically significant p-values were <0.05. A Bonferroni correction was applied to maintain the overall significance level while comparing multiple variables; thus, with three comparison groups, the effective p-value was 0.0167. To assess the associations between selected food intakes of the mother-child dyads, Pearson partial correlation coefficients were determined. Covariates were age and ethnicity/race for children and mothers, child BMI z-score or mothers' BMI, and child gender.

Table 1.1: Food Group Definitions used to assess diets of mother-child dyads from Head Start in Alabama and Texas .

Snacks	**Salty Snack Foods**
	Crackers – whole grain
	Crackers – some whole grain
	Crackers – refined grain
	Snack chips – whole grain
	Snack chips – some whole grain
	Snack chips – refined grain
	Popcorn
	Flavored popcorn
	Fruit-based savory snack
	Vegetable-based savory snack
	Meat-based savory snack
Sweets	**Cakes/Cookies/Pies/Pastries/Bars**
	Cakes/cookies/pies/pastries/Danish/doughnuts/cobblers – whole grain
	Cakes/cookies/pies/pastries/Danish/doughnuts/cobblers – some whole grain
	Cakes/cookies/pies/pastries/Danish/doughnuts/cobblers – refined grain
	Snack bars – whole grain
	Snack bars – some whole grain
	Snack bars – refined grain
Fruit	Citrus fruit
	Fruit excluding citrus fruit
	Avocado
Vegetables	Dark green/deep yellow vegetables
	Tomatoes
	Potatoes/starchy vegetables
	White potatoes, excluding fried potatoes
	Other starchy vegetables
	Fried vegetables
	Fried potatoes
	Fried fruit
	Other vegetables
	Legumes

Results

Demographics of Mother-Child Dyads

Black mother-child dyads comprised 42.5% (n=276) of the population, while 30% (n=195) of the dyads were Hispanic and 27.5% (n=179) were White (Table 1.2). The average ages of the mothers and children were 31.8±8.3 y and 4.4±0.6 y, respectively. Black mothers

had a higher mean BMI (33.5±8.8) than either Hispanic (29.6±6.1) or White mothers (30.4±8.8) ($p<0.05$). Mothers that were overweight or obese comprised 26.4% and 51.3% of the sample, respectively. Children that were overweight or obese comprised 13.9% and 26.0% of the sample, respectively. There was also a difference in BMI z-scores among the racial/ethnic groups of the children, with Black (0.5±1.6) children having the lowest score, followed by Hispanic children (0.9±1.2), and then White (1.3±1.7) children ($p<0.05$).

Food Consumption Patterns of Children and Mothers by Race

Hispanic children consumed the same number of servings of snacks (0.32±0.54) as Black and White children (Table 1.3), but the number of snacks consumed by White children (0.42±0.57) was higher than that of Black children (0.27±0.46) ($p<0.05$). White children consumed the same number of servings of sweets (0.34±0.64) as Black and Hispanic children, but Hispanic children (0.45±0.70) consumed more than Blacks (0.21±0.47) ($p<0.05$). There was no difference between the number of servings of fruit consumed between Black (0.33±0.61) and White children (0.40±0.77); however, both groups had lower intake than Hispanic children (0.99±1.12) ($p<0.05$). Hispanic children consumed the most servings of vegetables (1.62±1.40), followed by White (1.24±1.08) and Black children (0.95±0.87) ($p<0.05$).

Black mothers consumed the same number of snack servings (0.27±0.56) as Hispanic or White mothers, while the number of snack servings consumed by Hispanic mothers (0.19±0.52)

Table 1.2: Demographics and Anthropometrics for Children and Mothers by Race from One Weekend Day 24-Hr Recalls (N=650)

	Total		Black		Hispanic		White	
	M ± SD	Min–Max	M ± SD	Min–Max	M ± SD	Min–Max	M ± SD	Min–Max
Mothers Age, yr[1]	31.8 ± 8.3	20.1–72.4	32.9 ± 9.1 [a]	20.6–72.4	30.5 ± 5.9 [b]	20.1–49.3	31.3 ± 9.2 [ab]	20.2–67.8
Child Age, yr	4.4 ± 0.6	2.8–5.8	4.6 ± 0.7 [a]	2.8–5.8	4.1 ± 0.5 [b]	2.9–5.7	4.6 ± 0.5 [a]	3.2–5.7
Household Number	4.4 ± 1.6	1.0–12.0	4.3 ± 1.7 [ab]	1.0–12.0	4.7 ± 1.5 [a]	2.0–12.0	4.2 ± 1.5 [b]	2.0–12.0
Maternal BMI[2] **kg/m²** [3]	31.4 ± 8.2	17.1–77.4	33.5 ± 8.8 [a]	17.1–61.4	29.6 ± 6.1 [b]	18.3–48.1	30.4 ± 8.8 [b]	18.3–77.4
Child's BMI z-score	0.8 ± 1.6	-8.3–6.5	0.5 ± 1.6 [a]	-8.3–6.1	0.9 ± 1.2 [b]	-2.4–5.2	1.3 ± 1.7 [c]	-7.4–6.5
	N	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Race/Ethnicity, self defined	650	100	276	42.5	195	30.0	179	27.5
Education Completed [4]								
High School or less	386	59.4	124	44.9	146	64.8	386	59.4
Some College/Technical	206	31.7	121	43.8	33	29.1	206	31.7
College Grad and Higher	58	8.9	31	11.3	16	6.1	58	8.9
Marital Status[4]								
Married	311	47.8	78	28.3	112	57.4	121	47.8
Divorced/Widowed/Separated	131	20.2	60	21.7	26	13.3	45	20.2
Never Married	169	26.0	132	47.8	24	12.4	13	26.0
Other	39	6.0	6	2.2	33	16.9	0	6.0
Mother's Weight Status[4, 5]								
<25.0 Normal/Underweight	140	22.3	43	15.7	46	24.2	51	31.1
25.01 – 29.9 Overweight	166	26.4	62	22.6	60	31.6	44	26.8
≥30 Obese	322	51.3	169	61.7	84	44.2	69	42.1
Child's Weight Status[4, 5]								
<5th percentile Underweight	23	3.6	15	5.6	2	1.0	6	3.5
5th - 84th percentile Normal	358	56.5	159	59.8	122	62.6	77	44.5
85th-95th percentile Overweight	88	13.9	40	15.0	25	12.8	23	13.3
>95th percentile Obese	165	26.0	52	19.5	46	23.6	67	38.7

Means ± (standard deviation) with same letter in their superscripts do not differ significantly from one another according to Bonferroni correction with $p<0.0167$.
[1] Years; [2] Body mass index; [3] Kilograms per meter squared; [4] Overall X^2 <0.0001; [5]not all mothers and children had weights taken, thus the numbers do not total 650

Table 1.3: Mean ± Standard Deviation of Food Servings for Children and Mothers by Race from One Weekend Day 24-hr Recalls (N=650)

	Total		Black		Hispanic		White	
	M ± SD	Min–Max	M ± SD	Min–Max	M ± SD	Min–Max	M ± SD	Min–Max
Children:								
Snacks	0.33 ± 0.52	0.00–2.05	0.27 ± 0.46 [a]	0.00–2.05	0.32 ± 0.54 [ab]	0.00–2.05	0.42 ± 0.57 [b]	0.00–2.05
Sweets	0.32 ± 0.60	0.00–2.41	0.21 ± 0.47[a]	0.00–2.41	0.45 ± 0.70 [b]	0.00–2.41	0.34 ± 0.64 [ab]	0.00–2.41
Fruit	0.55 ± 0.88	0.00–3.89	0.33 ± 0.61 [a]	0.00–2.77	0.99 ± 1.12 [b]	0.00–3.89	0.40 ± 0.77 [a]	0.00–3.89
Vegetables	1.23 ± 1.14	0.00–5.09	0.95 ± 0.87 [a]	0.00–4.50	1.62 ± 1.40 [b]	0.00–5.09	1.24 ± 1.08 [c]	0.00–5.09
Mothers:								
Snacks	0.28 ± 0.56	0.00–2.45	0.27 ± 0.56 [ab]	0.00–2.45	0.19 ± 0.52 [a]	0.00–2.45	0.38 ± 0.60 [b]	0.00–2.45
Sweets	0.36 ± 0.73	0.00–3.04	0.22 ± 0.59 [a]	0.00–3.04	0.54 ± 0.88 [b]	0.00–3.04	0.37 ± 0.71 [ab]	0.00–3.04
Fruit	0.44 ± 0.88	0.00–3.90	0.25 ± 0.62 [a]	0.00–3.90	0.92 ± 1.22 [b]	0.00–3.90	0.23 ± 0.52 [a]	0.00–2.77
Vegetables	2.65 ± 2.31	0.00–10.22	1.86 ± 1.56 [a]	0.00–7.31	4.20 ± 2.85 [b]	0.00–10.22	2.17 ± 1.73 [a]	0.00–10.22

Means ± (standard deviation) with same letter in their superscripts do not differ significantly from one another according to t-tests with a Bonferroni correction ($p<0.0167$).

was less than the number consumed by White mothers (0.38±0.60) ($p<0.05$). White mothers consumed the same number of sweets (0.37±0.71) as Black and Hispanic mothers, but Black mothers consumed fewer sweets (0.22±0.59) than Hispanic mothers (0.54±0.88) ($p<0.05$). The number of servings of fruit and vegetables consumed by Black (0.25±0.62 and 1.86±1.56, respectively) and White mothers (0.23±0.52 and 2.17±1.73, respectively) did not differ; however, Hispanic mothers consumed more servings of these food groups (0.92±1.22 and 4.20±2.85, respectively) than Black and White mothers ($p<0.05$).

Food Consumption Patterns of Children Only and Mothers Only

Children's intake of snacks was correlated with intake of sweets and snacks combined (Table 1.4) ($p<0.0001$). Intake of sweets by children was also correlated with intake of sweets and snacks combined ($p<0.0001$). Fruit intake by children was positively correlated with intake of vegetables ($p<0.05$).

Table 1.4: Partial Correlation Snacks, Sweets, and Fruit and Vegetables (Servings) for Children and Mothers: One Weekend Day 24-hr Recall (N=650)

	Children[1]					Mothers[2]				
Food Group	**Snacks**	**Sweets**	**Sweets & Snacks**	**Fruit**	**Vegetables**	**Snacks**	**Sweets**	**Sweets & Snacks**	**Fruit**	**Vegetables**
Sweets	0.058					0.044				
Sweets & Snacks	0.682**	0.770**				0.629**	0.804**			
Fruit	0.032	0.050	0.057			-0.090*	0.096*	0.021		
Vegetables	-0.033	-0.023	-0.038	0.128*		-0.057	0.115*	0.055	0.251**	

[1]Adjusted for BMI z-score, sex, age, ethnicity/race
[2]Adjusted for BMI, age, ethnicity/race
p-value: ** <0.0001, *<0.05

Intake of snack servings by mothers was positively correlated with mothers' consumption of sweets and snacks combined (Table 1.4) ($p<0.0001$), but negatively correlated with mothers'

consumption of fruit ($p<0.05$). Mothers' intake of sweets was positively correlated with consumption of sweets and snacks combined ($p<0.0001$), and fruit and vegetables (both $p<0.05$). Fruit intake by mothers was positively correlated with intake of vegetables ($p<0.0001$).

Correlation of Intake between Children and Mothers

The partial correlations for food group consumption of mothers and children are summarized in Table 1.5. Mothers' number of servings of snacks, sweets, fruit, and vegetables consumed was associated with the number of servings that their child consumed of the same foods (all $p<0.0001$). Mothers' intake of servings of sweets was associated with children's intake of fruit servings ($p<0.05$). Mothers' number of servings of fruit consumed was associated with their children's intake of servings of vegetables ($p<0.05$). Intake of vegetable servings by mothers was correlated with children's intake of servings of fruit ($p<0.0001$). Finally, the total gram amount of food/beverages consumed by mothers and their children was positively correlated ($p<0.0001$) (Figure 1.1).

Table 1.5: Partial Correlation Foods (Serving) for Children and Mothers: One Weekend Day 24-hr Recall (N=650)

	Mothers			
Children	**Snack**	**Sweets**	**Fruit**	**Vegetables**
Snack	0.340**	0.053	-0.045	-0.021
Sweets	0.000	0.345**	0.050	0.057
Fruit	-0.049	0.126*	0.349**	0.226**
Vegetables	0.005	0.007	0.124*	0.476**

Adjusted for child BMI z-score, child sex, child age, ethnicity/race, Parent age (yrs), Parent BMI.
p-value: **<0.0001, *<0.05.

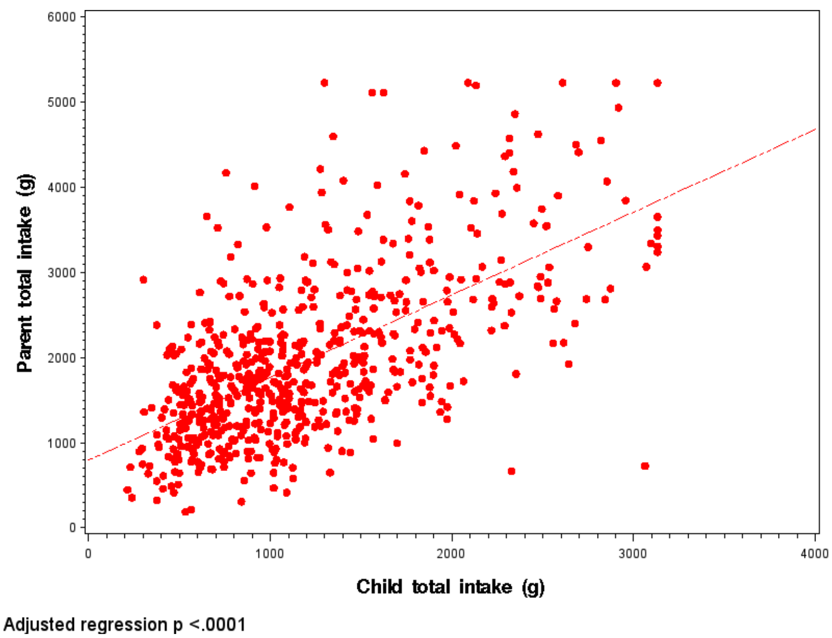

Figure 1.1: Total Intake for One Weekend Day (grams) by Mother-Child Dyads from Head Start in Alabama and Texas

Discussion

The diets of HS children and their mothers have been understudied. The major findings of this study were the differences in intakes among race/ethnicity groups, the positive correlations between the mother-child dyad intakes of snacks, sweets, fruit, and vegetables, and the positive association between the total gram amount of food consumed by mothers and children. It is particularly important to study the relationship between mother-child food consumption since parental modeling and food preparation is part of the “family food environment” that can influence eating patterns in young children (51).

Little is known about the snacking patterns of preschool children in general and those of a multi-racial/ethnic low income population in particular. Data from the 2007-2008 NHANES showed that most males and females 2-5 y had 2-4 snacking occasions/day; however, the number of servings of specific foods was not provided in that report. Those analyses showed that 25% of

all snack occasions consisted of water only (55). Using those data, it was shown that Black and White children tended to have more snacking occasions than Hispanic children (151). The current study found that Hispanic children consumed the same number of servings of snacks as Black and White children, but that White children consumed more servings than Black children. However, it is possible that the number of snacking occasions and the number of snack servings are not associated. Data from the 2008 Feeding Infants and Toddlers Study showed that 86% of children 2 and 3 y consumed some type of sweetened beverage, dessert, sweet, or salty snack in a day; however, that study did not look at the number of servings consumed (59). The current study found that the number of servings of snacks consumed by children was positively associated with consumption of servings of sweets and snacks combined.

The relationship of snacking behavior and weight in preschool children is not clear; although in older children, sedentary behavior (56), which may occur during snacking occasions, coupled with large portion size, intake of sweets and salty foods which may be nutrient-poor, energy dense, and low intake of FV, may contribute to high BMI (56-58). Another study showed that snacking was associated with reduced risk of weight and abdominal obesity (152); however, that study was done in adolescents. Because of the uncertainty of the effect of snacks, it is important to study snack intake in children and adults. Previous studies have suggested that mothers' intake of snacks, as well as nutrient-poor, energy-dense foods, such as sweets, influenced intake of children (6,52,54); however, another study suggested there was no correlation between sweet or savory snack food consumption of parents and children 5-6 y (51). This study showed that consumption of servings of snacks and intake of sweet and salty snacks in the mother-child dyads was highly correlated. This provides the opportunity for the mother to model consumption of nutrient-dense snack foods for their children.

Consumption of FV is associated with intake of key nutrients which have a protective effect on health, especially cardiovascular health (153) and cancer (154). Intuitively it would be expected that FV consumption would also be associated with a healthy weight (61,155); however, this relationship has recently been questioned (142). In the current study, the average intake of FV by low-income mothers and children was well below the recommended number of 1-1½ cups of fruit and 1-1½ cups of vegetables per day for children, and 1½-2½ cups of fruit and 2-4 cups of vegetables per day for adult females (16,150). Low-income status may affect intake of FV due to reduced availability (116). Stronger positive correlations between FV intake in parents and children have been observed in those households with sufficient availability of these foods (61); although, that study was done in children and adolescents 6-18 y, not in preschool children. Other studies involving older children and adolescents have also shown this association (3,61,144). The positive association in FV intake shown in this study between mothers and preschool children suggested that parental modeling was important and that mothers could encourage consumption of these healthful foods by consuming them themselves.

Differences in FV intakes among Blacks, Hispanics, and Whites have been shown. Mexican Americans and Whites were found to consume more servings of fruit than Blacks. Whites consumed the most servings of vegetables, and Blacks consumed the least (116). In the current study, Hispanic children consumed more servings of FV than Black or White children. Some differences in intake among races have been explained by differences in socioeconomic status (SES). Blacks have been shown to consume fewer servings of FV than Whites; half of this difference was associated with SES (116). In the current study, SES was not a determinant of differences in intake since all subjects were low-income. Cultural preferences or the lack of availability of FV may have accounted for these findings (156).

The gram amount of food consumed was highly correlated in mother-child dyads. The amount of food intake has been understudied and a direct association between food intake and BMI is unclear. Energy intake was more likely to be associated with BMI than food intake *per se* (157). High energy intake has been associated with high BMI in children (158). Controlling portion sizes of energy-dense foods, frequency of meals, and increasing portion sizes of FV (159) may be beneficial in controlling energy intake. This may be an effective method of controlling weight. Since children imitate the diets of their parents (1,3), teaching mothers to control portion sizes and frequency of meals may be beneficial in preventing childhood obesity. Further research is needed to determine if a causative relationship exists between volume of food intake and energy intake and BMI.

Efforts to prevent childhood obesity should include promotion of healthy snacking and low intake of nutrient-poor energy dense foods by parents. Additionally, it is important for children to be exposed to an environment that promotes intake of healthy foods, such as FV. Ideally, this environment should include high availability of FV, parental promotion of their consumption, and parental modeling of consumption (59). Therefore, nutrition professionals and communities need to work together to increase availability and knowledge of the benefits of FV to low-income populations.

<u>Study Limitations</u>

This is a cross-sectional study, thus causal inferences cannot be drawn. Twenty-four hour dietary recalls may not reflect usual intake. They depend on memory; thus, subjects may under- or over-report intake. However, a single 24-hour recall is sufficient to report mean usual intake of a group (120). The mother served as a proxy for their child during the 24-hour recall interview; whereas, mothers can often accurately report what the child consumed at home (132)

and they may not know what the child consumed outside the home (134) which can result in reporting errors. Lastly, this study was conducted in low-income mother-child dyads in HS programs in the southern United States, and findings cannot be generalized to other populations.

Conclusions

Food group consumption from snacks was highly correlated in the mother-child dyads studied. Fruit and vegetable consumption was low in mothers and their children and consumption was highly correlated in the dyads. It is important that nutrition educators address healthy snacking, low consumption of sweets, and increased consumption of FV with mothers so that they are more likely to provide and model consumption of healthy foods for their preschool children. This may be an important strategy in the prevention and reduction of childhood obesity and a way to increase overall diet quality.

CHAPTER 4

DIETARY INTAKES OF ENERGY, SELECTED MACRONUTRIENTS, AND SELECTED MICRONUTRIENTS AMONG MOTHER-CHILD DYADS FROM HEAD START ARE HIGHLY CORRELATED

Introduction

Influences on the diets of preschool children have been understudied. However, studies have shown that the diets of preschool children and their parents were more strongly correlated than the diets of older children (6,160) or adolescents (160) and parents. Overall, preschool children's diets and food preferences have been shown to be influenced by those of their parents, especially mothers (1,3). Mothers' own food preferences influence the foods they buy and consume, as well as those made available to their children (1). Mothers also model eating behaviors to their children (3). Outside the home, preschool children chose foods they had seen their parents purchase (12,143). If the diets of mothers are poor, the diets of their children may also be poor, putting both groups at risk for chronic disease (15).

Children attending Head Start (HS), a preschool program for low-income children 3-5 y (139), consumed fewer essential nutrients than children attending other preschool programs (9). Children from HS were also more likely to be obese than children from other preschool programs (9). Further, the body mass index (BMI) z-score of children attending HS was significantly associated with parental BMI (161). This was not unexpected, as the diets of low-income populations were generally energy-dense and nutrient-poor (11,115). Further, low-income women had poorer diets than their higher income counterparts (115).

Energy intake by children and adult females decreased between 2003 and 2008 (22). The recommendations of 4,180-6,690 kilojoules (kJ) per day for children 2-5 y, and 6,690-10,040 kJ per day for adult females are dependent on age and activity level (21), and since that study did not look at physical activity (22), it is difficult to determine if children's and adults' energy

intakes actually exceeded their recommendations. However, in the past 25 years, obesity and related comorbidities increased in children and adults (162). As excess energy intake is a well-known contributor to obesity, this suggests that mean energy intake may have exceeded recommendations.

The 2010 Dietary Guidelines for Americans (DGA) identified dietary fiber, vitamin D, calcium, and potassium as nutrients of public health concern for children and adults (21). Recommended intakes of nutrients for children and mothers are summarized in Table 2.1. Mean intake of dietary fiber and vitamin D by children (9,10,22) and adult females (22) was insufficient to meet the adequate intake (AI) and estimated average requirement (EAR), respectively, established by the Institute of Medicine (IOM) (15). Recent evidence showed that calcium may be a shortfall nutrient in children as young as 4 y (26). Calcium was also a shortfall nutrient among adult females, as mean intake did not meet the recommended dietary allowance (RDA) (15,22). Finally, mean intake of potassium was below the AI for both children (9,10,15,22) and adults (15,22).

Nutrients of overconsumption in the diets of children and adults, as identified by the 2010 DGA, are added sugars, saturated fatty acids (SFA), trans fat, and sodium (21). Added sugars, SFA, and trans fat are thought to contribute large amounts of energy to the diet, and relatively few essential nutrients (15,21). Sodium was positively associated with blood pressure (BP) in preschool children (32) and risk of hypertension in adults (111). Because of the associations of those nutrients and the nutrients of public health concern with the health of children and adults, the objective of our study was to determine the correlation in intakes of energy, dietary fiber, vitamin D, calcium, potassium, added sugars, SFA, trans fat, and sodium between mother-child dyads from Head Start.

Table 2.1: Recommended Nutrient Intakes per Day for Children Under 8 y and Adult Females.

	Children < 8 y	Adult Females
Energy (kJ)[a]	2010 DGA[f]: 4180-8370 (21)	2010 DGA: 7535-9210 (21)
Dietary Fiber (g)[b]	AI[g] 1 – 3 y: 19 (15) AI 4 – 8 y: 25 (15)	AI: 25 (15)
Vitamin D (µg)[c]	EAR[h]: 10 (15)	
Calcium (mg)[d]	RDA[i] 1 – 3 y: 700 (15) RDA 4 – 8 y: 1000 (15)	RDA: 1000 (15)
Potassium (mg)	AI 1 – 3 y: 3000 (15) AI 4 – 8 y: 3800 (15)	AI: 4700 (15)
Added Sugars (g)	IOM[j]: < 25% energy (15)	IOM: < 25% energy (15) AHA[k]: < 420 kJ (37)
SFA[e] (g)	IOM: As low as possible (15) 2010 DGA: < 10% energy (21)	
Trans Fat (g)	IOM & 2010 DGA: As low as possible (15,21)	
Sodium (mg)	UL[l] 1 – 3 y: 1500 (15) UL 4 – 8 y: 1900 (15)	UL: 2300 (15) UL for Blacks: 1500 (15)

[a]Kilojoules; [b]grams; [c]micrograms; [d]milligrams; [e]saturated fatty acids; [f]Dietary Guidelines for Americans; [g]adequate intake; [h]estimated average requirement; [i]recommended dietary allowance; [j]Institute of Medicine; [k]American Heart Association; [l]tolerable upper level limit

Methods and Materials

Study Participants

This study was a secondary analysis of data collected to assess the diets of mothers and children enrolled in HS centers (N=57) in Alabama and Texas. Study participants (N=650) self identified race as Black, Hispanic, or White. All mothers had an income at or below 100% of the poverty level and had a child enrolled in HS. Details of the study design have been published previously (163). The Institutional Review Board of the Baylor College of Medicine approved this study. Informed consent was obtained from adults for themselves and their child.

Dietary Data

Twenty-four hour dietary recalls were collected on all subjects for one weekend day using a standard multiple pass method (122). Mothers, grandmothers, and guardians (subsequently referred to as mothers) provided recalls for their child. Energy and nutrient content of foods were determined using Nutrient Data System for Research software (version 5.0_35, 2004, Nutrition Coordinating Center, University of Minnesota, MN).

Statistical Analysis

Statistical Analysis Software (version 9.2, SAS Institute Inc, Cary, NC, 2008) was used to analyze the data. Means ± standard deviations of nutrient intakes, as well as frequency distributions were calculated. Homogeneity of variance and normal distribution of variables were investigated using plots and histograms of residuals. Differences by race/ethnicity groups were determined using analysis of variance for continuous variables. Chi-square analysis was used for categorical variables. Significant p-values were ≤ 0.05. A Bonferroni correction was applied when comparing multiple variables; thus, the effective p value was 0.0167. Pearson partial correlation coefficients were determined to assess differences in nutrient intakes in the mother-child dyads. Age, ethnicity/race, child BMI z-score, BMI of mothers, and child gender were all covariates.

Results

Demographics of Mother-Child Dyads

Black, Hispanic, and White mother-child dyads comprised 42.5%, 30.0%, and 27.5% of the sample, respectively. The average age of mothers was 31.8±8.3 y, and the average age of children was 4.4±0.6 y.

Nutrient Consumption Patterns of Children and Mothers by Race

Energy intake in children varied significantly by race (Table 2.2) with Hispanic children consuming the most (6,987±2,607 kJ), followed by White (5,577±2,222 kJ) ($p<0.05$) and Black children (4,305±1,828 kJ) ($p<0.05$). Intake of dietary fiber was highest among Hispanic children (12.42±8.36 grams [g]), lower among White children (8.39±4.82 g) and lowest among Black children (6.63±3.85 g) ($p<0.05$). Intake of vitamin D, calcium, and potassium was highest among Hispanic children (6.46±4.21 micrograms [μg], 930.97±558.78 milligrams [mg], and 2,170±961 mg, respectively), lower among White children (4.18±3.58 μg, 634.43±397.25 mg, and 1,509±685 mg, respectively), and lowest among Black children (3.1±4.02 μg, 373.28±219 mg, and 1,054±524 mg, respectively) ($p<0.05$). Intake of added sugars was lowest among Black children (38.8±28.78 g) ($p<0.05$), but did not differ between Hispanic (68.23±46.31 g) and White children (61.61±49.59 g). Intake of SFA was highest among Hispanic children (23.36±12.71 g), lower among White children (19.93±11.22 g), and lowest among Black children (14.27±8.66 g) ($p<0.05$). Trans fat and sodium intake was lowest among Black children (3.16±2.84 g and 1,816±999 mg, respectively) ($p<0.05$), but did not differ between Hispanic (4.04±3.02 g and 2,409±1,094 mg, respectively) and White children (4.72±3.89 g and 2,286±1,157 mg, respectively).

Energy intake was highest in Hispanic mothers (9,414±3,941 kJ) ($p<0.05$), but did not differ between Black (6,205±2,954 kJ) and White mothers (6,858±2,870 kJ). Dietary fiber intake did not differ between Black (8.86±5.68 g) and White mothers (10.4±5.97 g), but was higher among

Table 2.2: Mean ± Standard Deviation of Selected Nutrients for Children and Mothers in Head Start by Race from One Weekend Day 24-hr Recalls (N=650)

	Total		Black		Hispanic		White	
	M ± SD	Min-Max	M ± SD	Min-Max	M ± SD	Min-Max	M ± SD	Min-Max
Children:								
Energy (kJ)[1]	5369 ± 2485	1013–13,263	4305 ± 1828[a]	1013–11,774	6987 ± 2607[b]	1021–13,263	5577 ± 2222[c]	1870–13,263
Dietary Fiber (g)[2]	8.85 ± 6.29	0.48-55.73	6.63 ± 3.85[a]	0.48-25.62	12.42 ± 8.36[b]	0.57-55.73	8.39 ± 4.82[c]	1.05-28.87
Vitamin D (μg)[3]	4.4 ± 4.21	0.01-30.7	3.1 ± 4.02[a]	0.01-30.7	6.46 ± 4.21[b]	0.1-29.06	4.18 ± 3.58[c]	0.16-23.59
Calcium (mg)[4]	612.51 ± 460.3	10.94-4580.92	373.28 ± 219[a]	34.13-1400.53	930.97 ± 558.78[b]	10.94-4580.92	634.43 ± 397.25[c]	72.69-4026.61
Potassium (mg)	1519 ± 896	105–4212	1054 ± 524[a]	105–3394	2170 ± 961[b]	155–4212	1509 ± 685[c]	247–4212
Added Sugars (g)	53.91 ± 42.91	0.43-298.17	38.8 ± 28.78[a]	0.43-182.74	68.23 ± 46.31[b]	0.96-249.98	61.61 ± 49.59[b]	1.1-298.17
SFA[5] (g)	18.55 ± 11.39	1.11-110.88	14.27 ± 8.66[a]	1.11-75.11	23.36 ± 12.71[b]	2.3-76.27	19.93 ± 11.22[c]	3.09-110.88
Trans Fat (g)	3.85 ± 3.28	0.06-33.15	3.16 ± 2.84[a]	0.06-22.62	4.04 ± 3.02[b]	0.16-20.44	4.72 ± 3.89[b]	0.11-33.15
Sodium (mg)	2124 ± 1104	149–10836	1816 ± 999[a]	149–8301	2409 ± 1094[b]	463–7119	2286 ± 1157[b]	466–10836
Mothers:								
Energy (kJ)	7385 ± 3569	736–18,795	6205 ± 2954[a]	1146–18,795	9414 ± 3941[b]	1280–18,795	6845 ± 2870[a]	736–15,284
Dietary Fiber (g)	13.04 ± 10.51	0.5-114.68	8.86 ± 5.68[a]	0.5-38.84	21.36 ± 13.8[b]	2.76-114.68	10.4 ± 5.97[a]	1.1-31.56
Vitamin D (μg)	4.17 ± 6.35	0-82.2	4.18 ± 8.3[bc]	0-82.2	5.22 ± 5.1[b]	0.02-46.79	3 ± 3.15[c]	0.02-25.89
Calcium (mg)	649.51 ± 486.73	28.36-5847.14	469.55 ± 329[a]	28.36-2192.27	930.29 ± 599.24[b]	69.77-5847.14	621.11 ± 409.6[c]	72.9-2514.21
Potassium (mg)	1984 ± 1103	240–5485	1542 ± 824[a]	240–5485	2795 ± 1235[b]	321–5485	1719 ± 738[a]	288–4052
Added Sugars (g)	72.18 ± 59.29	0-448.95	58.17 ± 54.57[a]	0-448.95	83.22 ± 57.79[b]	0-271.8	81.74 ± 63.63[b]	0-414.03
SFA (g)	23.79 ± 15.78	0.34-132.81	20.13 ± 12.07[a]	0.4-64.42	29.33 ± 19.59[b]	1.24-132.81	23.4 ± 14.51[a]	0.34-97.91
Trans Fat (g)	4.97 ± 4.5	0-39.8	4.39 ± 4.23[a]	0-35.3	4.97 ± 4.3[ac]	0.18-39.8	5.84 ± 4.96[c]	0.01-36.79
Sodium (mg)	3075 ± 1770	91.11–17700	2616 ± 1535[a]	91.11–14140	3747 ± 2154[b]	220–17700	3053 ± 1381[a]	476–8261

Means ± (standard deviation) with same letter in their superscripts do not differ significantly from one another according to t-tests with a Bonferroni correction ($p<0.0167$).
[1]Kilojoules; [2]grams; [3]micrograms; [4]milligrams; [5]saturated fatty acids

Hispanic mothers (21.36±13.8 g) ($p<0.05$). Vitamin D intake was higher in Hispanic mothers (5.22±5.1 μg) than White mothers (3±3.15 μg) ($p<0.05$); however intake by Black mothers (4.18±8.3 μg) did not differ from the intakes of Hispanic and White mothers. Calcium intake was highest among Hispanic mothers (930.29±599.24 mg), lower among White mothers (69.77±5847.14 mg), and lowest among Black mothers (469.55±329 mg) ($p<0.05$). Potassium intake did not differ between Black (1,542±824 mg) and White mothers (1,719±738 mg), but was higher among Hispanic mothers (2,795±1,235 mg) ($p<0.05$). Added sugars intake was lowest among Black mothers (58.17±54.57 g) ($p<0.05$), but did not differ between Hispanic (83.22±57.79 g) and White mothers (81.74±63.63 g). Intake of SFA did not differ between Black (20.13±12.07 g) and White mothers (23.4±14.51 g), but was higher among Hispanic mothers (29.33±19.59 g) ($p<0.05$). Intake of trans fat by Black mothers (4.39±4.23 g) was higher than intake by White mothers (5.84±4.96 g) ($p<0.05$); however intake by Hispanic mothers (4.97±4.3 g) did not differ from Black or White mothers' intakes. Sodium intake did not differ between Black (2,616±1,535 mg) and White mothers (3,053±1,381 mg), but was higher among Hispanic mothers (3,747±2,154 mg) ($p<0.05$).

<u>Nutrient Consumption Patterns of Children Only and Mothers Only</u>

Intake of energy in children was positively associated with intake of macronutrients and all selected micronutrients (all $p<0.0001$) (Table 2.3). Potassium intake was associated with intake of dietary fiber and calcium (both $p<0.0001$). Added sugars intake was associated with intake of SFA and trans fat (both $p<0.0001$).

In mothers, intake of energy was associated with intake of all other nutrients (all $p<0.0001$) (Table 2.4). Potassium intake by mothers was associated with intake of dietary fiber and calcium

Table 2.3: Partial Correlations Between Energy, Dietary Fiber, Vitamin D, Calcium, Potassium, Added Sugars, SFA, Trans Fat, and Sodium for Children in Head Start: One Weekend Day 24-hr Recall (N=650)

Children	Energy	Dietary Fiber	Vitamin D	Calcium	Potassium	Added Sugars	SFA[5]	Trans Fat	Sodium
Energy (kJ)[1]									
Dietary Fiber (g)[2]	0.676[a]								
Vitamin D (µg)[3]	0.377[a]	0.265[a]							
Calcium (mg)[4]	0.669[a]	0.530[a]	0.512[a]						
Potassium (mg)	0.809[a]	0.745[a]	0.516[a]	0.719[a]					
Added Sugars (g)	0.577[a]	0.221[a]	0.115[b]	0.239[a]	0.265[a]				
SFA (g)	0.816[a]	0.447[a]	0.341[a]	0.703[a]	0.614[a]	0.345[a]			
Trans Fat (g)	0.506[a]	0.215[a]	0.074	0.219[a]	0.259[a]	0.241[a]	0.523[a]		
Sodium (mg)	0.740[a]	0.470[a]	0.235[a]	0.513[a]	0.546[a]	0.319[a]	0.692[a]	0.524[a]	

Adjusted for child BMI z-score, sex, age, ethnicity/race
p-value: [a]$p<0.0001$; [b]$p<0.005$
[1]Kilojoules; [2]grams; [3]micrograms; [4]milligrams; [5]saturated fatty acids

Table 2.4: Partial Correlations Between Energy, Dietary Fiber, Vitamin D, Calcium, Potassium, Added Sugars, SFA, Trans Fat, and Sodium for Mothers of Head Start Children: One Weekend Day 24-hr Recall (N=650)

Mothers	Energy	Dietary Fiber	Vitamin D	Calcium	Potassium	Added Sugars	SFA[5]	Trans Fat	Sodium
Energy (kJ)[1]									
Dietary Fiber (g)[2]	0.681[a]								
Vitamin D (µg)[3]	0.283[a]	0.183[a]							
Calcium (mg)[4]	0.623[a]	0.605[a]	0.294[a]						
Potassium (mg)	0.794[a]	0.801[a]	0.386[a]	0.633[a]					
Added Sugars (g)	0.545[a]	0.177[a]	0.007	0.153[a]	0.223[a]				
SFA (g)	0.818[a]	0.477[a]	0.196[a]	0.649[a]	0.581[a]	0.301[a]			
Trans Fat (g)	0.518[a]	0.230[a]	0.156[a]	0.306[a]	0.273[a]	0.246[a]	0.520[a]		
Sodium (mg)	0.752[a]	0.507[a]	0.274[a]	0.536[a]	0.630[a]	0.250[a]	0.711[a]	0.500[a]	

Adjusted for child BMI z-score, sex, age, ethnicity/race
p-value: [a]p<0.0001
[1]Kilojoules; [2]grams; [3]micrograms; [4]milligrams; [5]saturated fatty acids

(both p<0.0001). Intake of added sugars was associated with intake of SFA and trans fat (both p<0.0001).

Correlation of Intake between Children and Mothers

Intake of energy, dietary fiber, vitamin D, calcium, potassium, added sugars, SFA, trans fat, and sodium in mothers was associated with intake of the corresponding nutrients in children (all p<0.0001) (Table 2.5). As expected, energy intake in mothers was positively associated with intake of all nutrients in children (all p<0.0001).

Discussion

Nutrient consumption among mother-child dyads was highly correlated. There was a strong correlation in mean energy intake between preschool children and their mothers, suggesting that parental intake influenced the child's intake. Mean intake of dietary fiber, vitamin D, calcium, and potassium did not meet recommendations in either age group. Mean intake of added sugars by mothers exceeded the American Heart Association (AHA) recommendation, but did not exceed the IOM recommendation. Mean intake of SFA and sodium by children and mothers exceeded the recommendations.

Energy intake was highly correlated between children and mothers (Figure 2.1), and also varied by race. The reported energy intake of Black and White children was less than that of Hispanic children. Data from the 2007-2008 National Health and Nutrition Examination Survey (NHANES) showed that among children 2-5 y, White children had the lowest mean energy intake (164), whereas the current study showed that Black children consumed the least energy. However, that study did not look at income and race together.

Intakes of dietary fiber, vitamin D, calcium, and potassium were correlated in mother-child dyads. Children's intakes of dietary fiber, vitamin D, calcium, and potassium were

Table 2.5: Partial Correlations for Nutrients Between Children and Mothers from Head Start: One Weekend Day 24-hr Recall (N=650)

Children	Mothers								
	Energy	**Dietary Fiber**	**Vitamin D**	**Calcium**	**Potassium**	**Added Sugars**	**SFA[5]**	**Trans Fat**	**Sodium**
Energy (kJ)[1]	0.483[a]	0.461[a]	0.100[d]	0.405[a]	0.490[a]	0.181[a]	0.384[a]	0.212[a]	0.390[a]
Dietary Fiber (g)[2]	0.311[a]	0.529[a]	0.070	0.339[a]	0.433[a]	0.020	0.178[a]	0.010	0.236[a]
Vitamin D (µg)[3]	0.220[a]	0.248[c]	0.428[a]	0.197[a]	0.344[a]	0.014	0.136[b]	0.048	0.174[a]
Calcium (mg)[4]	0.349[a]	0.410[a]	0.122	0.538[a]	0.408[a]	0.057	0.318[a]	0.101[d]	0.292[a]
Potassium (mg)	0.413[a]	0.509[a]	0.137[b]	0.376[a]	0.560[a]	0.068	0.289[a]	0.079	0.323[a]
Added Sugars (g)	0.231[a]	0.135[b]	0.029	0.103[d]	0.167[a]	0.298[a]	0.129[b]	0.097[d]	0.162[a]
SFA (g)	0.440[a]	0.348[a]	0.087[d]	0.421[a]	0.394[a]	0.150[a]	0.460[a]	0.231[a]	0.341[a]
Trans Fat (g)	0.252[a]	0.111[c]	0.056	0.149[a]	0.141[a]	0.069	0.227[a]	0.380[a]	0.188[a]
Sodium (mg)	0.354[a]	0.283[a]	0.053	0.308[a]	0.322[a]	0.150[c]	0.310[a]	0.229[a]	0.401[a]

Adjusted for child BMI z-score, child sex, child age, parent age (yrs), parent BMI
p-value: [a]<0.0001; [b]<0.005; [c]<0.01; [d]<0.05
[1]Kilojoules; [2]grams; [3]micrograms; [4]milligrams; [5]saturated fatty acids

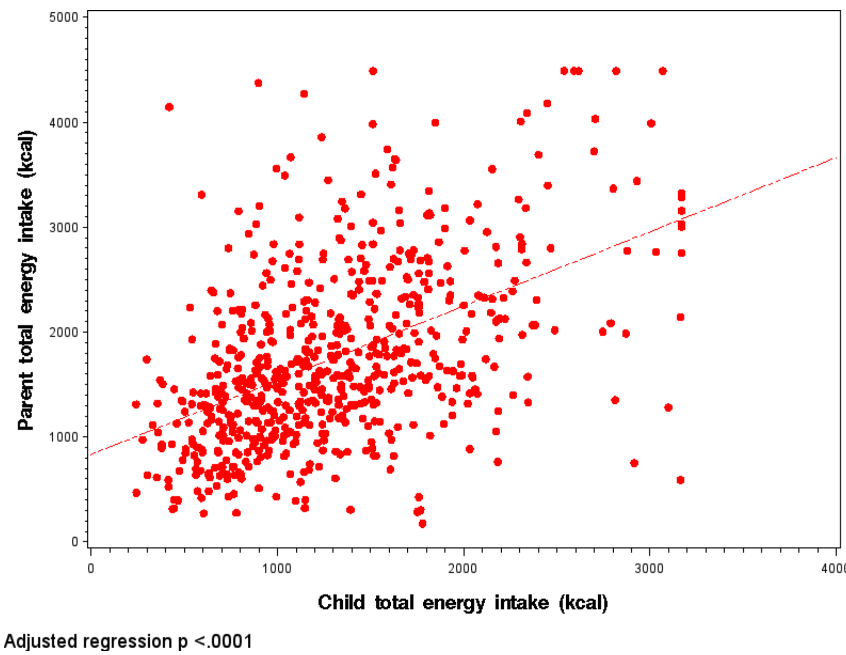

Figure 2.1: Total Energy Intake for One Weekend Day (kilojoules) by Mother-Child Dyads from Head Start in Alabama and Texas

correlated. However, children consumed less than the AI for dietary fiber, the EAR for vitamin D, the RDA for calcium, and the AI for potassium. In children, consumption of dietary fiber below the AI and vitamin D below the EAR was associated with constipation (23) and rickets disease (24), respectively. Recent evidence showed that calcium may be a shortfall nutrient in children as young as 4 y (26). Further, inadequate intake of calcium during childhood may increase the risk of fractures during adulthood (165). A relationship between potassium intake and children's health is unclear; however, nutrient intakes were shown to track, beginning in early childhood (31). This suggests that inadequate intake of potassium during childhood may continue in adulthood.

Mothers' intakes of dietary fiber, vitamin D, calcium, and potassium were also correlated. Similar to their children, mothers did not meet the AI for dietary fiber, the EAR for vitamin D, the RDA for calcium, or the AI for potassium. In adults, consumption of dietary fiber above the

AI and vitamin D above the EAR was associated with better gastrointestinal function (28) and immune health (29), respectively. In adults, calcium intake below the RDA was associated with risk of osteoporosis (27), while intake above the RDA was positively associated with bone health (15). Inadequate potassium intake in adults was positively associated with BP (15), while consumption above the AI was associated with reduced risk of cardiovascular disease (CVD) (30).

Because fruit and vegetables (FV) are high in dietary fiber and potassium (21), and dairy products may be fortified with vitamin D and are high in calcium and potassium (21), the associations between and inadequate intakes of dietary fiber and potassium may indicate low FV consumption in low-income mother-child dyads. Low-income families consumed 0.62 fewer servings of FV than families from higher incomes (116). The associations between and inadequate intakes of vitamin D, calcium, and potassium may indicate low intake of dairy. Evidence showed a positive association between intake of dairy and potassium (166).

Intake of added sugars, SFA, trans fat, and sodium were correlated between children and mothers. Intakes of added sugars, SFA, trans fat, and sodium by children were correlated. Intake of added sugars among children did not exceed the IOM recommendation; however, intake was shown to increase between 2 and 7 y (86) and to continue to increase with age (38). High intake of added sugars contributed energy to the diet, but few other nutrients (21). Children's intake of SFA exceeded recommended intake. Mean trans fat intake in children comprised approximately 2.7% of total energy. While there is no clear recommendation for trans fat intake, the 2010 DGA recommended consuming as little as possible (21). Further, it is likely that children's intakes of SFA and trans fat are indicators of solid fat intake. Data from the 2001-2004 NHANES showed that children consumed approximately 1422-1674 kJ per day from solid fat (87). This exceeded

the 2010 DGA recommendation of no more than 500-570 kJ per day from solid fat and added sugars (21). Finally, sodium intake in children exceeded the tolerable upper level limit (UL). This may lead to elevated BP in children (32,74), which was shown to track into adulthood (88).

Mothers' intakes of added sugars, SFA, trans fat, and sodium were also correlated. In the current study, added sugars intake by mothers did not exceed the IOM recommendation, but did exceed the AHA recommendation. The IOM established its recommendation since intake of added sugars above this amount was associated with intake of other essential nutrients below recommendations (15,94). However, the rationale for the AHA recommendation is largely based on the discretionary energy allowance defined by the 2005 DGA (38), which is now antiquated. Mothers' SFA intake exceeded the 2010 DGA recommendation. Intake of SFA and trans fat were associated with high levels of low-density lipoprotein cholesterol (LDL-C) (95,167) and low levels of high-density lipoprotein cholesterol (HDL-C) (167). These are both risk factors for CVD (98,105). Finally, mothers' intake of sodium exceeded the UL. Sodium intake in adults was associated with high BP and increased risk for hypertension (32,73,74,90).

Mothers served as a proxy for their children during 24-hour recall interviews, and may have underreported intake for their children and themselves (132-134). However, a relationship between parental over- or underreporting of child's intake using 24-hour recalls and other factors, including ethnicity, income, or weight, is not clear. Differences in body weight expectations among adults of different races were shown (168), and this may account for some differences in reported intakes. In one study, Blacks were less likely to underreport intake than Whites; however, that study was conducted among elderly adults (169). In another study, Hispanics underreported intake by an average of 1,063 kJ/day; however, that study did not look

at reported intake of other races (170). Thus it is unclear if underreporting of children's and mothers' intakes occurred in the current study.

Study Limitations and Strengths

This study had several limitations. As a cross-sectional study, the data do not imply causality. Data were collected on low-income children and mothers participating in HS in Alabama and Texas, and results may not be generalized to another population. Because 24-hour recalls are memory-dependent, reporting errors may occur. Additionally, 24-hour recalls may not reflect usual intake; however, 24-hour recalls for a single day have been shown to effectively represent usual intake of a population (120).

This study looked at the diets of preschool children and their mothers from a low-income, multi-ethnic population. This population is understudied; thus it was a strength of our study. The current study also had a large sample size (n=650), likely increasing precision. Finally, 24-hour recalls were used to collect dietary data, and these were shown to estimate the dietary intake of a population within 10% of actual intake (121-123).

Conclusions

This study showed that nutrient intake is highly correlated between low-income children and mothers. Further, both children and mothers consumed dietary fiber, vitamin D, calcium, and potassium in insufficient amounts to meet recommendations, and consumed more than the recommended amounts of SFA and sodium. Therefore, it is evident that the diet of this population needs improvement. Nutrition educators have an opportunity to intervene by encouraging and teaching healthy eating habits to low-income mothers so that they can model these habits to their children.

CHAPTER 5

SUMMARY

These two studies have shown that there is a strong correlation between the diets of low-income preschool children and their mothers. The first study showed that children's and mothers' consumption of snacks, sweets, fruit, and vegetables was highly correlated. Additionally, fruit and vegetable consumption in mother-child dyads was low. Healthy snacking, low consumption of sweets, and increased consumption of FV should be encouraged in mothers so that they can model healthy eating habits to their children.

The second study showed that energy, macronutrient, and micronutrient consumption was highly correlated in mother-child dyads. Children and mothers did not meet the recommendations for dietary fiber, vitamin D, calcium, and potassium, and exceeded the recommendations for SFA and sodium. Mothers' intakes also exceeded the AHA recommendation for added sugars. Consumption of foods high in dietary fiber, vitamin D, calcium, and potassium, and low in added sugars, SFA, trans fat, and sodium should be encouraged in mothers so that they can model these habits to their children.

The limitations of both of these studies were similar. Both studies used cross-sectional data; thus, causal inferences cannot be drawn. Twenty-four hour recalls were used to assess dietary intake. Because these rely on memory, over- or underreporting may have occurred; however, single-day 24-hour recalls have been shown to be sufficient for estimating intake of a group (120). Mothers served as a proxy for their children during the 24-hour recall; however, mothers may not know what their children consumed outside of the home, which could result in reporting errors. Finally, this study was conducted in low-income children participating in HS

and their mothers in the southern United States, and therefore, cannot be generalized to another population.

These data clearly show that intake between low-income preschool children and their mothers is highly correlated. The diet of this population, however, needs improvement. Head Start provides an ideal venue for dietary intervention. Possible interventions include educational programs for parents of HS children, integration of nutrition education into the HS curriculum, and provision of nutrient-dense meals and snacks.

REFERENCES

1. Anzman S, Rollins B, Birch L. Parental influence on children's early eating environments and obesity risk: implications for prevention. *Int J Obes*. 2010;34:1116-1124.

2. Fisher J, Mitchell D, Smiciklas-Wright H, Birch L. Maternal milk consumption predicts the tradeoff between milk and soft drinks in young girls' diets. *J Nutr*. 2000;131:246-250.

3. Hart C, Raynor H, Jelalian E, Drotar D. The association of maternal food intake and infants' and toddlers' food intake. *Child Care Health Dev*. 2010;36:396-403.

4. Savage J, Fisher J, Birch L. Parental influence on eating behavior. *J Law Med Ethics*. 2007;35:22-34.

5. Fisk CM, Crozier SR, Inskip HM, Godfrey KM, Cooper C, Robinson SM. Influences on the quality of young children's diets: the importance of maternal food choices. *Brit J Nutr*. 2011;105:287-296.

6. Papas M, Hurley K, Quigg A, Oberlander S, Black M. Low-income, African American adolescent mothers and their toddlers exhibit similar dietary variety patterns. *J Nutr Ed Behav*. 2009;41:87-94.

7. Wang Y, Beydoun M, Li J, Liu Y, Moreno L. Do children and their parents eat a similar diet? Resemblance in child and parental dietary intake: systematic review and meta-analysis. *J Epidemiol Community Health*. 2011;65:177-189.

8. Lorson B, Melgar-Quinonez H, Taylor C. Correlates of fruit and vegetable intake in U.S. children. *J Am Diet Assoc*. 2009;109:474-478.

9. Bucholz E, Desai M, Rosenthal M. Dietary intake in Head Start vs non-Head Start preschool-aged children: results from the 1999-2004 National Health and Nutrition Examination Survey. *J Am Diet Assoc*. 2011;111:1021-1030.

10. Butte NF, Fox MK, Briefel RR, Siega-Riz AM, Dwyer JT, Deming DM, Reidy KC. Nutrient intakes of US infants, toddlers, and preschoolers meet or exceed dietary reference intakes. *J Am Diet Assoc*. 2010;110:S27-S37.

11. Drewnowski A, Darmon N. The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr*. 2005;82:265S-273S.

12. Sutherland L, Beavers D, Kupper L, Bernhardt A, Heatherton T, Dalton M. Like parent, like child: child food and beverage choices during role playing. *Arch Pediatr Adolesc Med*. 2008;162:1063-1069.

13. Piernas C, Popkin BM. Trends in snacking among U.S. children. *Health Aff*. 2010;29:398- 404.

14. Lucas BL. Nutrition in childhood. In: Mahan LK, Escott-Stump S, eds. *Krause's Food, Nutrition, & Diet Therapy*. Philedelphia, PA: Saunders; 2004:259-283.

15. Otten JJ, Hellwig JP, Meyers LD, eds. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, D.C.: The National Academies Press; 2006.

16. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc*. 2006;106:1371-1379.

17. Piernas C, Popkin BM. Snacking increased among U.S. adults between 1977 and 2006. *J Nutr*. 2010;140:325-332.

18. Kerver JM, Yang EJ, Obayashi S, Bianchi L, Song WO. Meal and snack patterns are associated with dietary intake of energy and nutrients in US adults. *J Am Diet Assoc*. 2006;106:46-53.

19. Dauchet L, Amouyel P, Hercberg S, Dallongeville J. Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. *J Nutr*. 2006;136:2588-2593.

20. Harding A, Wareham NJ, Bingham SA, Khaw K, Luben R, Welch A, Forouhi NG. Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus: the European Prospective Investigation of Cancer-Norfolk Prospective Study. *Arch Intern Med*. 2008;168:1493-1499.

21. United States Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010*. 7th Edition, Washington, DC: U.S. Government Printing Office.

22. United States Department of Agriculture: Agricultural Research Service. What We Eat in America. *Nutrient intakes from food: mean amounts consumed per individual by gender and age in the United States: National Health and Nutrition Examination Survey 2007-2008*. Available at http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0708/Table_1_NIN_GEN_07.pdf. Accessed August 23, 2011.

23. Morais MB, Vitolo MR, Aguirre AN, Fagundes-Neto U. Measurement of low dietary fiber intake as a risk factor for chronic constipation in children. *J Pediatr Gastroenterol Nutr*. 1999;29:132-135.

24. Holick MF. Vitamin D: photobiology, metabolism, mechanism of action, and clinical

application. In: Favus MJ, eds. *Primer on the Metabolic Bone Diseases and Mineral Metabolism 4th edition*. Philadelphia, PA: Lippincott, Williams and Wilkins; 1999:92-98.

25. Nicklas TA, O'Neil CE, Fulgoni VL III. The role of dairy in meeting the recommendations for shortfall nutrients in the American diet. *J Am Coll Nutr*. 2009;28:73S-81S.

26. Bailey RL, Dodd KW, Goldman JA, Gahche JJ, Dwyer JT, Moshfegh AJ, Sempos CT, Picciano MF. Estimation of total usual calcium and vitamin D intakes in the United States. *J Nutr*. 2010;140:817-822.

27. Ilich JZ, Kerstetter JE. Nutrition in bone health revisited: a story beyond calcium. *J Am Coll Nutr*. 2000;19:715-737.

28. Anderson JW, Baird P, Davis Jr RH, Ferreri S, Knudtson M, Koraym A, Waters V, Williams CL. Health benefits of dietary fiber. *Nutr Rev*. 2009;67:188-205.

29. Liu PT, Stenger S, Li H, Wenzel L, Tan BH, Krutzik SR, Ochoa MT, Schauber J, Wu K, Meinken C, Kamen DL, Wagner M, Bals R, Steinmeyer A, Zügel U, Gallo RL, Eisenberg D, Hewison M, Hollis BW, Adams JS, Bloom BR, Modlin RL. Toll-like receptor triggering of a vitamin D-mediated human antimicrobial response. *Science*. 2006;311:1770-1773.

30. D'Elia L, Barba G, Cappuccio FP, Strazzullo P. Potassium intake, stroke, and cardiovascular disease: a meta-analysis of prospective studies. *J Am Coll Cardiol*. 2011;57:1210-1219.

31. Singer MR, Moore LL, Garrahie EJ, Ellison RC. The tracking of nutrient intake in young children: The Framingham Children's Study. *Am J Public Health*. 1995;85:1673-1677.

32. He F, MacGregor G. Importance of salt in determining blood pressure in children: a meta-analysis of controlled trials. *Hypertension*. 2006;48:861-869.

33. Chen X. Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. *Circulation*. 2008;117:3171-3180.

34. Riccardi G, Giacco R, Rivellese AA. Dietary fat, insulin sensitivity and the metabolic syndrome. *Clin Nutr*. 2004;23:447-456.

35. Hu FB, Stampfer MJ, Manson JE, Ascherio A, Colditz GA, Speizer FE, Hennekens CH, Willett WC. Dietary saturated fats and their food sources in relation to the risk of coronary heart disease in women. *Am J Clin Nutr*. 1999;70:1001-1008.

36. Kromhout D, Menotti A, Bloemberg B, Aravanis C, Blackburn H, Buzina R, Dontas AS, Fidanza F, Giampaoli S, Jansen A, Karvonen M, Katan M, Nissinen A, Nedeljkovic S,

Pekkarinen J, Punsar S, Rasanen L, Simic B, Toshima H. Dietary saturated and trans fatty acids and cholesterol and 25-year mortality from coronary heart disease: the Seven Countries Study. *Prev Med*. 1995;24:308-315.

37. Cohen HW, Hailpern SM, Alderman MH. Sodium intake and mortality follow-up in the third National Health and Nutrition Examination Survey (NHANES III). *J Gen Intern Med*. 2008;23:1297-1302.

38. Johnson RK, Appel LJ, Brands M, Howard BV, Lefevre M, Lustig RH, Sacks F, Steffen LM, Wylie-Rosett J. Dietary sugars intake and cardiovascular health. *Circulation*. 2009;120:1011-1020.

39. Giskes K, Turrell G, Patterson C, Newman B. Socioeconomic differences among Australian adults in consumption of fruit and vegetables and intakes of vitamins A, C and folate. *J Hum Nutr Diet*. 2002;15:375-385.

40. Giskes K, Avendano M, Brug J, Kunst AE. A systematic review of studies on socioeconomic inequalities in dietary intakes associated with weight gain and overweight/obesity conducted among European adults. *Obes Rev*. 2010;11:413-429.

41. Irala-Estevez JD, Groth M, Johansson L, Oltersdorf U, Prättälä R, Martínez-González MA. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. *Eur J Clin Nutr*. 2000;54:706-714.

42. Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *Am J Public Health*. 2010;100:216-222.

43. Cleveland LE, Moshfegh AJ, Albertson AM, Goldman JD. Dietary intake of whole grains. *J Am Coll Nutr*. 2000;19:331S-338S.

44. Hoerr S, Nicklas T, Franklin F, Liu Y. Predictors of calcium intake at dinner meals of ethnically diverse mother-child dyads from families with limited incomes. *J Am Diet Assoc*. 2009;109:1744-1750.

45. Pinard CA, Davy BM, Estabrooks PA. Beverage intake in low-income parent-child dyads. *Eat Behav*. 2011. doi: 10.1016/j.eatbeh.2011.7.012.

46. Wiig K, Smith C. The art of grocery shopping on a food stamp budget: factors influencing the food choices of low-income women as they try to make ends meet. *Public Health Nutr*. 2008;12:1726-1734.

47. Glanz K, Sallis JF, Saelens BE, Frank LD. Nutrition Environment Measures Survey in Stores (NEMS-S). Development and evaluation. *Am J Prev Med*. 2007;32:282-289.

48. Horowitz CR, Colson KA, Hebert PL, Lancaster K. Barriers to buying healthy foods for people with diabetes. Evidence of environmental disparities. *Am J Public Health*. 2004;94:1549-1554.

49. Zenk SN, Schultz AJ, Hollis-Neely T, Campbell RT, Holmes N, Watkins G, Nwankwo R, Odoms-Young A. Fruit and vegetable intake in African-Americans: income and store characteristics. *Am J Prev Med*. 2005;29:1-9.

50. Morton JF, Guthrie JF. Diet-related knowledge, attitudes, and practices of low-income individuals with children in the household. *Fam Econ Nutr Rev*. 1997;10:2-14.

51. Campbell KJ, Crawford DA, Ball K. Family food environment and dietary behaviors likely to promote fatness in 5-6 year-old children. *Int J Obes*. 2006;30:1272-1280.

52. Wardle J, Cooke L. Genetic and environmental determinants of children's food preferences. *Br J Nutr*. 2008;99:S15-S21.

53. Fisher J, Mitchell D, Smiciklas-Wright H, Birch L. Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *J Am Diet Assoc*. 2002;102:58-64.

54. Beydoun MA, Wang Y. Parent-child dietary intake resemblance in the United States: evidence from a large representative study. *Soc Sci Med*. 2009;68:2137-2144.

55. United States Department of Agriculture. Agricultural Research Service. *Snacks: Distribution of Snack Occasions by Gender and Age. What We Eat in America 2007-2008. National Health and Nutrition Examination Survey*. Available at http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0708/Table_29_DSO_GEN_07.pdf. Accessed July 7, 2011.

56. Gubbels J, Kremers S, Stafleu A, Dagnelie P, de Vries S, de Vries N, Thijs C. Clustering of dietary intake and sedentary behavior in 2-year-old children. *J Pediatr*. 2009;155:194-198.

57. Looney S, Raynor H. Impact of portion size and energy density on snack intake in preschool-aged children. *J Am Diet Assoc*. 2011;111:414-418.

58. Maffeis C, Grezzani A, Perrone L, Del Guidice E, Saggese G, Tato L. Could the savory taste of snacks be a further risk factor for overweight in children? *J Pediatr Gastroenterol Nutr*. 2008;46:429-437.

59. Fox M, Condon E, Briefel R, Reidy K, Deming D. Food consumption patterns of young preschoolers: are they starting off on the right path? *J Am Diet Assoc*. 2010;110:S52-S59.

60. O'Connor TM, Hughes SO, Watson KB, Baranowski T, Nicklas TA, Fisher JO, Beltran A, Baranowski JC, Qu H, Shewchuk, R. M. Parenting practices are associated with fruit

and vegetable consumption in pre-school children. *Public Health Nutr*. 2010;13:91-101.

61. Rasmussen M, Krolner R, Klepp K, Lytle L, Brug J, Bere E, Due P. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part 1: quantitative studies. *Int J Behav Nutr Phys Act*. 2006;3:22.

62. Demory-Luce D, Morales M, Nicklas T, Baranowski T, Zakeri I, Berenson G. Changes in food group consumption patterns from childhood to young adulthood: The Bogalusa Heart Study. *J Am Diet Assoc*. 2004;104:1684-1691.

63. Kant AK. Consumption of energy-dense, nutrient-poor foods by adult Americans: nutritional and health implications. The third National Health and Nutrition Examination Survey, 1988-1994. *Am J Clin Nutr*. 2000;72:929-936.

64. Sabaté J, Ang Y. Nuts and health outcomes: new epidemiologic evidence. *Am J Clin Nutr*. 2009;89:1643S-1648S.

65. United States Department of Agriculture. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. *Part D: Science Base, Section 2: Nutrient Adequacy*. Available at http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/DGAC/Report/D-2-NutrientAdequacy.pdf. Accessed November 4, 2011.

66. Williams CL, Bollella M, Spark A, Puder D. Effectiveness of a psyllium enriched step 1 diet in hypercholesterolemic children. *J Am Coll Nutr*. 1991;14:251-257.

67. Glassman M, Spark A, Berezin S, Schwarz S, Medow M, Newman LJ. Treatment of type IIa hyperlipidemia in childhood by a simplified American Heart Association diet and fiber supplementation. *Am J Dis Child*. 1990;144:973-976.

68. Gropper SS, Acosta PB. The therapeutic effect of fiber in treating obesity. *J Am Coll Nutr*. 1987;6:533-535.

69. Wagner CL, Greer FR. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. *Pediatrics*. 2008;122:1142-1152.

70. Boulton TJ, Magarey AM, Cockington RA. Tracking of serum lipids and dietary energy, fat and calcium intake from 1 to 15 years. *Acta Pediatr*. 1995;84:1050-1055.

71. Welton DC, Kemper HC, Post GB, Van Staveren WA, Twisk JW. Longitudinal development and tracking of calcium and dairy intake from teenager to adult. *Eur J Clin Nutr*. 1997;51:612-618.

72. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. 2000;14:222-228.

73. Cook NR, Obarzanek E, Cutler JA, Buring JE, Rexrode KM, Kumanyika SK, Appel LJ, Whelton PK. Joint effects of sodium and potassium intake on subsequent cardiovascular disease: the Trials of Hypertension Prevention follow up study. *Arch Intern Med*. 2009;169:32-40.

74. He F, Marrero N, MacGregor G. Salt and blood pressure in children and adolescents. *J Hum Hypertens*. 2008;22:4-11.

75. Weickert MO, Pfeiffer AFH. Metabolic effects of dietary fiber consumption and prevention of diabetes. *J Nutr*. 2008;138:439-442.

76. Estruch R, Martinez-González MA, Corella D, Basora-Gallisá J, Ruiz-Gutiérrez V, Covas MI, Fiol M, Gómez-Gracia E, López-Sabater MC, Escoda R, Pena MA, Diez-Espino J, Lahoz C, Lapetra J, Sáez G, Ros E. Effects of dietary fibre intake on risk factors for cardiovascular disease in subjects at high risk. *J Epidemiol Community Health*. 2009;63:582-588.

77. Hayes CE. Vitamin D: a natural inhibitor of multiple sclerosis. *Proc Nutr Soc*. 2000;59(4):531-535.

78. Munger KL, Zhang SM, O'Reilly E, Hernán MA, Olek MJ, Willett WC, Ascherio A. Vitamin D intake and incidence of multiple sclerosis. *Neurology*. 2004;62:60-65.

79. Merlino LA, Curtis J, Mikuls TR, Cerhan JR, Criswell LA, Saag KG. Vitamin D intake is inversely associated associated with rheumatoid arthritis: results from the Iowa Women's Health Study. *Arthritis Rheum*. 2004;50:72-77.

80. Holick MF. Vitamin D: importance in the prevention of cancers, type 1 diabetes, heart disease, and osteoporosis. *Am J Clin Nutr*. 2004;79:362-371.

81. Lefkowitz ES, Garland CF. Sunlight, vitamin D, and ovarian cancer mortality rates in US women. *Int J Epidemiol*. 1994;23:1133-1136.

82. Chiu K, Chu A, Go VL, Soad MF. Hypovitaminosis D is associated with insulin resistance and beta cell dysfunction. *Am J Clin Nutr*. 2004;79:820-825.

83. Consensus Development Conference. Diagnosis, prophylaxis, and treatment of osteoporosis. *Am J Med*. 1993;94:646-650.

84. Conlin PR, Chow D, Miller 3rd ER, Svetkey LP, Lin PH, Harsha DW, Moore TJ, Sacks FM, Appel LJ. The effect of dietary patterns on blood pressure control in hypertensive patients: results from the Dietary Approaches to Stop Hypertension (DASH) trial. *Am J Hyperten*. 2000;13:949-959.

85. Marriott BP, Olsho L, Hadden L, Connor P. Intake of added sugars and selected nutrients in the United States, National Health and Nutrition Examination Survey (NHANES) 2003-2006. *Crit Rev Food Sci Nutr*. 2010;50:228-258.

86. Buyken A, Cheng G, Gunther A, Liese A, Remer T, Karaolis-Danckert N. Relation of dietary glycemic index, glycemic load, added sugar intake, or fiber intake to the development of body composition between ages 2 and 7 y. *Am J Clin Nutr*. 2008;88:755-762.

87. National Cancer Institute. Usual Intake of Solid Fats. Risk Factor Monitoring and Methods Branch Web site. Applied Research Program. http://riskfactor.cancer.gov/diet/usualintakes/pop/solid_fat.html. Updated *August 25, 2010*. Accessed October 7, 2011.

88. Nelson M, Ragland D, Syme S. Longitudinal prediction of adult blood pressure from juvenile blood pressure levels. *Am J Epidemiol*. 1992;136:633-645.

89. Chobanian A, Bakris G, Black H, Cushman W, Green L, Izzo Jr J, Jones D, Materson B, Oparil S, Wright Jr J, Roccella E. Seventh Report of the Joint National Committee on Prevention, Detection, and Treatment of High Blood Pressure. *Hypertension*. 2003;42:1206-1252.

90. He FJ, MacGregor GA. Effect of modest salt reduction on blood pressure: a meta-analysis of randomized trials. Implications for public health. *J Hum Hypertens*. 2002;16:761-770.

91. Steinberger J, Daniels SR, Eckel RH, Hayman L, Lustig RH, McCrindle B, Mietus-Snyder ML. Progress and challenges in metabolic syndrome in children and adolescents. *Circulation*. 2009;119:628-647.

92. Thompson FE, McNeel TS, Dowling EC, Midthune D, Morrissette M, Zeruto CA. Interrelationship of added sugars intake, socioeconomic status, and race/ethnicity in adults in the United States: National Health Interview Survey, 2005. *J Am Diet Assoc*. 2009;109:1376-1383.

93. Britten P, Basiotis PP, Davis CA, Anand R. Is intake of added sugars associated with diet quality? *Nutrition Insights, Insight 21*. USDA Center for Nutrition Policy and Promotion, Washington DC; 2000.

94. Bowman SA. Diets of individuals based on energy intakes from added sugars. *Family Econ Nutr Rev*. 1999;12:31-37.

95. Mensink RP, Katan MB. Effect of dietary fatty acids on serum lipids and lipoproteins: a meta-analysis of 27 trials. *Arterioscler Thromb*. 1992;12:911-919.

96. Clarke R, Frost C, Collins R, Appleby P, Peto R. Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies. *BMJ*. 1997;314:112-117.

97. Hegsted DM, Ausman LM, Johnson JA, Dallal GE. Dietary fat and serum lipids: an evaluation of the experimental data. *Am J Clin Nutr*. 1993;58:875-883.

98. Jousilahti P, Vartiainen E, Pekkanen J, Tuomilehto J, Sundvall J, Puska P. Serum cholesterol distribution and coronary heart disease risk: observations and predictions among middle-aged population in eastern Finland. *Circulation*. 1998;97:1087-1094.

99. Neaton JD, Wentworth D. Serum cholesterol, blood pressure, cigarette smoking, and death from coronary heart disease: overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. *Arch Intern Med*. 1992;152:56-64.

100. Weijenberg MP, Feskens EJ, Kromhout D. Total and high density lipoprotein cholesterol as risk factors for coronary heart disease in elderly men during 5 years of follow-up: the Zutphen Elderly Study. *Am J Epidemiol*. 1996;143:151-158.

101. Goldbourt U, Yaari S, Medalie JH. Factors predictive of long-term coronary heart disease mortality among 10,059 male Israeli civil servants and municipal employees: a 23-year mortality follow-up in the Israeli Ischemic Heart Disease Study. *Cardiology*. 1993;82:100-121.

102. Ascherio A, Rimm EB, Giovannucci EL, Spiegelman D, Stampfer M, Willett WC. Dietary fat and risk of coronary heart disease in men: cohort follow up study in the United States. *BMJ*. 1996;313:84-90.

103. Chiuve SE, Rimm EB, Manson JE, Whang W, Mozaffarian D, Stampfer MJ, Willett WC, Albert CM. Intake of total *trans*, *trans*-18:1 and *trans*-18:2 fatty acids and risk of sudden cardiac death in women. *Am Heart J*. 2009;158:761-767.

104. Lichtenstein AH, Ausman LM, Jalbert SM, Schaefer EJ. Effects of different forms of dietary hydrogenated fats on serum lipoprotein cholesterol levels. *N Engl J Med*. 1999;340:1933-1940.

105. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation*. 2002;106:3143-3421.

106. Grundy SM, Cleeman JI, Merz CNB, Brewer Jr HB, Clark LT, Hunninghake DB, Pasternak RC, Smith Jr SC, Stone NJ. Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. *Circulation*. 2004;110:227-239.

107. Hu FB, Stampfer MJ, Manson JE, Rimm E, Colditz GA, Rosner BA, Hennekens CH, Willett WC. Dietary fat intake and the risk of coronary heart disease in women. *N Engl J Med*. 1997;337:1491-1499.

108. Morris Jr RC, Sebastian A, Forman A, Tanaka M, Schmidlin O. Normotensive salt sensitivity: effects of race and dietary potassium. *Hypertension*. 1999;33:18-23.

109. Luft FC, Miller JZ, Grim CE, Fineberg NS, Christian JC, Daugherty SA, Weinberger MH. Salt sensitivity and resistance of blood pressure. Age and race as factors in physiological responses. *Hypertension*. 1991;17:1102-1108.

110. Burnier M. Ethnic differences in renal handling of water and solutes in hypertension. *Hypertension*. 2008;52:203-204.

111. Reuter S, Büssemaker E, Hausberg M, Pavenstädt H, Hillebrand U. Effect of excessive salt intake: role of plasma sodium. *Curr Hypertens Rep*. 2009;11:91-97.

112. Strazzullo P, D'Elia L, Kandala N, Cappuccio FP. Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. *BMJ*. 2009;339:b4567.

113. Geleijnse JM, Witteman JC, Stijnen T, Kloos MW, Hofman A, Grobbee DE. Sodium and potassium intake and risk of cardiovascular events and all-cause mortality: the Rotterdam Study. *Eur J Epidemiol*. 2007;22:763-770.

114. United States Department of Agriculture: Agricultural Research Service. What We Eat in America. *Nutrient intakes from food: mean amounts consumed per individual by family income (as % of federal poverty threshold) and age, in the United States, 2007-2008*. Available at http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0708/Table_4_NIN_POV_07.pdf. Accessed October 9, 2011.

115. Monsivais P, Drewnowski A. Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher socioeconomic status. *J Am Diet Assoc*. 2009;109:814-822.

116. Dubowitz T, Heron M, Bird C, Lurie N, Finch B, Basurto-Davila R, Hale L, Escarce J. Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *Am J Clin Nutr*. 2008;87:1883-1891.

117. Smith AM, Baghurst K, Owen N. Socioeconomic status and personal characteristics as predictors of dietary change. *J Nutr Educ*. 1995;27:173-181.

118. Stafleau A, Van SW, De Graaf C, Burema J, Hautvast J. Nutrition knowledge and attitudes towards high-fat foods and low-fat alternatives in three generations of women. *Eur J Clin Nutr*. 1996;50:33-41.

119. Trexler ML, Sargent R. Assessment of nutrition risk knowledge and its relationship to the dietary practices of adolescents. *J Nutr Educ*. 1993;25:337-344.

120. Thompson FE, Byers T. Dietary assessment resource manual. *J Nutr*. 1994;124:2245S-2317S.

121. Ard JD, Desmond RA, Allison DB, Conway JM. Dietary restraint and disinhibition do not affect accuracy of 24-hour recall in a multiethnic population. *J Am Diet Assoc*. 2006;106:434-437.

122. Conway JM, Ingwersen LA, Vinyard BT, Moshfegh AJ. Effectiveness of the US Department of Agriculture 5-Step Multiple Pass Method in assessing food intake in obese and nonobese women. *Am J Clin Nutr*. 2003;77:1171-1178.

123. Conway JM, Ingwersen LA, Moshfegh AJ. Accuracy of dietary recall using the USDA five-step multiple-pass method in men (an observational validation study). *J Am Diet Assoc*. 2004;104:595-603.

124. Burrows TL, Martin RJ, Collins CE. Systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc*. 2010;110:1501-1510.

125. Livingstone MBE, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc*. 2000;59:279-293.

126. Kaskoun M, Johnson R, Goran M. Comparison of energy intake by semiquantitative food frequency questionnaire with total energy expenditure by the doubly labeled water method in young children. *Am J Clin Nutr*. 1994;60:43-47.

127. Lanigan JA, Wells JCK, Lawson MS, Lucas A. Validation of food diary method for assessment of dietary energy and macronutrient intake in infants and children aged 6-24 months. *Eur J Clin Nutr*. 2001;55:124-129.

128. Livingstone MBE, Prentice AM, Coward WA, Strain JJ, Black AE, Davies PS, Stewart CM, McKenna PG, Whitehead RG. Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. *Am J Clin Nutr*. 1992;56:29-35.

129. Montgomery C, Reilly J, Jackson D, Kelly L, Slater C, Paton J, Grant S. Validation of energy intake by 24-hour multiple pass recall: comparison with total energy expenditure in children aged 5-7 years. *Br J Nutr*. 2005;93:671-676.

130. Reilly J, Montgomery C, Jackson D, MacRitchie J, Armstrong J. Energy intake by multiple pass 24h recall and total energy expenditure: a comparison in a representative sample of 3-4 year-olds. *Br J Nutr*. 2001;86:601-605.

131. Davies PS, Coward WA. Total energy expenditure and intake in the pre-school child: a comparison. *Br J Nutr*. 1994;72:13-20.

132. Basch CE, Shea S, Arliss R, Contento IR, Rips J, Gutin B, Irigoyen M, Zybert P. Validation of mothers' reports of dietary intake by four to seven year-old children. *Am J Public Health*. 1990;80:1314-1317.

133. Johnson R, Driscoll P, Goran M. Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. *J Am Diet Assoc*. 1996;96:1140-1144.

134. Baranowski T, Sprague D, Baranowski JH, Harrison JA. Accuracy of maternal dietary recall for preschool children. *J Am Diet Assoc*. 1991;91:669-674.

135. Mendez MA, Wynter S, Wilks R, Forrester T. Under- and overreporting of energy is related to obesity, lifestyle factors and food group intakes in Jamaican adults. *Public Health Nutr*. 2004;7:9-19.

136. Johansson G, Wikman Å, Åhrén A, Hallmans G, Johansson I. Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public Health Nutr*. 2001;4:919-927.

137. Johnson RK, Soultanakis RP, Matthews DE. Literacy and body fatness are associated with underreporting of energy intake in US low-income women using the multiple-pass 24-hour recall: a doubly labeled water study. *J Am Diet Assoc*. 1998;98:1136-1140.

138. Kretsch MJ, Fong AK, Green MW. Behavioral and body size correlates of energy intake underreporting by obese and normal-weight women. *J Am Diet Assoc*. 1999;99:300-306.

139. United States Department of Agriculture: Administration for Children and Families. Head Start: About Head Start. Available at http://eclkc.ohs.acf.hhs.gov/hslc/About%20Head%20Start. Accessed November 3, 2011.

140. Starfield B, Shi L. The medical home, access to care, and insurance: a review of evidence. *Pediatrics*. 2004;113:1493-1498.

141. Vivier PM. The impact of Medicaid on children's healthcare and health. *Curr Opin Pediatr*. 2005;17:759-763.

142. Ledoux TA, Hingle MD, Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obes Rev*. 2011;12:e143-e150.

143. Busick DB, Brooks J, Pernecky S, Dawson R, Petzoldt J. Parent food purchases as a measure of exposure and preschool-aged children's willingness to identify and taste fruit and vegetables. *Appetite*. 2008;51:468-473.

144. Wang Y, Li J, Caballero B. Resemblance in dietary intakes between urban low-income African American adolescents and their mothers: the Healthy Eating and Active Lifestyles from School to Home for Kids study. *J Am Diet Assoc*. 2009;109:52-63.

145. Lohman TJ, Roache AF, Martorell R. (1998). *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetic Books.

146. Department of Health and Human Services: Centers for Disease Control and Prevention. *Healthy Weight – It's Not a Diet, It's a Lifestyle*. Available at http://www.cdc.gov/healthyweight/assessing/bmi/adult_BMI/index.html. Accessed August 5, 2011.

147. Department of Health and Human Services: National Heart Lung and Blood Institute. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: the Evidence Report*. Available at http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf. Accessed May 27, 2011.

148. Department of Health and Human Services: Centers for Disease Control and Prevention. *Growth Charts: Z-Score Data Files*. Available at http://www.cdc.gov/growthcharts/zscore.htm. Accessed May 20, 2011.

149. Department of Health and Human Services: Centers for Disease Control and Prevention. *2000 CDC Growth Charts for the United States*. Available at http://www.cdc.gov/growthcharts/clinical_charts.htm. Accessed May 25, 2011.

150. United States Department of Agriculture. *Choose MyPlate*. Available at http://www.choosemyplate.gov/. Accessed July 31, 2011.

151. United States Department of Agriculture. Agricultural Research Service. *Snacks: Distribution of Snack Occasions by Race/Ethnicity and Age. What We Eat in America 2007-2008. National Health and Nutrition Examination Survey*. Available at http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0708/Table_30_DSO_RAC_07.pdf. Accessed July 15, 2011.

152. Keast DR, Nicklas TA, O'Neil CE. Snacking is associated with reduced risk of overweight and reduced abdominal obesity in adolescents: National Health and Nutrition Examination Survey (NHANES) 1999-2004. *Am J Clin Nutr*. 2010;92:428-435.

153. Srinath Reddy K, Katan MB. Diet, nutrition and the prevention of hypertension and cardiovascular diseases. *Public Health Nutr*. 2004;7:167-186.

154. Key TJ. Diet, insulin-like growth factor-1 and cancer risk. *Proc Nutr Soc*. 2011;3:1-4.

155. Cooke L, Wardle J, Gibson E, Sapochnik M, Sheiham A, Lawson M. Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutr*. 2003;7:295-302.

156. Grigsby-Toussaint D, Zenk S, Odoms-Young A, Ruggiero L, Moise I. Availability of commonly consumed and culturally specific fruits and vegetables in African-American and Latino neighborhoods. *J Am Diet Assoc*. 2010;110:746-752.

157. Rolls BJ, Morris EL, Roe LS. Portion size of food affects energy intake in normal weight and overweight men and women. *Am J Clin Nutr*. 2002;76:1207-1213.

158. Butte N, Christiansen E, Sorenson T. Energy imbalance underlying the development of childhood obesity. *Obesity*. 2007;15:3056-3066.

159. Kral TV, Kabay AC, Roe LS, Rolls BJ. Effects of doubling the portion size of fruit and vegetable side dishes on children's intake at a meal. *Obesity*. 2010;18:521-527.

160. Vauthier JM, Lluch A, Lecomte E, Artur Y, Herbeth B. Family resemblance in energy and macronutrient intakes: the Stanislas family study. *Int J Epidemiol*. 1996;25:1030-1037.

161. Acharya K, Feese M, Franklin F, Kabagambe EK. Body mass index and dietary intake among Head Start children and caregivers. *J Am Diet Assoc*. 2011;111:1314-1321.

162. Ford ES, Mokdad AH. Epidemiology of obesity in the western hemisphere. *J Clin Endocrinol Metab*. 2008;93:S1-S8.

163. O'Neil CE, Nicklas TA, Liu Y, Franklin FA. Impact of dairy and sweetened beverage consumption on diet and weight of a multiethnic population of Head Start mothers. *J Am Diet Assoc*. 2009;109:874-882.

164. United States Department of Agriculture: Agricultural Research Service. What We Eat in America. *Nutrient intakes from food: mean amounts consumed per individual by race/ethnicity and age in the United States: National Health and Nutrition Examination Survey 2007-2008*. Available at http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0708/Table_2_NIN_RAC_07.pdf. Accessed August 9, 2011.

165. Kalkwarf HJ, Khoury JC, Lanphear BP. Milk intake during childhood and adolescence, adult bone density, and osteoporotic fractures in US women. *Am J Clin Nutr*. 2003;77:257-265.

166. McGill CR, Fulgoni III VL, DiRienzo D, Huth PJ, Kurilich AC, Miller GD. Contribution of dairy products to dietary potassium intake in the United States population. *J Am Coll Nutr*. 2008;27:44-50.

167. Mensink RP, Katan MB. Effect of dietary trans fatty acids on high-density and low-density lipoprotein cholesterol levels in healthy subjects. *N Engl J Med*. 1990;323:439-445.

168. Tooze JA, Vitolins MZ, Smith SL, Arcury TA, Davis CC, Bell RA, DeVellis RF, Quandt SA. High levels of low energy reporting on 24-hour recalls and three questionnaires in an elderly low-socioeconomic status population. *J Nutr*. 2007;137:1286-1293.

169. Tomoyasu NJ, Toth MJ, Poehlman ET. Misreporting of total energy intake in African Americans. *Int J Obes Relat Metab Disord*. 2000;24:20-26.

170. Olendzki BC, Ma Y, Hébert JR, Pagoto SL, Merriam PA, Rosal MC, Ockene IS. Underreporting of energy intake and associated factors in a Latino population at risk of developing type 2 diabetes. *J Am Diet Assoc*. 2008;108:1003-1008.

VITA

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