The Dissertation Committee for Maria Jose Romo Palafox Certifies that this is the approved version of the following dissertation:

Dietary Quality of Preschoolers' Sack Lunches

Committee:

Margaret E. Briley, Supervisor

Jaimie Davis

Michele Forman

Deanna Hoelscher

Nalini Ranjit

Cindy Roberts-Gray

DIETARY QUALITY OF PRESCHOOLERS' SACK LUNCHES

by

Maria Jose Romo Palafox, B.S.

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Dedication

To my Mom who taught me how to dream; to my Grandparents that supported my every move; and to my sisters, Ines and Monica who challenged me every day. To those whose paths have crossed with mine, who have shaped the person I am today. To those who have walked beside me and have given me the strength to keep moving.

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DIETARY QUALITY OF PRESCHOOLERS' SACK LUNCHES

Maria Jose Romo Palafox, PhD

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Supervisor: Margaret. E Briley

The objective of this study was to analyze the dietary quality of preschoolers' content and intake of sack lunches from the Lunch is in the Bag (LIITB) Efficacy Trial. The main hypothesis was that the nutrient composition of the lunches packed by parents and the portion consumed by their preschool children were not adequate and that the dietary quality of the lunches was associated with beverage choice.

For this cross-sectional study, dietary data were obtained from 30 Early Care and Education (ECE) centers in Central Texas. Foods and beverages present in lunches that parents (n=607) from the LIITB Efficacy Trial packed for their preschool child were recorded on two non-consecutive days.

The average meal included 6.5 individual food items and a mean of 602.5 kcals. The macronutrient energy distribution was adequate; however, lunches contained high amounts of sugars (29% of energy) and saturated fat (11% of energy). Preschoolers consistently consumed between 61% and 79% of the food packed by their parents ($p<0.01$). Parents included less than the recommended amounts of dietary fiber, calcium, vitamin A, and potassium. Mean HEI total scores of lunches packed (58/100) differed from scores of lunches consumed (52/100) ($p<0.01$). Meals scored low for the greens and beans, total vegetables, seafood and plant proteins and whole grain HEI components. Most parents packed a beverage as part of their preschoolers' lunch; sugar sweetened beverages being

the most popular choice. Beverage choice was significantly associated with the presence of vegetables, refined grains and chips in preschoolers' lunches as well as the dietary quality ($p<0.05$).

The nutrient content of preschoolers' sack lunches were inadequate and a cause for concern. The HEI-2010 was a useful tool to measure the dietary quality of children's meals and provided statistical advantages over nutrient analysis. Specific food choices such as beverages were associated with the dietary quality the meals, beverage choice could be a viable intervention target. These findings suggest that parents of preschool children need more guidance in order to provide better foods and beverages to promote the development of healthy food preferences and eating habits.

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Chapter 1: Introduction

The high prevalence of childhood obesity in the U.S. is a matter of public health concern. Thirty percent of 2-5 year old children are overweight or obese and have higher risk factors for adult comorbidities [1]. Dietary patterns that promote obesity are characterized by large portions of energy dense foods [2]. In addition to obesity, these dietary patters promote under or over nutrition and related diseases and usually provide inadequate amounts of nutrients [3]. More than half (61%) of preschool aged U.S. children are enrolled in out of the home care. Early Care and Education (ECE) centers have become a significant influence in the development of food preferences and eating habits of preschoolers [4].

Food preferences and eating habits are developed during the preschool years and track into the school years and beyond [5-7]. Licensed ECE centers follow guidelines to ensure the dietary quality of the children in their care. But legislative changes in Texas allowed for ECE centers to close their kitchens and relinquish the responsibility of providing healthy foods and beverages [8]. Sweitzer and colleagues recognized the need to evaluate the foods and beverages parents were packing for their preschool age child [9]. Preliminary data suggested that parents of preschool children were packing lunches that did not provide adequate amounts of nutrients for a healthy diet. Preschoolers' diets have been reported to lack vegetables and whole grains; and have been found deficient in calcium, dietary fiber, potassium and vitamin D [3].

The study of preschoolers' sack lunches has focused on either food groups or nutrient composition [9, 10]. The plethora of guidelines available to parents can be overwhelming, there is a need for a comprehensive analysis of the dietary quality of preschoolers' sack lunches. Dietary indices provide a score of dietary quality that allows for in depth analysis of adequacy of food and nutrient content of lunches. This research provides a rounded evaluation of the dietary quality of preschoolers sack lunches. Findings can be used by caregivers and health professionals to guide parents of preschool children in choosing foods and beverages that promote healthy eating patterns and food preferences.

The objective of this study was to analyze the dietary quality of preschoolers' content and intake of sack lunches from the Lunch is in the Bag (LIITB) Efficacy Trial. The main hypothesis was that the nutrient composition of the lunch packed by parents and the portion consumed by their preschool children were not adequate when compared to 33% of the DRI; when measured with the Healthy Eating Index; and that the dietary quality of the lunches can be associated with beverage choice. This main hypothesis was be tested through 3 specific aims. Aim 1 was to analyze the nutrient composition of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler. Aim 2 was to analyze the dietary quality of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler. And Aim 3 was to examine the association of beverage choice with the nutrient composition of the parent-packed meal, and to examine whether the presence of these predicts the dietary quality of the meal as well as the presence or absence of other specific food groups included in parent-packed sack lunches.

Chapter 2: Review of literature

Malnutrition and Obesity

The prevalence of overweight and obesity in young children is a national public health concern in the United States. One out of every four children aged 2 – 5 years is overweight or obese as evidenced by Body Mass Index (BMI) ≥ 85th percentile [1, 11, 12]. Preschool children, aged 3-5, who are overweight are at a 5-fold risk of being overweight or obese by age twelve [13, 14]; and have an elevated risk for adult obesity. Obese children also have an increased risk for adult comorbidities such as cancers, cardiovascular diseases, impaired glucose tolerance, type 2 diabetes mellitus, and an overall decrease in life expectancy [15-21]. Moreover, obese children have a higher risk of having psychological and social issues such as bullying, both as victims and perpetrators [22]. The complete etiology of obesity in young children is still uncertain. Determining environmental and behavioral factors that can be modified and have a significant impact on weight status could be the key to prevention of this disease [23]. Modifiable factors include: feeding practices and behaviors that impact diet quality and weight status [24]; and diet patterns, which have been studied and established as significant predictors of weight in preschool aged children [25].

The number of overweight and obese children increased significantly from 1980 to 2000, with significant increases only in the obese category up to 2008 and has remained unchanged until 2010. The increased prevalence of obesity has been correlated with multiple variables including marked increases in portion size of foods offered, frequency of eating occasions; and increased intake of sugar, saturated fat and energy dense foods [23, 26]. The current obesogenic eating environment is characterized by convenient access to energy dense foods that usually come in large portion sizes, are inexpensive, and highly palatable [2]. Many obesity prevention efforts have focused on reducing of limiting the consumption of energy dense foods, snacks and drinks [27, 28]. Younger children are more prone to modify their behavior and do so with more ease than older children, therefore the preschool years could be a critical period for obesity prevention [29, 30].

Obesity is a complex disease that can't be explained by the simple relationship of energy consumption and expenditure. Moreover, energy requirement guidelines are far from perfect. Preschool children's energy intake seems to be lower than the Estimated Energy Requirement (EER), but researchers have proposed that the current EER is an overestimation [31]. Ramsey and colleagues measured the energy expenditure of 30 preschoolers and found that the current equations produce consistently higher values than measured Basal Metabolic Rates (BMR) [32]. Even though preschoolers can self-regulate the amount of food consumed, energy intake is also determined by social and situational conditions of the food environment including energy density of foods offered [33-35]. Additionally, McConahy and colleagues determined that about 38% of the variance in energy intake of preschoolers was determined by eating behaviors and body weight, [36] indicating that obesity prevention efforts should focus on modifiable behavioral and environmental factors. In particular, the strong effect of portion sizes, frequency of eating occasions, and energy density of foods on preschoolers' energy intake has been established [36]. Parents and caregivers could positively impact preschoolers' obesity risk by modifying these factors and by providing low energy dense, high nutrient dense foods [36].

Adequate nutrient intakes in preschoolers is key to preventing malnutrition, a concept that includes both the deficiency and excess of nutrients; where overnutrition results in obesity and many associated comorbidities, and undernutrition results in nutrient deficiencies and related diseases. Consuming age appropriate diets that provide enough energy and nutrients are essential to support growth and development as well as prevent nutrition related problems including iron-deficiency anemia and dental caries [3]. The current U.S. diet consists of high energy-dense foods and beverages that have low nutrient densities, which promote both obesity and undernutrition. Research has determined U.S. preschool children's diets lack vitamin A, D, E, folate, and calcium [37] and provide excessive amounts of zinc [37], solid fats and added sugars [38-39]. Both the Academy of Nutrition and Dietetics (AND) and the Dietary Guidelines for Americans have established that calcium, dietary fiber, potassium and vitamin D are nutrients of public health concern [3] (DGA). Efforts to increase the dietary quality of children's diets should focus both on preventing obesity and providing sufficient amounts of nutrients.

INFLUENCES OF PRESCHOOLERS' DIETARY INTAKE

Portion Sizes

An important aspect of the obesogenic environment is the availability of large portions of energy dense foods, which has increased over time [38, 40]. Duffey and colleagues analyzed nationally representative surveys for food availability from 1977 – 2010 [41]. Total energy intake increased over time by 100 kcals/day, with the highest energy increase in 2005 to 2010 while the number of meals increased by 1.2 eating occasions. Even though the average portion size decreased during this period, the highest energy density per eating occasion reached its peak in 2005-2010 [41].

The amount of food served to a preschool child can impact overall amount consumed [2, 41-43]. Fisher and colleagues found a 13% increase in consumption of a meal offered to 2-9 year old children when larger portions were offered, regardless of age [2, 33]. Energy intake increase due to larger portion sizes at one meal is not sufficient evidence to determine that larger portions lead to obesity [33]. Fisher and McConahy were able to demonstrate that overweight and obese children are more susceptible to portion size increases [33, 44]. Stronger evidence is needed to establish the correlation of larger portion size offering and weight status [45]. Parents and caregivers should be aware of the effects on obesity by overestimation of portion sizes of foods offered to preschoolers. Almiron-Roig and colleagues established that adult perception of the appropriate amount of food for children is intricate; and influenced by the number of units provided, the context of the meal, and children characteristics including gender [46].

Energy density has been another aspect of diet evaluation. When the energy density of entrees was reduced by 30%, children consumed 18% less energy from the total lunch [42]. Studies have confirmed that energy density of foods can be manipulated with little or no effect on acceptability [27, 42, 47]. When energy density was lowered during multiple meals, a persistent reduction in preschoolers' energy consumption was observed [27]. No compensation for reduced energy intake was observed for manipulated or non-manipulated meals over the course of 2 days. Similar results were observed when energy density of snacks were manipulated [48]. Given the high prevalence of childhood obesity, obesogenic food environments that offer large food portions should be avoided. Understanding the energy needs of preschool children is imperative in order to find a balance between offering age-appropriate portion sizes that in turn provide sufficient nutrients for optimal growth [31, 33]. Age-appropriate portions can meet the Dietary Reference Intakes (DRI) based on the energy and nutrient density of foods [31].

Food Preferences

During the preschool years, children develop and perfect their cognitive skills [49] by manipulation of their environment, exploring, questioning, comparing and labeling [49]. Children at this age are also acquiring and improving their understanding of relevant concepts including health and nutrition [49]. For example, 3-5 year old children can easily identify certain foods; at age 4 children understand the concepts of energy and a strong heart; at 5-6 years they can classify foods based on qualities and functions; but preschool children are not able to comprehend that food consumed transforms into nutrients that have an effect on health [49].

The food environment of preschool aged children consists of food experiences with parents, teachers and peers [50]. Certain parental feeding practices such as prompting and rewards are factors involved in the development of food preferences and eating habits of a young child [50, 51]. Research has consistently demonstrated that food preferences and eating habits are developed during the preschool years, and have a significant impact on the dietary quality later in life [5, 52, 53].

Studies have been conducted to establish the impact of different aspects of preschoolers' food preferences later in life. Nicklaus and colleagues established that children who select a large variety of foods by age 2–3 years continued to do so when older [54]. Skinner and colleagues found that the variety of foods accepted at age 4 was the strongest predictor of foods a child would consume 4 years later [55]. Vilela and colleagues found that the consumption of energy dense foods at age 2 was related to increased consumption of these foods at age 4, resulting in a poor dietary quality [56]. Consumption of sugar sweetened beverages (SSBs) at age 4 has been shown to be associated with consumption at 8-year-old children [56]. The types and amounts of foods offered to preschool children impact the development of healthy eating habits. Food preferences have also been linked to nutrient intake; Singer and colleagues reported significant correlations of nutrient intake over time in a sample of 106 families with 3-7 year old children. A strong correlation was found for carbohydrate and fat intake, 2-3 year old children (50%) who were in the top quintile for fat intake remained on the top quintile at age 7-8 [5]. Conclusions drawn from research supports the concept that nutrient intakes track from preschool age to the early school years [5].

Food preferences are an important indicator of food intake in preschool aged children because they have an innate predilection for sweet flavors and usually reject bitter and sour flavors [38, 49]. This fact helps explain why preschoolers' food neophobia and rejection is more strongly related to vegetables than sweeter, lower nutrient dense foods [55, 557]. Given the children's innate preference for sweet flavors, exposure to food items common in the US diet such as high energy dense, and sweet food and beverages could reinforce preschoolers' preference for them [58, 59]. Food neophobia has been shown to be a strong predictor of intake variety, food preferences and dietary quality [57]. Even though preferences are formed by age 4, children can learn to consume and like less sweet foods, like vegetables as they grow [60]. Providing a variety of vegetables and whole grains to taste during the early formative years is crucial to development of acceptance of a variety of foods for rest of their lives [61-64].

PRESCHOOLERS' DIETARY PATTERNS

For preschool aged children, an adequate diet is essential for appropriate growth, cognitive development, obesity prevention, and overall good health [65]. The cumulative array of foods habitually consumed over time throughout the lifecycle is known as dietary pattern. Researchers have established several changes in dietary patterns since the early 1990's. Ford and colleagues analyzed data from 2-6 year old children (n=10,647) using five nationally representative surveys from 1989 - 2008 [66]. The amount of energy that preschool children consumed increased by 109 kcals/day over this 20-year period; and there has been a noticeable increase in the amount of added sugars, saturated fats and sodium that preschool children consume [66]. Since the early 1990's, consumption of pizza, Mexican dishes, sweet and salty snacks, candies and SSBs increased by a combined 148 kcals/day [66].

The diets of overweight and obese children are characterized by a high consumption of energy-dense snack foods and meals, which limit their intake and preference for fruits, vegetables and whole grains [67-70]. Beets and colleagues found that when offered a varied selection of snacks children seldom chose fruit [71]. Main sources of calories for 2-8 year old children include milk, 100% fruit juice, french fries, and pasta dishes; major sources of added sugars include fruit drinks, grain desserts, dairy desserts and candy; and solid fat sources include whole milk, meats, pizza, grain desserts and cheese [66, 72, 73]. In a study of NHANES 2009-2010 data, Reicks and colleagues found that only 2.9% of 2-19 year olds consume at least 3 ounces of whole grain equivalents per day. In addition, consumption of whole grains at a younger age was associated with higher intakes when older [74]. The presence or absence of particular nutrients, foods or food groups can indicate overall dietary quality [62, 75]. Establishing the dietary patterns of preschool children is a necessary step to ascertain specific recommendations to significantly impact preschoolers' overall dietary quality [76].

Dietary patterns have been used to predict preschool children's nutrient intake. In the United Kingdom, Cribb and colleagues identified three distinct dietary patterns in preschool children's diets: "processed", "health conscious" and "traditional" [62]. Much of the variance in the consumption of energy, fiber, and nutrients was explained by dietary pattern [62]. Interestingly, after adjusting for energy, differences between patterns were only significant for: protein, fiber, potassium, magnesium, iron, zinc, folate, thiamin and vitamin B6 [62] because certain nutrients are associated with energy content. Some researchers have established that dietary patterns may be better indicators of obesity risk than individual nutrient analysis. Poti and colleagues proposed that the overall dietary pattern might be more strongly associated with obesity than fast food consumption alone [77]. A snack intake study by Mallan and colleagues found that for 37 preschool children, energy intake at lunch significantly correlated with energy intake from snacks [78]. This confirms that individual meals have an impact on preschoolers' overall health; therefore focusing on one meal could potentially provide enough information to significantly improve children's diets. A holistic approach that includes the analysis of nutrient content, food groups and dietary patterns of one meal would provide more information regarding the quality of foods offered to 3-5 year old children [62, 79].

CHILDCARE AND NUTRITION

The home environment had been the main influence in the development of food preferences and eating habits from the beginning of America's history; when women entered the work force during World War II out-of-the-home care became a vital part of the lives of many U.S. preschool aged children [80]. The need for care away from home kept increasing, the number of 3-4 year olds enrolled in non-parental care doubled from 1970 to 1993 [81]. To date, as many as 12 million children (61%) under the age of 6 are in care outside the home [80, 82-86]. Children spend an average of 33 hours per week in out of the home care [80] where they consume two or more meals and snacks and receive 50-67% of their daily energy requirements [80, 82, 86].

There are different levels of out-of-the-home care arrangements; licensed settings include Early Care and Education (ECE) centers and in-home care providers; non-licensed settings include homes of family, friends or neighbors [80]. Licensed ECE centers must comply with federal and state level regulations and guidelines regarding the foods served to preschoolers, in an effort to assure children receive nutrients for growth and development [87]. The major contributor of nutrition for many 3-5 year children is the ECE center where lifelong eating habits and food preferences are developed [83]. Erinosho and colleagues analyzed menus served at ECE centers in New York and found they provided better dietary quality than the meals served at home [88]. Theoretically, ECE centers that follow nutrition regulations can assure parents that their children are exposed and consume diets that meet their nutritional requirements.

Legislation changes in Texas allowed for ECE centers to close their kitchens in 2005 and relinquish the responsibility of providing healthy meals to the children in their care. Parents were expected to send sack lunches to fulfill their child's nutritional needs [8]. In two counties of central Texas 46% of a sample of 194 ECE centers closed their food preparation facilities according to a survey published in 2007 [89]. Sweitzer and colleagues conducted an informal survey of ECE centers in California, Georgia, Pennsylvania and Tennessee and found that 42% of ECE centers required parents to provide food from home [9]. Parents are the gatekeepers of the quality of their preschool child's diet by controlling the availability and accessibility of food. ECE center settings that require parents to send meals from home provide a unique opportunity for parents and caregivers to work together to shape children's dietary intake and eating behaviors [83, 90]. Dietary quality of sack lunches from home can be used to identify areas of public health concern in this population.

DIETARY GUIDELINES

Nutritional guidelines for US preschool children have been developed to evaluate and promote healthy diets. Different guidelines can be used to evaluate the dietary quality of foods served at ECE centers, and can be classified into two main approaches: nutrient and food based. Depending on licensing requirements, ECE centers that provide food for the children in their care follow different recommendations [91, 92]. ECE center directors have access to adequate information for making decisions about foods for preschool children [91, 92]. In contrast, in ECE centers where parents are responsible for sending food from home, there are no specific federal or state guidelines to follow. Parents rely on health professionals for guidance to determine foods that provide adequate nutrients to promote growth and development and prevent obesity [31].

Food Based Dietary Guidelines

Food based dietary guidelines focus on food groups and portion sizes for young children [31, 93] The MyPlate nutrition scheme that was developed by USDA provides a pictorial guideline to show servings by food group [94]. The Child and Adult Care Feeding Program (CACFP) recommends serving sizes for each food group based on age and meal type [95]. Head Start and the Nutrition Education and Training and Special Supplemental Food Program (SNAP) are other programs that established nutritious foods that should be served to children based on the Dietary Guidelines for Americans (DGA) [49, 96]. The Women and Infants and Children (WIC) program also includes nutrition guideline for preschoolers and their parents [49]. In a larger perspective, the World Health Organization (WHO), supports the DGA in recommending the limitation of saturated fat, trans fat, added sugar and sodium consumption [28] [93]. However, CACFP meal patterns are standardized and might not reflect the type and amounts that children receive at home or outside the childcare setting [2]. The food groups and serving sizes of different food based dietary guidelines are not always consistent. There is a real need of health professionals to deliver consistent messaging and target parents of preschoolers to increase their knowledge of the dietary needs of their child [97]. Parents of preschool children seem to be either unaware or disregard the different guidelines they could use to ensure adequate nutrition of their preschoolers' lunch [31]. Sweitzer and colleagues determined that even though parents in Central Texas are aware that lunch is an important opportunity to provide nutrients, only

23% packed fruits, vegetables and whole grains in their preschoolers' lunch [98]. Providing parents with additional, simple but accurate meal recommendations could significantly increase the dietary quality of meals offered to preschool children.

Nutrient Based Dietary Guidelines

The Dietary Reference Intake (DRI) provides information about specific daily nutrient needs for each age group and the latest publication by the Institute of Medicine (IOM) was in 2011 [99]. The Academy of Nutrition and Dietetics (AND) position for a child's intake based on child's age to determine the proportion of the DRI needed for adequate growth and development [100]. When Frampton, Oakley, Romaine and Briley compared menus to the standard energy, iron, zinc, vitamin E, and calcium fell below the recommendations and solid fats and added sugars were in excess of the recommendations [87] [101, 102, 103, 104]. Sweitzer and colleagues conducted a preliminary study of 97 parent-child dyads in 6 ECE centers in central Texas and found over 50% of the lunches parents packed included less than 1/3 of the DRI for energy, carbohydrates, vitamin A, calcium, iron, and zinc and the percentage of energy from fat was higher than recommended in 49% of lunches while the mean content of sodium was 114% of the DRI [9]. When researchers measured the amount consumed, they found that preschool children consumed an average of 59% of the entrée offered [105]. More research is needed to determine if lunches that parents of preschool children pack provide adequate nutrients when compared to the DRIs; and if the amounts packed are sufficient to meet the requirements when the portion consumed is analyzed.

Nutrient based analysis of dietary quality has limitations, different sources of nutrients have to be considered when analyzing preschool children's diets including dietary supplements. Bailey and colleagues analyzed the contribution of supplements to the intake of calcium, iron, magnesium and vitamins A, C, D and E [106]. Results indicated that non-supplement consumers had lower nutrient adequacy compared to consumers; and most children did not meet the requirements for calcium, vitamin D and E regardless of supplement consumption. Supplement intake did result in an excessive intake above the upper limit (UL) for iron, selenium, zinc, vitamin A, C, and folic acid [106]. Thus while knowledge is useful to elucidate specific nutrients of public health concern, more research is needed that encompasses both nutrient analysis and food based determinants of dietary quality. Nevertheless, nutrient analysis does not consistently determine factors that reduce risk for diseases such as cardiovascular disease, cancer or overall morality [107-110]. In contrast, the analysis of diets in the context of patterns has produced consistent results [107-110]. The study of preschoolers' dietary patterns requires a comprehensive view of preschoolers' intake of both food and nutrients.

EVALUATION OF DIETARY QUALITY

Dietary Quality Indices

Dietary pattern analysis led to the development of indices that measure the quality of individual and population diets. Indices were designed to generate scores that provide a comprehensive view of the diet by measuring multidimensional food and nutrient components that have been independently associated with health outcomes [111]. Indices that measure dietary quality use valid and reliable scoring methodologies, therefore provide extensive research opportunities. Several indices have been developed in the U.S. and worldwide to measure compliance with population specific dietary guidelines.

Country specific indices have been developed, for example the Dutch healthy diet index, is assumed to be a more appropriate approach for investigating diet-disease associations than focusing on a single food or nutrient [112-115]. In the U.S. The Revised Children's Diet Quality Index (RC-DQI) was published in 1995 to evaluate children's diets [116]. The Meal IQ, targets the dietary quality of 7-13 year old U.S. children's lunches [117]. Three of the more popular indices: the Healthy Eating Index, the Alternative Healthy Eating Index, and the Dietary Approaches to Stop Hypertension sores have major public health importance [108]. Schwingshackl and colleagues determined that diets with high HEI, AHEI, and DASH scores were significantly associated with reduced risk of all-cause mortality (22%), cardiovascular mortality or incidence (22%), cancer mortality or incidence (15%), cancer types and type 2 diabetes (22%) [108]. Even though the RC-DQI and Meal IQ were developed to measure children's diets, the Healthy Eating Index provides increased generalizability [108] because it can be used to measure population and individual diets for all ages.

The Healthy Eating Index (HEI) was first published in 1995, this index included 10 components that measured food groups and nutrients. In 2008, the HEI was revised to reflect changes published in the Dietary Guidelines for Americans (DGA) 2005, and the amount of energy in the diet was controlled by dividing amounts of foods and nutrients consumed per 1,000 kcals [118, 119]. After the publication of the DGA 2010, the HEI was updated and validated to reflect the newest recommendations [108, 118]. McCullough and colleagues developed the Alternate Healthy Eating Index (AHEI) in 2002 [120]. The AHEI is based on the HEI, but the components chosen have evidence of predicting chronic disease risk; contrary to the HEI, the AHEI uses an absolute intake approach [120]; Chiuve and colleagues developed an update in 2012 [121]. Several different versions of the Dietary Approaches to Stop Hypertension (DASH) score have been published [122-125]. The most commonly used DASH score includes eight components; higher scores on this dietary pattern have been strongly correlated with lower blood pressure [126].

The HEI (both 2005 and 2010 versions) has been used to measure the dietary quality of preschoolers' overall diets and specific meals. Erinosho and colleagues computed the HEI-2005 for lunches served at 6 ECE centers in North Carolina [127]. Two non-consecutive observations of lunch yielded a mean HEI of 59.12 out of 100 possible points, most of the centers met the requirements for milk (100%), total (85%) and whole fruit (75%) and sodium (95%). Mean sores for vegetables, dark green/orange vegetables and legumes, total grains, whole grains, oils, meat and beans were lower than the maximum scores recommended ($p<0.01$) [88]. Dietary pattern analyses have been successful in measuring the dietary quality of diets and are useful tools to elucidate environmental factors and health outcomes.

Beverages as Predictors of Dietary Quality

The use of specific foods or beverages to predict the dietary quality is another approach to the evaluation of nutritional adequacy. The ongoing debate over beverage consumption and onset of childhood obesity has resulted in studies of beverage consumption as indicators of medium and long-term weight status and food consumption [128]. Beverage consumption patterns have changed over the years. Children consumed more plain milk in 1976 – 1994 (84%) than in 200-2006 (77%), and flavored milk intake increased [3]. Additionally, fruit juice consumption increased to over 50% in the early 2,000s compared to about 30% in older surveys [3]. The amount of 100% fruit juice that children consume exceeds the 4-6 fl oz/day DGA recommendation, U.S. children are consuming an average of 10-12 fl oz/day [129]. SSB consumption has increased from 7 fl oz per day in the late 1970s to about 8 fl oz per day in the early 2,000's and contributes about 5% of the total energy intake [3, 130].

Several research groups have established the correlation of beverages as predictors of dietary quality in the diets of adults and children. Different researchers have evaluated the contribution of dairy milk [131, 132], non-dairy milk [133], 100% fruit juice [134 – 137], and sugar sweetened beverages (SSBs) (including fruit flavored drinks and sodas) [138 – 144] to overall dietary quality. Consumption of fluid milk has been associated with higher dietary quality [131, 132]. Milk adds vitamins A, D, calcium, potassium, magnesium, phosphorus and dietary fiber to the diet of U.S. children; some of which are considered shortfall nutrients [131]. Marshall and colleagues found that 2-5 year old children who consumed milk had lower intakes of SSBs [132]. Dror and colleagues found that dairy consumption was inversely associated (effect size -0.26, $p<0.0001$) with body fat in a prospective cohort study [133]. Several studies have found that higher intakes of milk and 100% fruit juice during childhood and adolescence have positive effects on body fat; in contrast, SSB intake was not associated with any body fat change [134 – 137].

Fruit provides essential nutrients for preschoolers, Clemens and colleagues compared the nutrient composition of 100% fruit juice and whole fruit and reported equivalent amounts of nutrients, with the exception of fiber and vitamin C [138]. Nicklas and colleagues analyzed nutrient intake of 2-11 year old, the nutrient profile of 100% fruit juice consumers was significantly higher in energy, carbohydrates, vitamin C and B6, potassium, riboflavin, magnesium, iron, and folate and significantly lower intakes of total fat, saturated fat and added sugar [139]. Other studies have found better health outcomes when comparing 100% fruit juice consumers and non-consumers [140 – 144]; and increased dietary quality when comparing HEI scores [141]. The impact of 100% fruit juice consumption on weight status and/or body fat is not yet clear; overall, there seems to be no increased risk among 100% fruit juice consumers [138 – 141]. The relationship between 100% fruit juice consumption and BMI might be mediated by amount consumed; in one study, preschool children consuming more than 12oz of 100% fruit juice per day had a higher BMI [128].

Conversely, SSB consumption has been consistently associated with children's BMI and increased risk of adult obesity [128, 145 – 147]. Habitual SSB consumption in 5-year-old children increased risk of obesity by 43% [147]. Furthermore SSB consumers tend to have higher C - reactive protein concentrations, increased waist circumference and decreased HDL cholesterol concentrations [148]. Dietary patterns of SSB consumers have been evaluated; compared to milk and 100% fruit juice, SSB consumers have significantly higher energy intakes, lower dietary quality [145]. Additionally, SSB intake apparently displaces milk and 100% fruit juice consumption [145]. SSB consumption has also been associated with socio-economic status and maternal education; these associations were moderated by parental feeding practices and television time [149]. More research is needed to establish the contribution of beverages to nutrient and their use as predictors of dietary quality.

DIETARY QUALITY OF PRESCHOOLERS' SACK LUNCHES

Given the high prevalence of childhood obesity with marked nutrient deficiencies, there is a real need to evaluate the dietary quality of preschool aged children [30, 150]. ECE centers are an ideal venue, they provide an appropriate setting to study preschoolers' food preferences and eating habits through the collaboration of parents, teachers and ECE center directors [30, 85, 151]. Research teams at the University of Texas at Austin, the University of Texas School of Public Health and Third Coast Research and Development Inc. have developed a behavioral based intervention that aims to increase the amount of fruits, vegetables and whole grains that parents pack in preschoolers' lunches [9, 10, 98, 103, 104, 152]. The Lunch is in the Bag study provided a unique opportunity to evaluate the dietary quality of lunches packed by parents for their preschool children.

Sweitzer and colleagues have studied the content of parent packed lunches and developed an intervention called Lunch is in the Bag (LIITB) [9, 10, 98, 103, 104, 152]. The LIITB program has been tested in different stages: 1) LIITB exploratory study in Waco, Texas in 2006 included n = 97 parent child dyads [9]; 2) the LIITB pilot study in 2009 included n = 132 dyads in Austin, Texas [10]; 3) the LIITB booster study in 2011 was a smaller study where an extra week of intervention was added and involved n = 103 parent-child dyads [153]; and 4) LIITB efficacy trial 2011-2014 where n = 607 parent-child dyads were included in Austin, Houston and San Antonio. The LIITB study was the first to evaluate the foods that parents packed for their preschool children. Analysis of nutrient content and food groups present in parent packed lunches have been published by Sweitzer and colleagues, more research is needed to present a rounded view of the nutritional quality of these meals.

Preliminary nutrient data

Sack lunches sent from home do not regularly provide adequate nutrients for the growth and development of children [9, 10]. For the LIITB pilot, Sweitzer and colleagues found that more than half of packed lunches included less than the recommended amounts of energy, carbohydrates, vitamin A, calcium, iron, and zinc; with excessive amounts of total fat and sodium [9].

Unpublished sack lunch nutrient data from the LIITB pilot and LIITB booster (2008 – 2011 Austin, Texas) show similar results. These data included a total n=235 parent-child dyads. All parents of 3-5 year old children in 9 different Early Childhood Education Centers were invited to participate in the program. Data were collected at baseline and 3 Lunchbox observations per child were completed (n=607). To determine the nutrient composition of lunches, data were entered into the Food Intake Analysis System (FIAS) which is a nutrient analysis software program developed by the University Of Texas School Of Public Health in 2010. SPSS 19 was utilized to compute means, standard errors (SE) and sample T tests for these data [154]. For this analysis a total of 27 nutrients (energy, carbohydrates, sugars, dietary fiber, protein, total fat, saturated fat, cholesterol, calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, zinc, folate, niacin, riboflavin, thiamin, and vitamins A, B6, B12, C, and K) were included. DRIs are reported by age group, IOM considers 3-year-old and 4 to 5-year-old children in different categories therefore their

DRIs are not equal. As a result, all statistics were computed separately for 3 year olds and 4-5 year old children. Descriptive statistics (means and SE) were computed. Subsequently, means were compared to 33% of the DRI of each nutrient to determine compliance with the AND recommendations through Two Sample T tests [100].

In this sample of parent packed lunches for 3, 4 and 5 year old children nutrients that were significantly higher than the recommended portion (33%) of the DRI included energy (41-47%), carbohydrates (47-52%), protein (38-44%), saturated fat (43-52%), sugars (44-52%), and total fat ($p<0.05$). Calcium (24-36%), cholesterol (1%), dietary fiber (21-29%), and potassium (16-22%) were significantly lower than the guideline suggesting deficiencies in these preschoolers' diets ($p<0.05$). Micronutrients that were significantly higher ($p<0.05$) when compared to the respective DRI included copper (72-101%), folate (93-109%), iron (32-49%), magnesium (52-90%), sodium (62-85%), zinc (50-87%), niacin (64-84%), phosphorus (63-76%), riboflavin (78-95%), selenium (78-124%), thiamin (66-83%), vitamins A (42-57%), B-12 (69-92%), B-6 (71-89%), C (104-202%), and K (29-73%).

Baseline nutrient analysis from the LIITB pilot and LIITB booster studies provided evidence that parents did not pack lunches to meet the dietary recommendations for their preschool children. Both LIITB pilot and LIITB booster included a small sample of parents with similar demographic characteristics in Austin, Texas as published elsewhere [155], therefore generalization to a bigger population would not be suitable. The analysis of dietary quality of lunches packed by parents from a larger and more diverse population is essential to gain further understanding of the quality of this their preschoolers' diets and intake at lunchtime.

Data Collection

For the LIITB efficacy trial (2011-2014), a survey was designed to recruit ECE centers via telephone. Recruitment was conducted six months before the beginning academic year during the summer of 2011. Centers that cared for at least 15 children ages 3 - 5, who attended daily, and required parents to pack lunches, were eligible for the study. ECE centers that agreed to participate in the program signed a consent form. All parents who were enrolled in ECE centers for the fall of 2011 and the fall of 2012, with children ages 3 – 5 were eligible to participate. During a 2 - week period before baseline (summer 2011, summer 2012), staff form the Lunch is in the Bag program presented the project concepts and timeline to the parents and invited them to partake in the study. Parents had to agree to complete the surveys and allow the research team to observe and note the food inside their child's lunchboxes, as well as record the food items that their child consumed during lunch. Parents who were willing to participate have signed a consent form for them and their child.

Due to the size of the sample and the staff available for data collection, ECE centers were divided into two groups. For group 1, baseline data were collected during the fall semester of 2011 in ECE centers recruited in San Antonio and in Houston; for group 2 baseline data were collected in ECE centers recruited in Austin and Houston; total study included 30 ECE centers and n = 607 parent-child dyads.

Training

A protocol for observational data collection was modified by Sweitzer and colleagues from previous research and used for this study [152, 156]. A Registered Dietitian trained all data collectors on the scientific method for visual estimation of parent-packed portion sizes, and assessment of food consumed or wasted [10]. Data collectors measured foods commonly seen in preschoolers' sack lunches into the usual portion sizes (e. g. cups, ounces, pieces). The lunchbox observation protocol for data collectors and the format used for the lunchbox observation Food Records can be found in Appendix 1-2. Training took place during the summers of 2011 and 2012, with 6 hour retraining sessions in January of 2012 and 2013. Different types and sizes of topper ware, plates and containers were utilized in order to familiarize data collectors with what might appear in the field. Correct and incorrect forms for recording observed estimation data were discussed. To certify trained data collectors, an examination that included 10 lunches (with 4-5 food items each) was performed. Portion size accuracy at or above 85% was considered sufficient. A Registered Dietician performed a quality control check in the field for all new data collectors in duplicate, in addition to the usual quality control checks done for 10% of the total lunches.

Data Management

Baseline data was collected in two groups during the course of two academic years (fall of 2011 and fall of 2012). A registered dietitian cleaned the data for all lunchbox observations and lunchtime observations to ensure that serving size and food groups were accurate before data entry. A "cheat sheet" with examples of commonly found foods and their corresponding food group and serving size was developed for data collectors to use in the field (Appendix 3). The Lunch is in the Bag data entry website was loaded with the Food

Intake Analysis System (FIAS), which is a food analysis system developed by the University of Texas School of Public Health, Houston. A second round of data cleaning was done to certify that all food items were entered and categorized correctly. During data cleaning food items and portion sizes were not modified, only food groups and servings were revised for accuracy. Quality control checks were done for 10% of all measurements, including lunchbox observations. Children's heights and weights were measured in duplicate by trained personnel, 10% of the children received an extra measurement, which was done by a different data collector. For lunchbox observations, a Registered Dietician filled an extra form for 10% of the lunches in the field and compared the data to ensure at least 85% accuracy. The data collector database included all measures for the efficacy trial. Data collectors were trained in the correct use of the database in order to enter all information for the efficacy trial.

AIMS OF THIS RESEARCH

The aims of this research include: 1) analyzing the nutrient composition of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler; 2) analyzing the dietary quality of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler; and 3) examining the contribution of beverage choice to the dietary quality of the parent-packed meal, and to examine their power to predict presence or absence of food groups included in parent-packed sack lunches.

Chapter 3: Nutrient Quality of Preschoolers' Packed Lunches as Measured by Dietary Reference Intakes and Acceptable Macronutrient Distribution Range.

ABSTRACT

Preschool aged children enrolled in Early Care and Education (ECE) centers should receive at least 33% of the Dietary Reference Intake (DRI) for nutrients of public health significance at lunch. The purpose of this study was to evaluate the nutrient quality of lunches packed by parents, and consumed by their preschool aged child using the Dietary Reference Intakes (DRI) and the Acceptable Macronutrient Distribution Range (AMDR). Baseline dietary data from the "Lunch is in the Bag" cluster randomized controlled trial in Central Texas were included. Food packed by parents and consumed by children were observed for two non-consecutive days. Mean values for energy, carbohydrates, protein, sugar, total fat, dietary fiber, Vitamins A & C, thiamin, riboflavin, niacin, calcium, iron, zinc, sodium and potassium were estimated with three-level regression models that controlled for central-level clustering, and repeated measures for each child; adjusted for child age, gender and BMI. Mean and SE for energy (kcal) was 602.48 ± 11.70 for packed lunches compared to 374.40 ± 11.70 for consumed lunches. Percent of energy as macronutrients for protein, carbohydrate and total fat were within the accepted AMDR range for the children's ages: 14.8%, 55.9% and 31.2%, respectively. Total sugar (28.9% of energy) was above the AMDR recommendation of <25% of calories. Only 24.49% of parents packed 33% of the child's DRI for dietary fiber and only 53.8%, 51.7%, and 11.9% packed 33% of the DRI for calcium, Vitamin A and potassium, respectively. Children consistently consumed between 61 and 79% of the nutrients that were packed.

Preschoolers' lunches packed by their parents are not consistently providing adequate nutrient quality as measured by DRI. Since children rely on parents to present them with healthy food choices, future efforts should focus on parent education and center guidelines for healthy lunches.

INTRODUCTION

The Academy of Nutrition and Dietetics (AND) recommends that preschool children receive at least 33% of the Dietary Reference Intake (DRI) for all nutrients at lunch, based on the standard used by the US Department of Agriculture (USDA) in the Early Childhood and Child Care Study [100, 157, 158]. The evidence to date suggests that, compared to current nutritional guidelines, preschool aged children are not consuming adequate diets [159]. Bucholz et al. found that preschoolers did not eat adequate amounts of folate (20%), vitamin A (39%), vitamin E (79%), calcium (40.2%), iron (28.8%), and potassium (90.8%) [160]. Using data from the USDA Continuing Survey of Food Intake in Individuals [160]. Kranz found that only 12% of the preschoolers (n=5437) met the DRI for dietary fiber [161]. Overall, preschoolers' diets have been found deficient in vitamin E, potassium, dietary fiber, iron, calcium and, folate. Further, most preschool children consume more than recommended amounts of energy, sugar, saturated fat, sodium, vitamin A, and zinc [158, 159, 161, 162].

Early Care and Education (ECE) centers provide care for 61% of 3-6 year old U.S. children [4, 163, 164]. Preschool children who attend ECE centers consume one half to two thirds of their daily food in ECE centers; hence, the type and amount of food consumed at ECEs is a significant component of their overall nutrient intake [160]. ECE centers that provide food onsite are subject to regulations that govern the nutrient content of lunch and snacks provided to preschool children, such as the Child and Adult Care Feeding Program (CACFP) meal patterns [95, 165]. In contrast, no regulations govern the nutrition quality of lunches packed by parents and little is known regarding the content of such lunches. Characterizing the nutrient profile of foods packed is an important prerequisite to identifying areas of concern and educating parents accordingly. In addition, it is important to characterize the nutrient profile of food consumed by children in the ECE setting in order to inform parents and ECE providers how to direct efforts to improve children's diets. In a 2006 preliminary study, Sweitzer et al, using data from 74 preschoolers' packed sack lunches, found that parents were not including enough energy, carbohydrate, vitamin A, calcium, iron, and zinc, and had more than the recommended amount of sodium; however, no consumption data were observed [9]. The primary aim of this study was to analyze the nutrient composition of preschoolers' sack lunches that parent's pack and the portion consumed by the child. A secondary aim was to evaluate the dietary quality of lunches packed and consumed by comparing them to age-appropriate DRIs.

METHODS

Subjects: Baseline data from the Lunch is in the Bag (LIITB) cluster randomized trial were used for this study. More details on the LIITB study are available elsewhere [166]. Eligible ECE centers that were licensed by the Texas Department of Family and Protective Services were identified via telephone survey. ECE centers that cared for at least 15 preschool aged children, and required parents to provide food from home were invited to participate in the study. Parent-child dyads included 1) the family member primarily responsible for packing the food for lunch and 2) the 3-5 year old child who regularly ate lunch at a participating

ECE center. All ECE centers included in this study were in Central and Southeast Texas and all measurements and procedures were approved by the Institutional Review Boards at UTHealth/UT Health Science Center Houston and the University of Texas at Austin.

Measures and Data Collection: The data used in the current study included anthropometric measurements, demographic information, lunch box observations to evaluate the nutrient profile of the packed meals, and lunch time observations to evaluate the profile of the foods consumed by the children. Trained staff measured height and weight of participating children the week prior to the baseline period of lunch box observations, using standardized methods and equipment [167]. Body Mass Index (BMI) was calculated as height (m) / weight2 (kg). The parent of each dyad completed a self-reported survey for demographic data.

Data collectors were trained to recognize foods and serving sizes commonly found in preschoolers' lunches and visually estimate amounts [156]. In the field, data collectors observed and recorded the type and amount of foods and beverages inside sack lunches. Lunchbox observation records included a detailed, nominal description of foods and beverages found inside each sack lunch. Data collectors recorded the individual ingredients of "mixed dishes" and documented the estimated amounts for each ingredient and for the total dish. The amounts of food packed were documented in standard measuring units (e.g. cups, pieces or ounces). After the lunchbox observation, during the child lunch observation, trained data collectors used visual cues to determine and record the amount of each item consumed by the child. The amount consumed was reported with the same units as the amount packed, and when possible, as percent consumed. Both lunchbox observation and child lunch observation for each subject were conducted at baseline for two randomly selected, non-consecutive days [156].

The Food Intake and Analysis System (FIAS, Millenium, UT-Houston School of Public Health, Houston TX, 2000) was used for coding, entering and calculating the nutrient analysis of each food record. FIAS utilizes the Food and Nutrient Databases published by the United States Department of Agriculture's (USDA) Food Surveys Research Group including the 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII) Nutrient Data Base, FNDDS 1.0, FNDDS 2.0, FNDDS 3.0 and FNDDS 4.0 [168].

Quality control checks were completed for 10% of all measurements in the field, including food records. A Registered Dietitian reviewed the data for all lunchbox observations and child lunch observations at baseline to ensure that types and amounts of foods were accurately coded before data entry. After data were entered into FIAS, a Registered Dietitian reviewed the resulting database to certify that all food items were entered into FIAS with appropriate coding standards.

Data Analysis: All data were analyzed using SAS software (version 9.4, SAS Institute, Inc., Cary, NC, USA). Descriptive and central tendency statistics were computed to determine demographic characteristics of the sample. A random-effects regression model with random intercepts at the ECE center level, and repeated effects at the child level was used to analyze the nutrient data for the packed lunches and for the food consumed by the children. This modeling strategy was required to account for potential clustering of outcomes at the center level, and non-independence of observations within children [169].

Two separate models were designed to determine differences between amounts packed and consumed, and differences between age groups. In addition, all models were adjusted for child age, gender and BMI. Regressed means for nutrients from lunchbox observations and child lunch observations were estimated and compared to reference intakes. The point of reference used was established by the US Department of Agriculture in the Early Childhood and Child Care Study, which states that the lunch of a preschool child should contain 33% of the Dietary Reference Intakes (DRI) for each nutrient [157, 158, 170]. Preschool-aged children fall under two different categories of DRIs, 1-3 year and 4-8 year old children. Therefore, dietary data were analyzed separately for these age groups.

RESULTS

Baseline lunch box observation data were collected for 607 parent-child dyads from 30 ECE centers in central Texas. Demographic data for the sample are reported in Table 3.1. Participating children had a mean age of 3.5 years and BMI percentile of 56.8. Over 22% of the children measured were overweight or obese. Most of the children were identified as Caucasian (66%) by the parents. The sample included 52% boys and 48% girls. Parents had a mean age of 36.5 years and a BMI of 24.8. Over 37% of parents were overweight or obese. Most of the parents identified themselves as Caucasian (71%). The family members that were primarily responsible for packing the child's lunch were almost 90% female, and 91% of them reported living with a partner. More than half of the sample (57%) had an annual family income greater than $100,000. Over 80% of the sample had at least an associate or bachelor's degree. Additional demographic and sample descriptive data for the LIITB study are available in previous publications [166].

Table 3.1: Parent and child demographics[a] from the Lunch is in the Bag Trial.

Child	n	%
Age (Mean, SD)	3.51	(0.69)
Calculated BMI percentile (Mean, SD)	56.79	(29.99)
Child BMI categories		
Underweight[b]	32	(5.54)
Healthy weight[c]	416	(71.97)
Overweight[d]	75	(12.98)
Obese[e]	55	(9.52)
Race		
Caucasian	367	(66.01)
Hispanic	105	(18.88)
Other	84	(15.11)
Gender		
Boy	315	(52.33)

Parent	n	%
Age (Mean, SD)	36.51	(5.42)
Calculated BMI (Mean, SD)	24.76	(5.07)
Parent BMI categories		
Underweight[f]	15	(2.75)
Healthy weight[g]	327	(60.00)
Overweight[h]	127	(23.30)
Obese[i]	76	(13.94)
Gender		
Female	499	(89.75)
Race		
Caucasian	396	(71.74)
Hispanic	98	(17.75)
Other	58	(10.51)
Annual family income		
Less than \$59,999	92	(17.43)
\$60,000 - \$79,999	52	(9.85)
\$80,000 - \$99,999	83	(15.72)
Greated than \$100,000	301	(57.01)
Highest level of education		
Some college or less	96	(13.30)
Associate or Bachelors degree	274	(49.37)
Masters or Doctorate degree	185	(33.33)
Marital status		
With partner	503	(91.12)

[a] Numbers for different outcome measures may vary due to

[b] < 5th BMI percentile

[c] ≥5th - <85th BMI percentile

[d] ≥85th - <95th BMI Percentile

[e] ≥95th BMI percentile

[f] BMI > 18.5

[g] BMI 18.5 - 24.9

[h] BMI 25 - 29.9

[i] BMI ≥30

Table 3.2 Nutrient composition of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607).

	Packed		Consumed		% Consumed	
	Mean[a]	SE	Mean[a]	SE	Mean[a]	SE
Grams	504.67	± 9.45	302.87 *	± 9.45	64	± 4.90
Energy (kcal)	602.48	± 11.70	374.40 *	± 11.70	66	± 4.93
Macronutrients						
Protein (gm)	21.87	± 0.54	14.26 *	± 0.54	69	± 5.30
Carbohydrate (gm)	83.55	± 1.78	51.07 *	± 1.78	66	± 4.92
Dietary Fiber (gm)	5.59	± 0.15	3.33 *	± 0.15	61	± 5.52
Sugar (gm)	43.25	± 1.21	26.96 *	± 1.21	66	± 5.41
Total Fat (gm)	21.36	± 0.51	13.30 *	± 0.51	64	± 5.76
Saturated Fat (gm)	7.55	± 0.19	4.68 *	± 0.19	67	± 5.89
Monounsaturated Fat (gm)	7.82	± 0.20	4.87 *	± 0.20	63	± 5.92
Polyunsaturated Fat (gm)	4.11	± 0.12	2.56 *	± 0.12	62	± 5.96
Cholesterol (mg)	48.34	± 2.23	31.00 *	± 2.23	79	± 5.98
Vitamins:						
Vitamin A (mcg RAE)	187.03	± 7.52	104.96 *	± 7.52	68	± 6.35
Vitamin C (mg)	50.14	± 2.15	30.81 *	± 2.15	67	± 5.21
Thiamin (mg)	0.45	± 0.01	0.27 *	± 0.01	67	± 5.33
Riboflavin (mg)	0.56	± 0.01	0.34 *	± 0.01	71	± 5.14
Niacin (mg)	5.76	± 0.16	3.67 *	± 0.16	62	± 5.65
Minerals:						
Calcium (mg)	338.05	± 9.34	215.19 *	± 9.34	71	± 5.43
Iron (mg)	3.57	± 0.10	2.14 *	± 0.10	66	± 5.38
Zinc (mg)	2.94	± 0.08	1.89 *	± 0.08	68	± 5.31
Sodium (mg)	989.40	± 30.04	628.66 *	± 30.04	69	± 5.54
Potassium (mg)	715.14	± 14.50	445.36 *	± 14.50	62	± 4.93

[a] Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level; as well as child age, gender and BMI

* Significant at the < 0.001 level

Lunch box observations were analyzed with FIAS to determine the nutrient content of 1,196 recorded meals from 607 students. Table 3.2 includes regressed means of energy, macronutrients and micronutrients; both packed and consumed. The average meal packed by parents had 6.5 food items and an estimated weight of 504.7 grams. Lunches packed had a mean of 602.48 kcals, about 64% of which were consumed by the children. The average amount of food consumed from the lunches was 302.9 grams and the amounts of all nutrients consumed were consistently lower than nutrients packed. A random-effects regression model with random intercepts at the ECE center level, and repeated effects at the child level was used to compare regressed means for nutrients packed and consumed, a significant difference was found for all nutrients. Percent of meal consumed was calculated as follows: % Consumed = 100 - [((Packed -Consumed))/Packed] * 100. Children consistently consumed between 61-79% of the nutrients packed.

Acceptable Macronutrient Distributions Ranges (AMDR) are reported in Table 3.3. Percent of energy provided by protein, carbohydrate, sugar, total fat, and saturated fat were packed was 55% carbohydrate, 14.8% protein and 31.2% total fat. These AMDR values calculated and compared to age appropriate AMDRs. Mean energy distribution of meals were within those recommended by the IOM [157]. Percent of energy from total sugar exceeded the recommended <25%, and energy contributed by saturated fat was barely over the recommended 10%. Mean energy distribution of meals consumed was 56.2% for carbohydrates, 15.3% for protein and 30.4% for total fat, which are also within age-appropriate AMDRs. Percent of energy from sugar consumed exceeded the recommendation at 30.4%, and saturated fat remained barely over the recommendation. Percent of energy from protein and sugar were significantly higher for meals consumed, and total fat was significantly lower.

Table 3.3 AMDRa for macronutrients of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607).

	Packed			Consumed			AMDR [c]		
	Mean[b]		SE	Mean[b]		SE	3 yo		4-5 yo
	Macronutrients as % of Energy								
Protein	14.8 %		± 0.28	15.3 %	*	± 0.28	5-20%		10-30%
Carbohydrate	55.9 %		± 0.79	56.2 %		± 0.79		45-65%	
Sugar	28.9 %		± 0.85	30.4 %	*	± 0.85		<25%	
Total Fat	31.2 %		± 0.55	30.4 %	*	± 0.55	30-40%		25-35%
Saturated Fat	10.94 %		± 0.23	10.6 %		± 0.23		<10%[d]	

[a] Acceptable Macronutrient Distribution Range

[b] Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level; as well as child age, sex and BMI

[c] Established by the Dietary Guidelines for Americans 2010

* Significant at the > 0.001 level

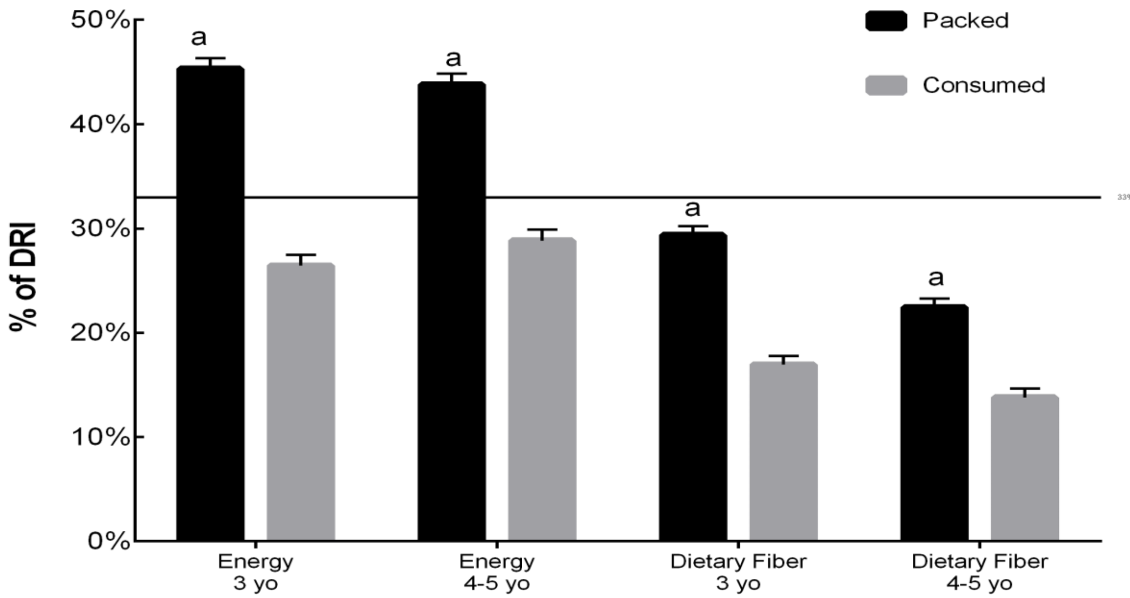
Table 3.4 indicates the DRI's for 3 and 4-5 year olds, respectively. The mean percentages of each DRI for lunches that were packed and consumed are illustrated in Figures 3.1 - 3.3. According to AND standards, preschoolers' lunches should provide at least 33% of age-appropriate DRIs [100]. The amount of energy packed was >33% for both groups, but the amount consumed was under the cutoff point. The amount of dietary fiber and potassium packed and consumed in both 3 and 4-5 year old lunches was <33%. Iron and Calcium packed were adequate (i.e., at least 33% of the recommendation), but when looking at the percent of the DRI that was consumed, preschoolers were not eating adequate amounts of either nutrient. The amount of sodium packed for one meal included more than 96% and 85% of the recommended sodium for one day for 3, and 4-5 year olds respectively. The amount of sodium consumed was also high, with 56.6% of the day's requirements for

Table 3.4 Percent of age-appropriate DRIs[a] and Ais[b] of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607).

	DRI		3 year olds				
			Packed		Consumed		
			Mean (%)[c]	SE	Mean (%)[c]	SE	
Energy[d]	1300	kcal/d	45.33 ±	1.03	26.44 ±	1.03	e,g
Dietary Fiber	19.00	g/d	29.38 ±	0.83	16.95 ±	0.83	e,f,g
Vitamins:							
Vitamin A	300.00	mcg/d	65.39 ±	2.95	35.50 ±	2.95	e,f,g
Vitamin C	15.00	mg/d	327.53 ±	15.61	196.10 ±	15.61	e,f,g
Thiamin	0.50	mg/d	89.68 ±	2.57	52.20 ±	2.57	e,f,g
Riboflavin	0.50	mg/d	113.62 ±	3.08	66.04 ±	3.08	e,f,g
Niacin	6.00	mg/d	92.52 ±	2.63	55.39 ±	2.63	
Minerals:							
Calcium	700.00	mg/d	49.48 ±	1.47	29.59 ±	1.47	e,f,g
Iron	7.00	mg/d	50.36 ±	1.43	28.39 ±	1.43	e,f,g
Zinc	3.00	mg/d	99.38 ±	2.41	59.90 ±	2.41	e,f,g
Sodium[d]	1000.00	mg/d	96.03 ±	3.25	56.60 ±	3.25	e,f,g
Potassium[d]	3000.00	mg/d	24.19 ±	0.53	14.41 ±	0.53	e,f,g
	DRI		**4 - 5 year olds**				
			Packed		Consumed		
			Mean (%)[c]	SE	Mean (%)[c]	SE	
Energy[d]	1400-1500	kcal/d	43.81 ±	1.04	28.85 ±	1.04	e,f
Dietary Fiber	25.00	g/d	22.43 ±	0.84	13.81 ±	0.84	e,f,g
Vitamins:							
Vitamin A	400.00	µg/d	44.29 ±	3.01	25.77 ±	3.01	e,f,g
Vitamin C	25.00	mg/d	202.550 ±	15.87	126.82 ±	15.87	e,f,g
Thiamin	0.60	mg/d	73.95 ±	2.62	48.31 ±	2.62	e,f,g
Riboflavin	0.60	mg/d	91.15 ±	3.13	59.82 ±	3.13	e,f,g
Niacin	8.00	mg/d	74.93 ±	2.66	50.51 ±	2.66	
Minerals:							
Calcium	1000.00	mg/d	32.88 ±	1.49	22.33 ±	1.49	e,f,g
Iron	10.00	mg/d	36.22 ±	1.45	23.13 ±	1.45	e,f,g
Zinc	5.00	mg/d	58.02 ±	2.45	40.19 ±	2.45	e,f,g
Sodium[d]	3800.00	mg/d	85.08 ±	3.28	57.96 ±	3.28	e,f,g
Potassium[d]	1200.00	mg/d	18.53 ±	0.54	12.09 ±	0.54	e,f,g

[b] AI = Adequate Intake
[c] Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level
[d] EER = Estimated Energy Requirement
[e] Packed vs consumed significant at the < 0.001 level
[f] Age significant at the < 0.001 level
[g] Interaction packed/age significant at the < 0.001 level

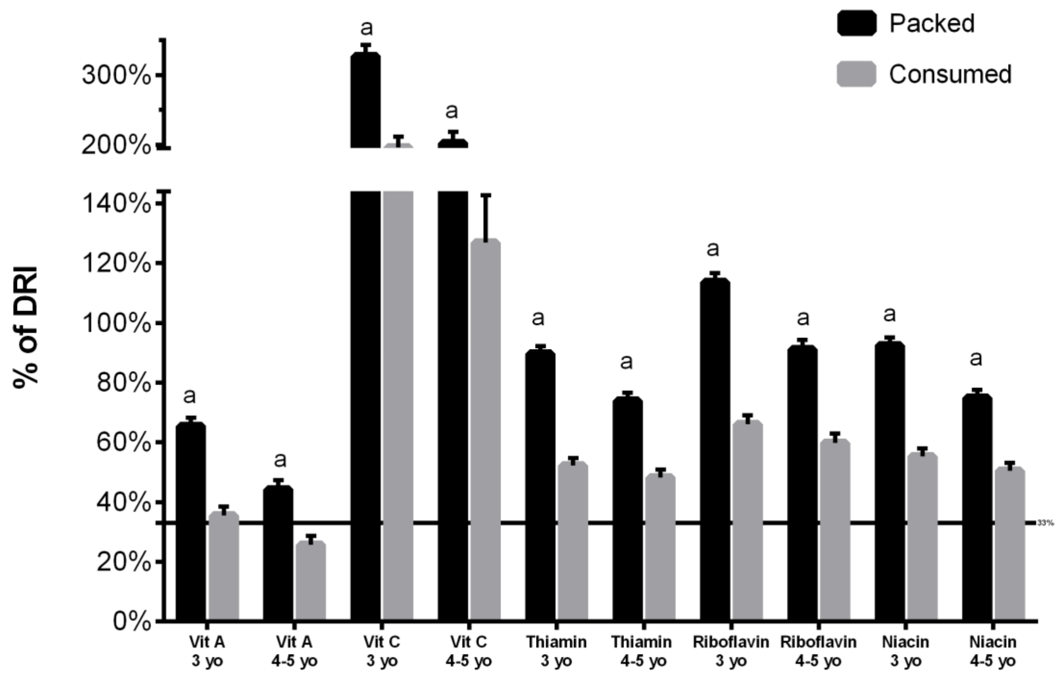
Figure 3.1: Percent of age-appropriate Macronutrient DRIs of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607).



Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level
Energy expressed in EER = Estimated Energy Requirement
Packed consumed / age interaction significant at the $p<0.001$ level

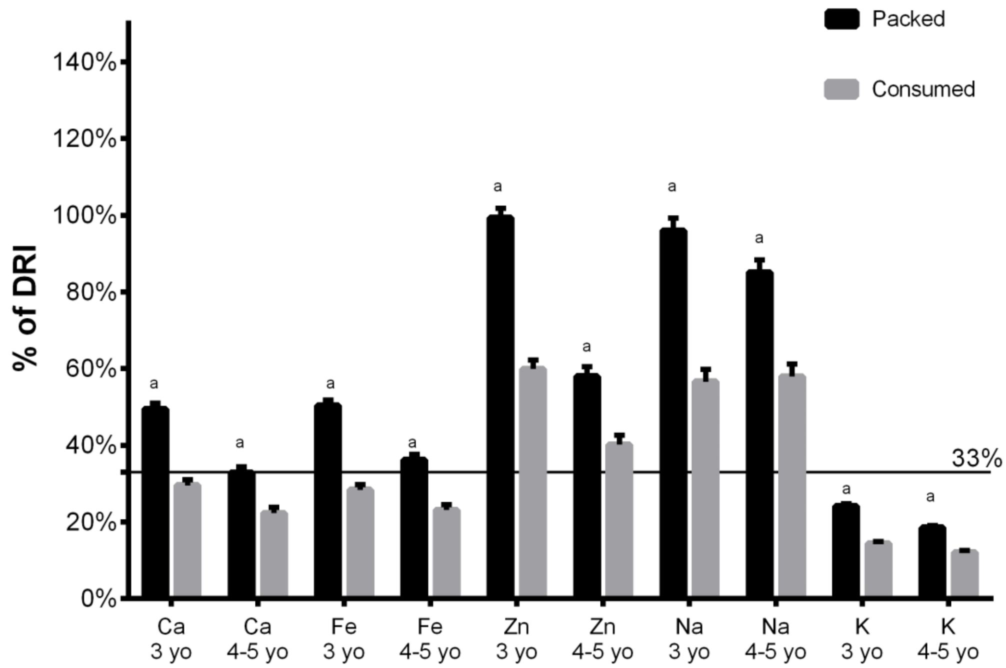
3 year olds and 57.9% for 4-5 year olds. Significant differences between percent of DRIs packed and consumed were computed as well as difference by age group. For all nutrients, the percent of DRI packed was significantly different from the percent of DRI consumed; the percent of DRI packed for and consumed by 3 year olds was also significantly different from the percent of DRI packed for and consumed by 4-5 year olds. A significant interaction between packed/consumed and age group was found for all nutrients, indicating that the difference between % of DRI packed and consumed varies depending on age group.

Figure 3.2: Percent of age-appropriate Vitamin DRIs and AIs of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607).



Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level
Energy expressed in EER = Estimated Energy Requirement
Packed consumed / age interaction significant at the p<0.001 level

Figure 3.3: Percent of age-appropriate Mineral DRIs and AIs of lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (n=607)



Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level
Energy expressed in EER = Estimated Energy Requirement
Packed consumed / age interaction significant at the p<0.001 level

Discussion

The purpose of this study was to characterize the nutrient composition of preschoolers' packed lunches and to evaluate the dietary quality using age-appropriate DRIs. On average, lunches packed by parents of 3 year olds as well as parents of 4-5 year olds did not provide sufficient dietary fiber and potassium, and provided excessive amounts of sodium, sugar and saturated fat. The amount of food consumed by 3 and 4-5 year olds provided less than the recommended amounts of energy, dietary fiber, calcium, potassium and iron; in addition, excessive amounts of sodium, sugar and saturated fat for one meal were consumed. The 4-5 year old group also consumed less than the recommended amount of vitamin A. The high amounts of sodium, sugar and saturated fat in children's lunches underscore that sack lunches packed by parents seem to be governed by taste considerations primarily. Caretakers and nutrition educators can help parents to understand and follow the nutrition recommendations for preschool children's diets.

The percent of food packed at lunch that was consumed by preschool aged children ranged from 60 - 74% (Table 3.2). The percent consumed remained consistent across nutrients suggesting that overall, a preschool child will eat 61 - 79% of the food offered at lunch, with some variation in the percent consumed for specific nutrients. Some of the highest consumption percentages included protein and cholesterol, suggesting that children might be choosing to consume a higher amount of animal protein foods as compared to other foods offered at lunch. This finding is also supported by the increase in energy from protein reported in Table 3.3. The lowest consumption percentages included dietary fiber and potassium, which were also below 33% for amount packed. Parents can be guided to pack healthier foods with higher amounts of these essential nutrients to ensure that a child who may consume only 61-79% of the food items at lunch will still be able to receive 33% of their DRI.

The average lunch that parents packed for their preschool child had a correct proportion of energy coming from protein, carbohydrate and fat as measured by the AMDR ranges [157].

Percentages of carbohydrate and saturated fat were similar between packed and consumed. But children consumed a significantly higher proportion of protein, and sugar calories than those packed by their parents and significantly lower proportion of total fat. Therefore, children appear to readily consume protein and high sugar foods offered at lunch. The increase of relative energy coming from sugar consumed represents another area of education for parents since parents are packing and children are eating more than the recommended amounts of sugar [157]. The amount of saturated fat packed and consumed also slightly exceeds the recommendation given by the DGA 2010 (<10% of energy should come from saturated fat) 2. These findings indicate that parents need more guidance to choose high protein foods with low saturated fat, it seems that food or food group based guidelines are needed to help parents understand what foods should be offered at lunch.

The DRI recommendations differ by age group and preschoolers fall under two different ranges. Parents do not seem to be aware that there is a significant increase in the dietary needs of 4-5 year olds as compared to 3 year-old children. The percent of DRI packed for nutrients are consistently and significantly lower in the 4-5 year old group (Graph 1- 3). Calcium requirements, for example, increase from 700 mg/day for 3 year olds to 1,000 mg/day for 4-5 year olds. The difference in DRI can be translated into one cup of 1% cow's milk, which contains 305 mg of calcium [171]. More information about the different nutrient needs by age in the DRIs should be emphasized so that parents can offer enough food to meet the dietary guidelines for their children as they grow older. The interaction between packed/consumed and age groups in terms of percent of DRI indicate that children are consuming higher percentages of food packed, as they get older.

Parents from the LIITB study packed lunches that were deficient in dietary fiber, calcium and potassium with excess amounts of sodium. Sweitzer et al had also reported that packed lunches lacked vitamin A, iron and zinc. Knowing that children consume 61-79% of the food packed at lunch, it can be assumed that lunches that seem to contain enough nutrients might not translate into an adequate consumption. For example, with calcium, parents of 3 year olds are packing 49% of the DRI for calcium but children are consuming only 30%; parents of 4-5 year olds are packing 33% of the DRI for calcium and children are consuming 22%. If parents do not recognize the increased nutrient needs of their 4 year-old child and continue to pack the same serving size that they used when the child was 3, then the older child will not meet their need even if they consumed 100% of what was packed.

Understanding the difference between foods offered and foods consumed can be beneficial when analyzing nutrients that are usually consumed in excess. The amount of sodium that parents packed is well over the recommendations; parents of 3 year olds packed 96% of the DRI for sodium therefore supplying almost an entire day's worth of the nutrient in one meal. Parents of 4-5 year olds packed 85% of the DRI for sodium. If parents are taught to maintain the serving size of foods that are high in sodium, saturated fat and sugar as their child gets older, then older children might receive lunches that do not exceed the recommendations. Children in both age categories consumed 60% of the DRI for sodium for lunch, which is almost double of the recommended 33%. Kranz et. al. in 2005 determined that preschoolers' that consumed higher levels of dietary fiber were more likely to consume nutrient-dense diets with the exception of calcium and vitamin B-12 [70, 172], whereas preschool children who consumed higher than 25% of energy from added sugars had low consumption of nutrients [70].

The relationship between the amounts of grams, energy, fiber, sugar and saturated fat in the lunches packed and the amounts of these nutrients consumed were analyzed using simple regression models. For every gram increase in the amount packed, children will consume 0.33 grams and for every kcal increase, children will consume 0.38 kcals. The children in this sample will consume more food and more calories when more foods are offered. This relationship is stronger for sugar, where an increase of 1 gram will produce a consumption increase of 0.46 grams of sugar and even higher for saturated fat, where 1-gram increase will produce an increase in 0.51 grams consumed. Therefore a parent who packs a lunch high in nutrients that are known to be consumed in excess such as sodium, sugar and saturated fat will likely lead to a higher consumption of these nutrients in their child. The same principle applies to dietary fiber, where an increase of 1 gram packed will produce an increase of 0.47 grams consumed. This could be employed as a message to guide parents to pack more food items rich in dietary fiber.

This study has some limitations. Time and data collection burden did not allow for differentiation of food items that were packed with the intention of being offered as snacks or as part of lunch. Variability of center policies and teacher practices regarding banned food items that were packed in the lunch but were not offered to children was another limitation. Strengths for this study include detailed observations of food packed by parents and consumed by preschool children. Data collectors went through extensive training and quality controls were conducted to ensure consistency and accuracy of data. Furthermore, sample size allowed for complex regression models that controlled for ECE center and repeated measure variances as well as controlling for child age, gender and BMI.

CONCLUSIONS

Sack lunches packed by parents of preschool children do not meet the dietary recommendations for dietary fiber and potassium and exceed the recommended amounts of sodium, sugar and saturated fat. Parents need to understand the impact of each food item they choose for or remove from their child's lunchbox: the nutrient density of the lunchbox is directly reflected in what their child will consume. These findings corroborate the areas of concern identified by the US Dietary Guidelines. These data and the relationships that exist between amounts parents pack and what children consume can be useful information to guide nutrition behavior change, either through individual or environmental interventions.

Chapter 4: Dietary Quality of Preschoolers' Sack Lunches as Measured by the Healthy Eating Index [173]

ABSTRACT

Eating habits are developed during the preschool years and track into adulthood, but few studies have quantified dietary quality of meals packed by parents for preschool children enrolled in Early Care and Education (ECE) centers. This study is a cross-sectional analysis of baseline dietary data from the Lunch is in the Bag trial. To evaluate the dietary quality of preschoolers' sack lunches using the HEI-2010 to provide parents of preschool children guidance to increase the healthfulness of their child's lunch. A total of 607 parent-child dyads from 30 ECE centers in Central and South Texas were included. HEI total and component scores were computed, using data obtained from direct observations of packed lunches and of children's consumption. Three-level regression models with random intercepts at the ECE center and child level were used; all models were adjusted for child gender, age and BMI. Mean HEI-2010 total scores were 58 for lunches packed and 52 for lunches consumed out of 100 possible points. Mean HEI component scores for packed and consumed lunches were lowest for greens and beans (6% and 8% of possible points), total vegetables (33% and 28%), seafood and plant proteins (33% and 29%) and whole grains (38% and 34%); and highest for empty calories (85% and 68% of possible points), total fruit (80% and 70%), whole fruit (79% and 64%) and total protein foods (76% and 69%). Parents of preschool children pack lunches with low dietary quality that lack vegetables, plant proteins and whole grains, as measured by the HEI. Education of parents and care providers in ECE centers is vital to ensure that preschoolers receive high dietary quality meals that promote their preference for and knowledge of a healthy diet.

INTRODUCTION

The high prevalence of overweight and obesity among young children is a public health concern. In the United States one out of every four children ages 2 – 5 is overweight or obese [1]. Dietary factors have been established as significant predictors of weight in preschool aged children [25], where the diet of overweight and obese children is characterized by a high consumption of energy dense snack foods and meals [70, 5]. Dietary intakes that include low nutrient, high energy dense foods may limit children's intake and preference for fruits, vegetables and whole grains [70, 67, 68, 69]. Moreover, research has shown that food preferences and eating habits developed during preschool years have a significant impact on diet quality in adulthood [5, 52, 53]. Early food-related experiences could define future dietary patterns and health consequences [5, 54] and early food preferences are influenced by exposure to food [55, 174 – 176]. Therefore, experiences such as eating in early childhood education (ECE) centers can play an important part in determining future food preferences [176, 30].

Compliance with nutritional guidelines can be used to evaluate and recommend food groups and portion sizes to parents of preschool children. Studies have reported that preschoolers' sack lunches do not meet the dietary recommendations of the Institute of Medicine in terms of the Dietary Reference Intakes. 16 Another study analyzed the foods offered by ECE centers in North Carolina and found that preschoolers' lunches, in average, did not meet the dietary guidelines [127]. Sweitzer et. al. (2010) demonstrated that parents are aware that lunch provides an important opportunity to receive nutrients for the day; nonetheless, most packed lunches do not meet the dietary recommendations for preschool children [10, 152].

Preschoolers' diets at ECE centers can be evaluated by comparing the meals to guidelines such as Choose MyPlate from the United States Department of Agriculture (USDA), the Dietary Reference Intakes published by the Institute of Medicine (IOM), and dietary indices including the Healthy Eating Index (HEI) [94, 157, 177]. The HEI-2010 has proven to be a valid and reliable method to determine compliance with the dietary guidelines [177]. Specifically, using the HEI to evaluate the dietary quality of preschoolers' lunches provides several advantages for research purposes. Dietary data is usually not easily represented by a normal curve; however when diets and meals are analyzed with the HEI-2010, the resulting data resemble a Gaussian distribution. Several studies report the validity and reliability of the HEI-2010 as a measure of dietary quality for populations thereby supporting the proposition that the HEI-2010 can be used to accurately measure dietary quality 22 and is suitable for use with complicated statistical models including hierarchical data. Indeed, several studies have used the HEI-2010 to evaluate the overall diets as well as particular meals for preschoolers, and have shown that it is a valid method in this context [127, 178].

The aim of this study was to measure and evaluate the dietary quality of preschoolers' sack lunches using the HEI-2010. The individual food components of the lunches packed by parents and consumed by their child were analyzed to determine differences in dietary quality. To our knowledge this was the first study to utilize the HEI-2010 to measure the dietary quality of lunches packed by parents and consumed by preschool children.

METHODS

Study Design: The present study is based on cross-sectional dietary data from the baseline measures in the Lunch is in the Bag trial (Unpublished data) [166]. The objective of the multilevel behavior-based Lunch is in the Bag intervention is to prompt parents to pack at least one serving each of fruits, vegetables and whole grains in preschool children's lunches. The LIITB trial methodology and study design have been described in detail elsewhere [156, 166, 179].

Study Population: A total of 30 ECE centers in three metropolitan areas of Central and South Texas that were licensed by Texas Department of Family and Protective Services, enrolled at least 15 preschool children and required parents to provide packed lunches participated in the study. ECE participation was confirmed with written consent from the center's director. Parent-child dyads were the unit of analysis. The parent-child dyads were formed by a) the family member who is primarily responsible for packing the child's lunch and b) the 3-5 year old child who regularly ate lunch at a participating ECE center. Parents provided written consent for their participation and their child's participation in the study. One parent-child dyad per family was invited to join the study, and a total of 607 parent-child dyads participated in the study. All measurements and procedures were approved by the Institutional Review Boards at UTHealth/UT Health Science Center Houston and the University of Texas at Austin.

Measures and Data Collection: This study utilized baseline data from 607 parent-child dyads across the 30 ECE centers. Baseline measures included demographic information for parents and children, child weight status, and the dietary observations of packed lunches and child consumption of the lunch foods on two randomly selected non-consecutive weekdays [156].

Demographic measures: Each parent completed a demographic questionnaire including race/ethnicity, gender, birthdate and marital status. In addition, parents self-reported their own height and weight to enable researchers to calculate Body Mass Index (BMI). Child height and weight were measured by trained research team using standardized methods and equipment at the ECE center [167]. BMI was calculated as weight (kg) / height2 (m).

Lunchbox observations: Observers were trained by a Registered Dietician to recognize foods commonly found in preschoolers' lunches and visually estimate amounts in standard measuring units (e.g., cups, pieces or ounces) [156]. Before lunchtime, and without the children present, the trained observers recorded in detail the type and amount of foods and beverages present in the lunchboxes. Observers collected the data in as much detail as possible, for example, the individual ingredients of "mixed dishes" were recorded with estimated amounts for each ingredient and for the total dish.

Child Lunch Observations: During lunchtime, the trained observers recorded the amount of each item consumed by the child, using a standard procedure [156]. The amount consumed was reported with the same units as the amount packed and, when possible, as percent consumed. Both lunchbox observation and child lunch observation for each child were conducted for 2 randomly selected, non-consecutive days [156].

The Food Intake and Analysis System (FIAS, Millenium, UT-Houston School of Public Health, Houston TX, 2000) was used for coding, entering and calculating the nutrient analysis from each food record. FIAS utilizes the Food and Nutrient Databases published by the USDA's Food Surveys Research Group; [168] and uses the USDA food coding system that enables the linking of the food records from LIITB trial with the MyPyramid Equivalents Database (MPED 2.0 for USDA Survey Foods, 2003-2004) [177]. The MPED coding system can in turn be used to calculate the HEI-2010 component and total scores [177, 180]. Research has shown that preschoolers' intake is directly correlated with the amount of food served [47, 131]. Analyzing meals that parents packed for their preschool children with the HEI-2010 automatically corrects for the amount of food present by using an energy density approach. For this study the HEI-2010 was calculated for the 1,196 meals that were recorded at baseline, and used to evaluate the dietary quality of preschoolers' sack lunches parents packed, as well as the portion consumed by the child.

The HEI was developed to measure compliance of diets and meals with the USDA Dietary Guidelines. 22 The current version, HEI-2010, has been updated from the HEI-2005 to reflect the Dietary Guidelines for Americans, 2010 [180]. This index uses an energy density approach to evaluate diets and meals against set standards. To control for the size and amount of food present all the HEI-2010 components are reported in function of 1,000 kcals. The HEI-2010 total score (range 0-100) is computed by adding 12 component scores with different maximum values. The first nine components measure adequacy, higher component scores indicate larger amounts of each type of food or nutrient present per 1,000 kcals. The adequacy components are: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins and fatty acid ratio. The remaining 3 components represent foods that should be served in moderation and are called moderation components, these are reverse coded in order to reflect higher dietary quality when less amounts of each type of food or nutrient is present per 1,000 kcals. The moderation components are: refined grains, sodium and empty calories. Calculations and codes for the correct allocation of food groups and computation of the HEI-2010 component scores are published by the USDA [181].

Quality Control Procedures: A Registered Dietitian reviewed the data for all lunchbox observations and child lunch observations at baseline to ensure that types and amounts of foods were accurately coded; this process was done in 4 stages. First, lunchbox observation and child lunch observation raw data were reviewed and cleaned to ensure that serving sizes were accurate before initiating the data entry process. Observers were also trained in the correct use of the database in order to accurately code and enter all food items. A second round of data cleaning was necessary to certify that all food items had been entered and categorized correctly. Third, quality control checks were completed for 100% of all dietary measurements for baseline. Finally, all food items were pulled from the database and a separate excel spread sheet was created and reviewed to ensure consistent coding of food item names and serving sizes.

Data Analysis: All data were analyzed using SAS software (version 9.4, SAS Institute, Inc., Cary, NC, USA). Descriptive and central tendency statistics were obtained to describe the sample and examine the distribution of each variable. To account for non-independence and potential clustering of observations, three-level regression models with random intercepts at the child and ECE levels were employed to model outcomes. Regressions were also adjusted for possible confounding from child gender, age and BMI. Regression-adjusted means for each HEI-2010 component score for packed in lunches (measured in lunchbox observation) were derived from these models. Similarly, regressed means for each HEI-2010 component score for food consumed (measured during child lunch observation) were determined. Subsequently, adjusted means for lunchbox observation and child lunch observation were compared to determine whether the HEI-2010 component and total scores of the lunch consumed were significantly different from those of the lunch packed.

RESULTS

The mean age of parents in the sample was 36.5 years, almost 90% of the parents included in the study were female, with 57% of the sample with an annual family income greater than $100,000 (Table 3.1). The mean age of children was 3.5 years and most of the children (70%) were within the healthy BMI category (5th – 85th percentile) [182].

The HEI-2010 component scores were derived from lunchbox observation and child lunch observation dietary data as mean HEI total and component scores, estimated from multilevel regression models adjusted for confounders (Table 4.1). Across the 607 children, the HEI-2010 mean total score for lunches packed was 58 out of 100 possible points with a range from 14 – 92; the HEI-2010 mean total score for lunches consumed was 52 and ranged from 0 – 95. Mean scores for each of the HEI-2010 component scores of lunches packed were different from those of the meals consumed except for fatty acids and sodium ($p<0.05$).

Table 4.1: Regressed Means for Healthy Eating Index 2010 component and total scores for lunches from in the Lunch is in the Bag trial that were packed by parents and consumed by their preschool child (children n=607) [173].

	HEI Standard for maximum score	Packed			Consumed			
		Mean[a]		SE	Mean[a]		SE	
HEI-2010 component (maximum points)								
Adequacy:								
[1] Total Vegetables (5)	≥1.1 cup equiv. per 1,000 kcal	1.67	±	0.09	1.39	±	0.09	**
[1] Greens and Beans (5)	≥ 0.2 cup equiv. per 1,000 kcal	0.39	±	0.04	0.29	±	0.04	*
[2] Total Fruit (5)	≥0.8 cup equiv. per 1,000 kcal	4.02	±	0.14	3.5	±	0.14	**
[3] Whole Fruit (5)	≥0.4 cup equiv. per 1,000 kcal	3.94	±	0.17	3.21	±	0.17	**
Whole Grains (10)	≥1.5 oz equiv. per 1,000 kcal	3.82	±	0.25	3.36	±	0.25	**
[4] Dairy (10)	≥1.3 cup equiv. per 1,000 kcal	6.22	±	0.2	5.73	±	0.2	**
[5] Total Protein Foods (5)	≥2.5 oz equiv. per 1,000 kcal	3.79	±	0.11	3.46	±	0.11	**
[5,6] Seafood and Plant Proteins (5)	≥0.8 oz equiv. per 1,000 kcal	1.67	±	0.15	1.45	±	0.15	**
[7] Fatty Acids (10)	(PUFAs + MUFAs)/SFAs >2.5	4.34	±	0.17	4.56	±	0.17	
Moderation:								
Sodium (10)	≤1.1 gram per 1,000 kcal	5.13	±	0.21	5.37	±	0.21	
Refined Grains (10)	0 ≤1.8 oz equiv. per 1,000 kcal	6.05	±	0.18	6.36	±	0.18	*
[8] Empty Calories (20)	≤19% of energy	16.94	±	0.2	13.59	±	0.2	**
Total Score (100)	Sum of component scores = 100	58.01	±	0.93	52.32	±	0.93	**

[a] Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level; as well as child age, sex and
* Significant at the < 0.05 level
** Significant at the < 0.001 level

[1] Includes any beans and peas not counted as total protein foods
[2] Includes fruit juice
[3] Includes all forms except juice
[4] Includes all milk products and derivatives
[5] Beans and peas included when the total protein foods standards was not met
[6] Includes seafood, nuts, seeds, and soy products; also beans and peas counted as total protein foods
[7] Ratio of Polyunsaturated fatty acids and monounsaturated fatty acids to saturated fatty acids
[8] Calories from solid fats and added sugars

The HEI-2010 standards used to determine if a meal or diet should receive the maximum total and component scores as well as the standard used to determine which would receive a score of zero are available elsewhere [179]. The number and percent of meals (packed and consumed) that achieved the maximum possible scores for each of the HEI-2010 individual components, as well as maximum total score, are reported in Figure 4.1. All HEI-2010 scores are expressed in units per 1,000 kcals. Only 1 in 10 of the meals packed and consumed had the recommended amount of greens and beans. Over 80% of the sample did not provide or consume the recommended amount of vegetables. Approximately 70% of the sample did not pack or eat enough whole grains, seafood and plant proteins to achieve the maximum scores, while 60 - 70% of the meals (packed and consumed) included higher than the recommended amounts of refined grains, sodium and saturated fats. In contrast, 50% of the lunches packed and consumed included the recommended amounts of dairy and total protein foods and achieved a perfect score for empty calories (< 19% of energy from empty calories); and most of the meals packed (70%) included the recommended amounts of total and whole fruits.

Similarly, the number and percent of meals with a score of zero for each HEI-2010 individual component and total score are reported in Figure 4.2. Where 49% of meals packed did not include any vegetables, over 90% did not include any greens, beans or peas. Parents were likely to pack fruit, since only 7% of parents packed no fruit at all; however, when only whole fruit (not fruit juice) was evaluated, 14% of parents did not pack fruit. About half of the meals packed (48%) did not include any whole grains and 18% of the meals packed had no dairy items included. Only 14% of the meals packed did not include any protein foods but 60% of the meals did not include any seafood and plant proteins specifically. Poly and monounsaturated to saturated fat ratio compliance was also low, with 30% of lunches packed with a ratio < 1.2. For the HEI components that represent nutrients and foods to consume in moderation, 25% lunches packed had > 2 g of sodium / 1,00kcals; 17% had > 4.3 equivalents of refined grains / 1,000 kcals and only 1.2% of the meals packed included more than 50% of energy from empty calories. Percent of meals consumed with a score of zero for each HEI-2010 individual component and total scores were consistently higher than the percent of meals packed.

Figure 4.1: Percent of meals from the Lunch is in the Bag trial packed by parents and consumed by their preschool child that scored zero Healthy Eating Index 2010 component or total scores (Meals n=1,196) [173].

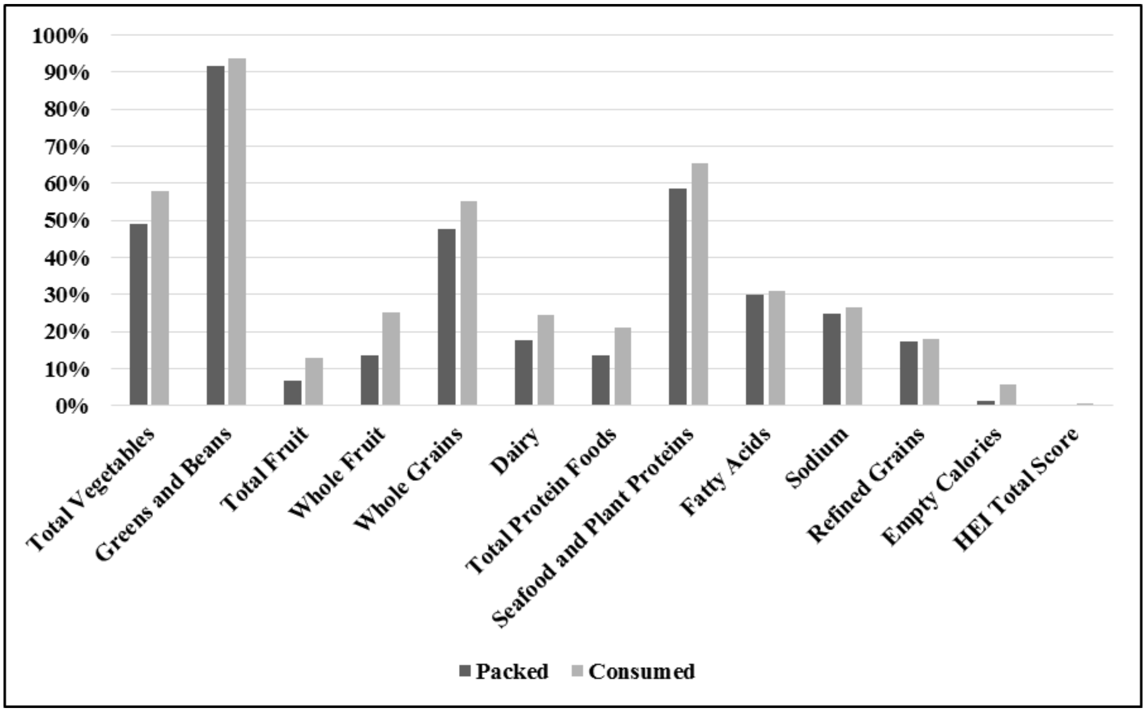
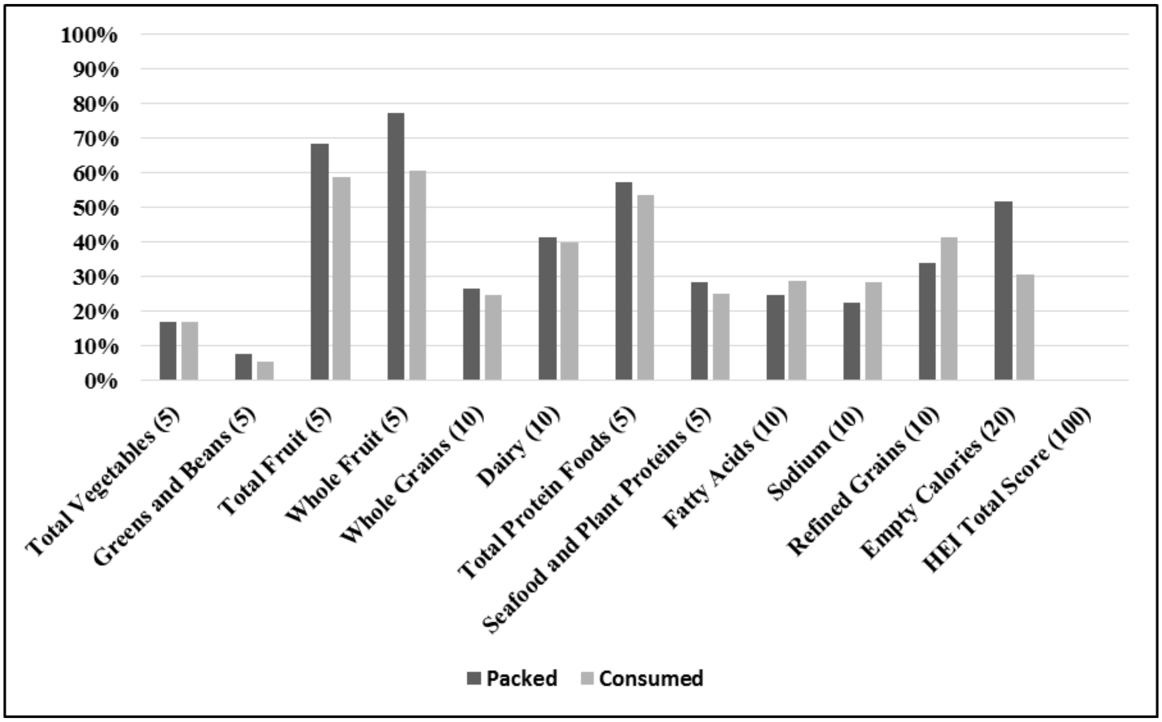


Table 4.3 illustrates examples of lunches and their individual food items that represent the highest HEI-2010 total scores, the mean HEI-2010 total scores and the lowest HEI-2010 total scores. Individual food items packed for lunches with high, mean and low HEI-2010 total and component scores provide an insight into the type of foods that parents pack, as well as the corresponding HEI-2010 score. As evidenced by the HEI-2010 total score of

Figure 4.2: Percent of meals from the Lunch is in the Bag trial packed by parents and consumed by their preschool child that achieved maximum score for Healthy Eating Index 2010 component or total scores (Meals n=1,196) [173].



the meals in Table 4.3, the lunch for a preschool child with a high score includes food items usually associated with foods readily consumed by preschool aged children. Although Lunch 1 included mostly healthful foods, the child who was offered this lunch only consumed 50% of some items, therefore reducing the HEI-210 total score from 90.21 to 78.97. In turn, Lunch 2 was an example of a packed lunch with a score of 86.93, which was increased to 91.11 given the foods that the child chose to consume. Lunches 3 and 4 illustrate how missing one or two food groups in a child's lunch would significantly decrease the HEI-2010 total score. Examples of the lowest HEI-2010 total scores include Lunches 5 and 6. Lunch 5 includes convenience foods in individual packaging, which is a trend seen in parental packed sack lunches. Those food items are high in energy density

Table 4.3: Examples of individual food items packed in lunches from the Lunch is in the Bag trial with high, mean and low Healthy Eating Index 2010 total scores [173].

Lunches with high HEI Scores	Food Item	Amount Packed	% Consumed	HEI Total Score Packed	HEI Total Score Consumed
1	Banana	1 Large (8"-8.8")	0%	90.21	78.97
	Sandwich:				
	Whole grain bread	1 Slice	50%		
	Nut butter	1 Tablespoon	50%		
	Jelly	1 Tablespoon	50%		
	Applesauce	4 Oz	0%		
	Crackers	2 Pieces	50%		
	Milk	8 Fl oz	50%		
	Carrots, Raw	1 Cup	0%		
2	Turkey, deli	0.5 Slices	10%	86.93	91.11
	Mozzarella stick	0.5 Oz	0%		
	Apple, raw	3 Slices	33%		
	Corn, cooked	0.5 Cup	80%		
	Sandwich:				
	Whole grain bread	2 Slices	25%		
	Nut butter	2 Tablespoon	25%		
	Milk	9 Fl oz	11%		
Lunches with mean HEI Scores	**Food Item**	**Amount Packed**	**% Consumed**	**HEI Total Score Packed**	**HEI Total Score Consumed**
3	Fruit cup, cocktail	4 Oz	100%	57.97	57.38
	Sandwich:				
	Whole grain bread	2 Slices	75%		
	Turkey, deli	3 Slices	75%		
	Cheese	1 Slices	75%		
	100% Fruit juice	4.23 Fl oz	100%		
	Potato chips, baked	0.74 Oz	100%		
4	Whole grain bread	1 Slice	100	57.97	46.34
	Pear, raw	0.5 Cup	0%		
	Multigrain cracker	0.5 Cup	90%		
	Weiner	1.5 Pieces	100%		
	Mozzarella stick	1 Stick	100%		
	Hummus	2 Tablespoon	75%		
	Fruit flavored drink	6.75 Fl oz	100%		
Lunches with low HEI Scores	**Food Item**	**Amount Packed**	**% Consumed**	**HEI Total Score Packed**	**HEI Total Score Consumed**
5	Fruit flavored drink	6.75 Fl oz	100%	20.63	20.63
	Beef jerky	0.28 Oz	100%		
	Tomato ketchup	1 Tablespoon	100%		
	Pita wrap:				
	Pita bread	1 Large piece	100%		
	Egg	0.25 Cup	100%		
	Bacon	1 Tablespoon	100%		
	Cheese	1 Tablespoon	100%		
	Fruit snacks (gummy)	0.8 Oz	100%		
6	Yogurt-covered pretzels	5 Pieces	100%	15.42	15.42
	Milk, 1%	1 Cup	100%		
	Fried cheese sticks	5 Pieces	100%		
	Handi-snack:				
	Bread sticks, hard	8 Pieces	100%		
	Cheese	2 Tablespoon	100%		

and low in nutrient density. Lunch 5 also lacked fruits, vegetables and whole grains. All the examples in Table 4.3 demonstrate the individual HEI-2010 components that can be improved in the lunches packed by parents, which would in turn increase the nutritional quality of the overall diet of these children.

DISCUSSION

In this cross-sectional analysis of lunches packed by parents and consumed by their preschool child at ECE centers, we found shortfalls of key food groups and nutrients recommended by the Dietary Guidelines for Americans 2010 and the Scientific Report of the 2015 Dietary Guidelines Advisory Committee. The HEI-2010 component scores for this sample (Table 4.2) are comparable to the component scores reported for the diets of the NHANES data [177]. Erinosho et. al. found that schools offered meals lacking vegetables (dark and green, orange vegetables and legumes), total grains and whole grains, meats and beans, oils and foods low in saturated fat, solid fat and added sugars [127]. Measurement of dietary quality with the HEI-2010 allows for the comparison of parental packed lunches to those provided by ECE centers. In the current study, the mean component scores suggest that parents are packing lunches that lack total vegetables, greens and beans, whole grains, seafood and plant proteins; and include foods high in saturated fat, sodium and empty calories. Although the mean total score of this sample at lunch is similar to the population mean score for the overall diet, previous studies suggest that parental packed sack lunches are an easy target to improve preschoolers' diets [10]. With knowledge of the specific components where parents are scoring high or low, health providers can craft messages that can promote the availability of specific foods in order to increase the dietary quality of the lunch.

Results from this study demonstrate that, when compared to the scores for lunches packed by parents, children are consuming lunches that have significantly lower component scores for total vegetables, greens and beans, total and whole fruit, whole grains, dairy, total protein, and seafood and plan proteins, as well as significantly lower scores for empty calories. Because sodium, refined grains and empty calorie components are reverse-coded, lunches with lower amounts of those foods per 1,000 kcals have higher scores for those HEI-2010 components. The overall dietary quality of the meals consumed by preschoolers is significantly lower than that of the meals packed. These data suggest that there is a need for nutrition education for teachers and parents to increase the dietary quality of the meals offered and consumed at lunch in ECE centers.

In order to further illustrate parental packing behavior, the number of meals that achieved the maximum score for each of the HEI-2010 components and total scores were evaluated. Findings suggest that parents need more guidance regarding the types and amounts of foods they are packing in their preschoolers' sack lunches. None of the parent packed lunches and consequently none of the meals consumed achieved 100/100 points in the HEI-2010 total score. The number of consumed meals that scored full points for the different HEI-2010 component scores differs depending on type and amount of individual food items that children choose to consume. Evaluating lunches with the HEI-2010 individual components is an accurate way to determine areas of opportunity to increase the dietary quality of preschoolers' sack lunches. The evaluation of the HEI-2010 total and component scores demonstrates that the dietary quality of the meal can be significantly impacted by the type and amount of food consumed. A lunch with a high total packed-score can be recorded as lower consumed-score if the child does not consume a particular food group such as dairy, or chooses to consume items that equate to > 50% of energy from empty calories.

Parents are responsible for packing nutritious lunches that are adequate for their child's consumption. But other factors influence the food that is ultimately offered to the child for example the ECE center policies. We found that some ECE centers banned items such as sugar sweetened beverages, and teachers would not offer those items if they were present in the lunch. We also observed that some teachers chose which food items to present to their students or would sometimes encourage the child to eat or finish certain foods.

Two components of the HEI-2010 index that are easy to miss, as evidenced by this sample, are greens and beans and seafood and plant proteins. The reason derives from the calculation of the HEI, where beans are allocated first to total protein and seafood and plant protein; until total protein = 5 and seafood and plant protein= 5 then beans count toward total vegetables and greens and beans. Therefore the component score for greens and beans depends on the total amount of protein present in the meal or diet. The same method is applied to seafood and plant proteins, where a nut butter would only count towards this component until total protein = 5. This knowledge can be used to determine that parents might not be aware that replacing animal proteins with plant proteins would result in a lower HEI-2010 total score unless they add enough to meet both the total protein and total vegetable requirements. To illustrate: 1 ounce of meat, 1 egg, 1 tablespoon of nut butter, ¼ cup of cooked dry beans, or ¼ ounce of nuts or seeds represent 1 ounce equivalent. A 1,000 kcal lunch with 2 tbsp. of nut butter or ½ cup of cooked dry beans or ½ ounce of nuts or seeds would have enough to achieve a perfect score for total protein and seafood and plant protein. And an extra 1.1 cups of vegetables that included 0.2 cups of green vegetables.

Examples of meals with the highest, mean and lowest scores were analyzed to clarify the specific food items and amounts that parents pack for their preschool child. These data are vital to demonstrate to parents of preschool children that it is not impossible, but actually quite easy to pack a high quality lunch that meets the recommendations for a healthy diet. Educated care providers could guide parents on the food items that will provide the highest dietary quality. For example, food items that deducted points because of the sodium and saturated fat content should be discouraged. The proportion of food groups and nutrients per 1,000 kcals is modified depending on the child's consumption of the items in the lunch. Therefore, teacher's input could increase the overall HEI-2010 score of the meal packed resulting in a higher dietary quality of the meal consumed. Lunches where the child consumed 100% of the food packed might encourage parents to continue sending the same food items. But continuous exposure to other food would increase the likelihood of the child eventually consuming them [55]. Parents should be advised to pack a healthful lunch and not be discouraged if the child does not consume all of it.

The large variability of center policies and teacher behaviors are limitations of this study, since they are not accounted for in the analysis. Given the large data collection burden from the LIITB trial, dietary records could not include differences between food items intentionally packed for snacks vs lunch or whether or not the child was presented with all food items at lunch. Further, the presence and use of refrigerators and microwaves in the classroom varied center-to-center as well as classroom-to-classroom. Nevertheless, careful training and evaluation of trained observers ensured a high level of accuracy and the detail of observed food records, and the results and conclusions of this study should be robust. Collaboration between ECE centers, parents and teachers would be beneficial to promote children's consumption of healthier lunches. ECE center policies could guide parents on foods to pack and teachers could enforce said policies. An informal survey was conducted in Central and South Texas to determine which ECE centers could be invited to participate in the LIITB trial. In our experience, ECE centers that cared for children with lower socio economic status would have supplemental assistance such as CACFP or Head Start. Therefore, these centers would not require parents to send complete lunches from home. More research on lower income populations is needed to determine the generalizability of this study.

Conclusions

The dietary quality of preschoolers' sack lunches packed by their parents is low when measured with the HEI-2010. The HEI-2010 can be used to research the areas of opportunity where parents need reinforcement in order to follow the Dietary Guidelines for Americans 2010. Even though these lunches are not 'hot meals' such as prepared by many ECE centers, Parents can easily follow the HEI-2010 components. For example, it is very common to find fruit in preschoolers' lunches, but there seems to be a lack of knowledge or motivation to pack vegetables, greens and beans, seafood and plant proteins, among other things. Vegetables can easily be served to children as either raw or as leftovers from the previous night's dinner meal. These findings illustrate the need for more information about the Dietary Guidelines for Americans 2010 as well as examples of meals that would represent high dietary quality. Education of parents, educators and care providers in ECE centers is vital to ensure that preschoolers receive high dietary quality meals that will promote their preference and knowledge of a healthy diet they grow and develop.

Chapter 5: Beverage Choice and Dietary Quality of Preschoolers' Sack Lunches

ABSTRACT

Preschoolers' consumption of milk, flavored milk, 100% fruit juice and sugar sweetened beverages (SSBs) have been correlated with health outcomes. Parents that pack lunches for preschoolers' should be aware of the impact that beverage choices have on the dietary quality of the meal. The objective of this study was to evaluate the dietary quality of preschoolers' sack lunches based on beverage choices. This study evaluated baseline cross-sectional dietary data from the *Lunch is in the Bag* trial. Data collectors were trained to estimate the type and amount of food packed by parents and the portion consumed by their preschool child (n=607). Food observation records were used to determine food group and servings then Healthy Eating Index (HEI-2010) scores were computed and analyzed. Three-level regression models with random intercepts at the child and Early Care and Education center levels were employed to model outcomes and were adjusted for child gender, age and body mass index (BMI). Beverage choice was significantly associated with presence of vegetables, refined grains, and chips in lunches. HEI-2010 *total scores* significantly differed ($p < 0.001$) by beverage choice. Meals containing plain milk received the highest HEI-2010 *total score* of 63%, followed by meals containing 100% fruit juice (60%), flavored milk (59%), no beverage (57%) and meals with a sugar sweetened beverage scored the lowest at 55%. The association of dietary quality of preschoolers' sack lunches and beverage choice was significant. Findings can guide development of future interventions that target parent meal planning for their preschool-aged children.

INTRODUCTION

Currently, up to 61% of U.S. preschool children spend an average of 3 hours per week in Early Care and Education (ECE) centers. These centers are viable venues to study the impact of preschoolers' dietary patterns [30]. Common dietary patterns of preschool children include fluid milk and 100% fruit juice as main sources of calories [66]; and fruit drinks as main sources of added sugars [73]. Beverage consumption patterns have changed over the years, more children (84%) consumed plain milk from 1976 – 1994 than in in 2000-2006 (77%); conversely flavored milk intake increased [182]. Additionally, 100% fruit juice consumption increased by 20% from 1976-1994 to the early 2,000s [183].

Beverage consumption patterns have been linked to overall dietary quality; Nicklas and colleagues analyzed the nutrient intake of 2-11 year old children, and found that the nutrient profile of 100% fruit juice consumers was significantly closer to the Dietary Reference Intake (DRI) age-appropriate recommendations than the diet of non-consumers [139]; similar patterns of dietary quality have been found in children who consume milk [131]. Garnett et al. compared energy intake and dietary quality of sugar sweetened beverage (SSB) consumers to milk and 100% fruit juice and found that SSB consumers have significantly higher energy intakes, and lower dietary quality [145]. Additionally, SSB consumption has been consistently associated with higher Body Mass Index (BMI) during childhood with an increased risk of adult obesity [128, 147]. The objective of this study was to evaluate the use of parental choice of beverage as a predictor of the dietary quality of lunches packed by parents for their preschool child; measured using food group presence and Health Eating Index (HEI) scores.

METHODS

Baseline dietary data from the Lunch is in the Bag (*LIITB)* trial was used for this study; *LIITB* trial methodology and study design have been described in detail elsewhere [166, 184, 185]. Self-reported demographic information, child anthropometrics, direct observations of food items present in parent-packed lunches and portion consumed by the child on two randomly selected non-consecutive weekdays were analyzed.

Subjects: Six hundred seven parent-child dyads from 30 ECE centers in Central and South Texas participated in the (*LIITB)* trial. A total of 1,196 lunches were observed and recorded. The unit of analysis was one parent-child dyad per family that consisted of the family member primarily responsible for packing the child's lunch and the 3-5 year old child who regularly ate lunch at the ECE center. Parents provided written consent for themselves and their child to confirm their participation in the study. The Institutional Review Boards at UT Health/UT Health Science Center Houston and The University of Texas at Austin approved all measurements and procedures.

Demographics: Surveys were delivered to parents to obtain data on race/ethnicity, gender, birthdate and marital status of the parents. Parent BMI was calculated with self-reported height and weight (weight in kg / height^2 in m). Child BMI was calculated using anthropometric measurements taken at the ECE center by trained research team members using standardized methods and equipment [167].

Lunchbox and Lunchtime Observations: Observers were trained by a Registered Dietitian to ensure adequate registry of foods and beverages present in preschoolers' sack lunches

[185]. In the ECE center, trained observers recorded types and amounts of foods and beverages packed by parents using standard measuring units (e.g. cups, pieces, or ounces). Observers were trained to include as much detail as possible, for example, if milk was packed in a thermos the food item was recorded as “milk, fat not specified” but if the lunch included a milk packaged for individual sale a more detailed description would be logged. Food records included food name (type), amount packed, food group type and serving. Plain water packed by parents was not consistently recorded since ECE centers provided water if no beverage was packed in the lunch.

Food groups and serving sizes: To code food groups and serving sizes, a Registered Dietitian compared the average nutrient composition of food items found in the lunchboxes to the pertinent dietary guidelines for preschool children. Nutrition composition was determined with the National Nutrient Database for Standard Reference by the Agricultural Research Service of the United States Department of Agriculture (USDA) [171]. Food groups were determined using the USDA MyPlate guidelines, food items that did not meet the criteria for MyPlate food groups were categorized as chips, sweets, oils, and condiments, respectively [94].

Energy, Macronutrients and Healthy Eating Index (HEI): Dietary data were analyzed with the Food Intake Analysis System (FIAS), energy and macronutrient content of individual food items were computed. FIAS uses the USDA food coding system that enables linking the food records from the *LIITB* trial with the MyPyramid Equivalents Database (MPED 2.0 for USDA Survey Foods, 2003-2004). The MPED coding system was used to calculate the HEI-2010 component for each of the 12 components and added to obtain HEI total scores [168]. More detail on the HEI scores for this sample has been published elsewhere [173].

Quality control: A registered dietitian reviewed and cleaned the data for all food records at baseline to ensure that serving size and food groups were accurate before initiating the data entry process. Observers were also trained by a registered dietitian to accurately code and enter all information into FIAS. To certify that all food items had been entered and categorized correctly, all entries to FIAS were reviewed and compared to the original food records. Quality control checks were completed for 10% of all dietary measurements in the field at baseline. Additionally, all food items were reviewed to ensure consistent coding of food item names, food groups and serving sizes.

Data analysis: Statistical Analysis System (SAS) software (version 9.4, SAS Institute, Inc., Cary, NC, USA) was used to analyze all data. Demographic characteristics of the sample were computed with descriptive and central tendency statistics. Models sought to examine if beverage choice served as a predictor of the presence of multiple food groups. Food groups of interest for this analyses included fruits, vegetables, whole grains, refined grains, meat and beans (protein in MyPlate terms), diary, chips or sweets. A binary variable reflecting presence or absence of each particular food group was created. Beverage choice was coded as a multi-category variable, with the categories including sugar sweetened beverage (SSB), 100% fruit juice, milk and flavored milk; meals that included more than one beverage were coded as "> 1 beverage". HEI-2010 total scores, energy and macronutrients were treated as continuous variables. Multivariate analyses were used to estimate food group presence and dietary quality (represented by HEI-2010 scores) across beverage categories. Random-effects regression models with random intercepts at the ECE center level, and repeated effects at the child level were used to estimate outcome measurements to account for potential clustering of outcomes at the center level, and non-independence of observations within children.

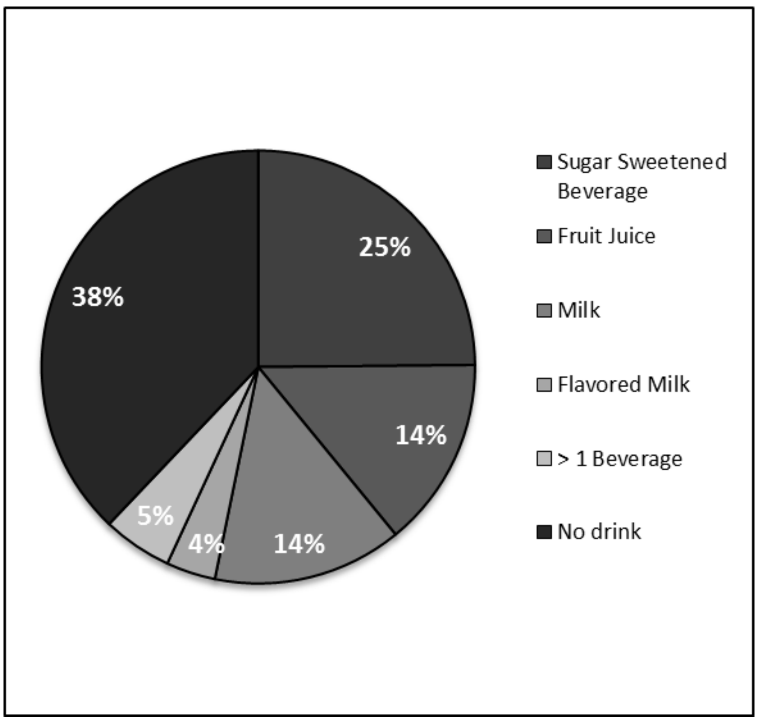
RESULTS

Lunch observation data were available for 607 preschool children age 3-5 years (mean 3.5 years) and their parents (mean 36.5 years) in 30 ECE centers in Central and South Texas. In this sample, 22% of the children and 37% of the parents were overweight or obese.

Frequency distribution of beverage types packed in child lunches: The majority (62.1%) of meals (n=1,195) packed by parents in this sample included a beverage as part of the preschoolers' lunch. The proportion of lunches that included 100% fruit juice, milk, flavored milk, SSB or did not include a beverage are represented in Figure 5.1. The most popular beverages in this sample were SSBs which were included in 25% of meals, followed by 100% fruit juice (14%), milk (14%) and flavored milk (3.7%); additionally, 5.2% of meals included more than 1 beverage. Not all parents packed the same beverage on both observed lunches, 31% of parents did not pack a beverage in either observed lunch, 15% packed a beverage only in one of the two observed lunches, 37% packed the same beverage on both days and 17% packed different beverages on each day.

Comparison of nutrient content of beverages packed: Mean energy content of beverages, and kcals from protein, carbohydrate, fat and sugars are illustrated in Figure 5.2. The amount of sugar present in beverages (Figure 5.3) was highest for SSBs followed by flavored milk, while plain milk had the lowest amount of sugar. Protein and fat content were higher in milk and flavored milk and relatively nonexistent in SSB and fruit juice. Overall, flavored milk had the highest energy content (170.73), while SSBs had the lowest energy content (92.33 kcal). Lunches with more than one beverage typically included a plain or flavored milk plus 100% fruit juice or SSB. The average energy content provided by beverages in the >1 beverage category was 215 kcals, with 36 grams of sugar.

Figure 5.1: Distribution of Beverages that Parents from the Lunch is in the Bag trial Packed for their Preschool Children n=1195



Beverage as Predictor of Foods packed in the lunches (Table 5.1): Associations of food group (vegetables, refined grains and chips) with beverage type are positive ($p<0.05$). Presence of these food groups increases significantly with type of beverage present in the lunch. With the rest of the food groups of interest (fruits, whole grains, meats and beans, dairy and sweets) the associations are not as clear or consistent within categories of beverage packed. Across beverage categories, lunches packed by parents in this sample generally included at least some fruit (78-88%), meat and beans (79-87%), dairy (65-70%) and sweets (48-60%). Presence of vegetables was significantly associated with meals that contained plain milk or no beverage at all, as compared to 100% fruit juice and SSB ($p<0.05$). While the presence of whole grains was not associated with beverage choice, it ranged generally from 30-40% across all meals, meals that included milk as beverage choice were significantly less likely ($p<0.05$) to include refined grains compared to all other beverage choices (except for meals with > 1 beverage).

Figure 5.2: Mean Energy Serving of Beverages that Parents from The Lunch is in the Bag trial Packed for their Preschool Child n = 1195

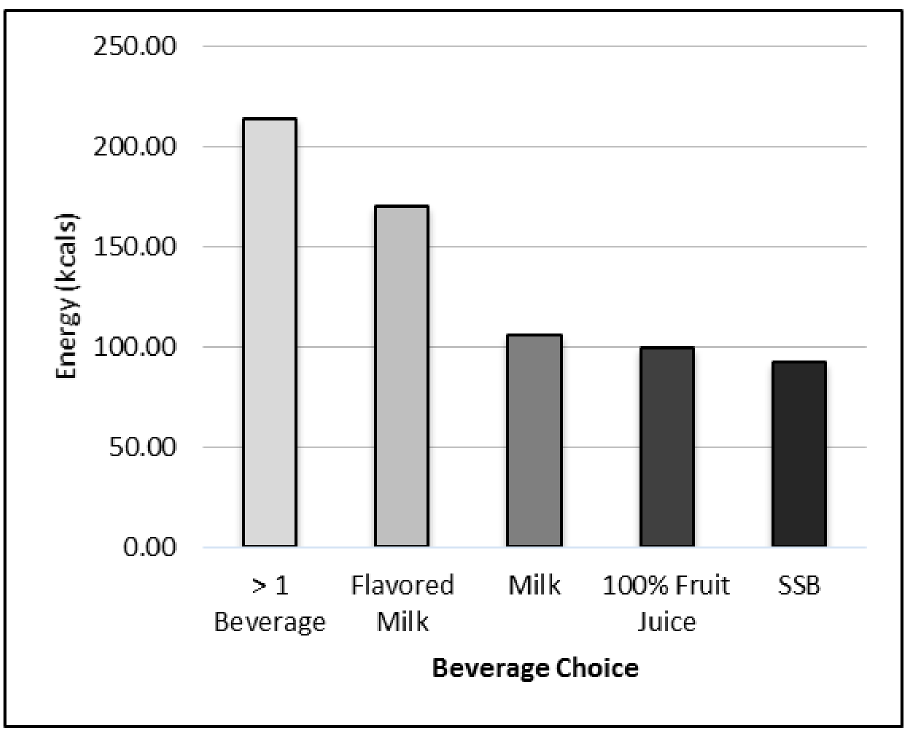
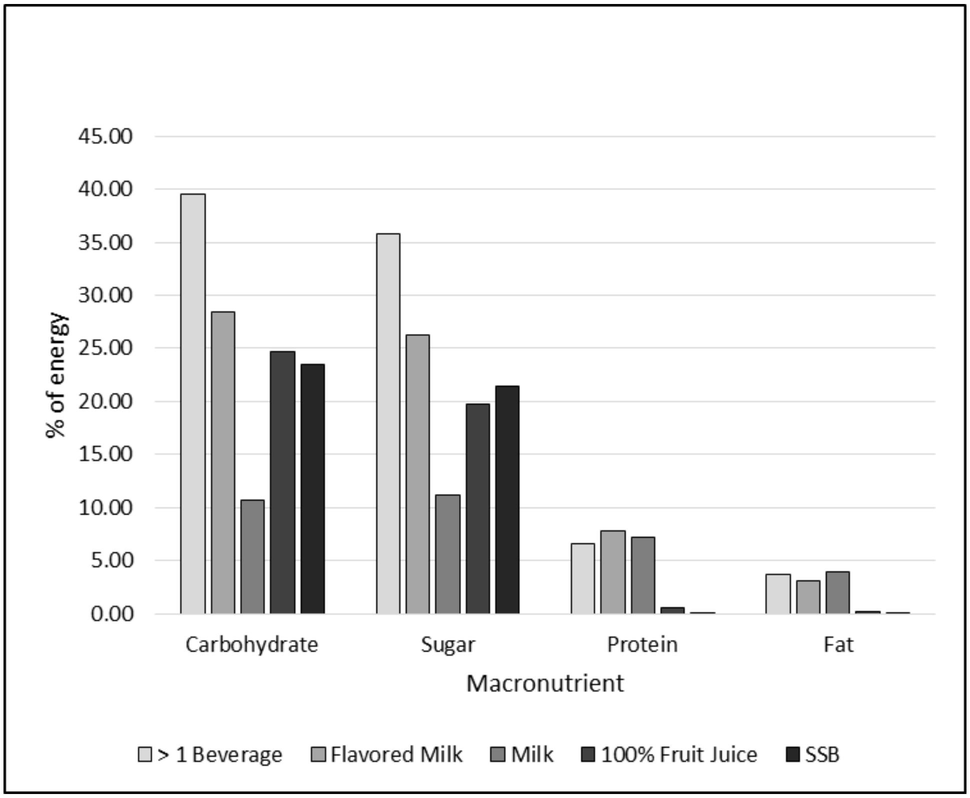


Figure 5.3: AMDR of Beverages that Parents from The Lunch is in the Bag trial Packed for their Preschool Child n = 1195.



Additional analyses examined the associations of beverage choice with dietary quality measured using the HEI-2010. The HEI-2010 *total score,* which measures dietary quality in a scale of 0-100, was computed for the food items in each lunch excluding beverage from the analysis. The highest score was allocated to meals that contained milk (55), followed by meals that contained 100% fruit juice (54.3), meals without a beverage (53.2), meals with flavored milk (44.8), with meals containing a SSB showing the lowest HEI total score (44.8).

Table 5.1: Probability of packing food groups in preschoolers lunches (excluding beverages), predicted by Beverage choice (n=607).

	SSB			Fruit Juice			Milk			Flavored Milk			Mix			No Beverage		
	%[a]		SE	%[a]		SE	%[a]		SE	%[a]		SE	%[a]		SE	%[a]		SE
Food Group																		
Fruits	85.1	±	3.4	88.4	±	3.8	78.5	±	3.8	80.3	±	6.0	85.3	±	5.2	82.7	±	3.1
Vegetables*	31.6	±	3.3	32.2	±	4.1	46.2	±	4.2	39.7	±	7.6	36.7	±	6.5	43.4	±	2.8
Whole Grains	30.8	±	3.6	33.1	±	4.3	37.9	±	4.3	40.3	±	7.5	28.0	±	6.5	32.7	±	3.1
Refined Grains*	75.2	±	2.9	71.5	±	3.7	59.9	±	3.8	66.3	±	7.1	73.9	±	6.1	69.4	±	2.3
Meat and Beans	85.1	±	2.9	80.9	±	3.5	87.1	±	3.6	79.0	±	6.2	79.9	±	5.3	80.5	±	2.5
Dairy	65.7	±	3.5	69.6	±	4.3	67.0	±	4.3	67.2	±	7.5	70.9	±	6.4	63.0	±	3.0
Chips*	36.1	±	3.3	28.1	±	4.0	25.2	±	4.0	16.3	±	7.2	42.3	±	6.1	28.8	±	2.8
Sweets	58.1	±	3.4	58.4	±	4.3	50.8	±	4.3	54.9	±	7.8	60.8	±	6.7	48.1	±	2.9
HEI Total Score including beverages**	55.05	±	1.11	60.25	±	1.30	62.81	±	1.31	59.52	±	2.18	60.37	±	1.89	56.88	±	0.99
HEI Total Scores excluding beverages**	44.81	±	1.36	54.35	±	1.36	55.05	±	1.37	49.51	±	2.32	47.5	±	2	53.17	±	1.02

[a] Regressed mean and Standard Error (SE) adjusted to control for cluster effect at the school and child level
* Significant at the $p < 0.05$ level
** Significant at the $p < 0.001$ level

DISCUSSION

In this cross-sectional analysis of dietary data from the *LIITB* efficacy trial, we examined the food group and dietary quality correlates of the types of beverage choices present in parent-packed lunches for preschoolers in central Texas. The significant association of beverage choice and presence of vegetables, refined grains and chips is noteworthy. When looking at lunches with only one beverage, lunches that included a SSB were significantly more likely to contain chips compared to lunches with plain and flavored milk. When parents pack milk as a beverage there appears to be a positive correlation with vegetables, a nutritious food group, and negative correlations with refined sugars and chips, less nutrition food groups. Parents may associate milk with other nutritious foods.

The use of the HEI-2010 to provides advantages for evaluating the dietary quality of preschoolers' sack lunches [173]. The HEI controls for the amount of energy packed, because all components are scored in terms of 1,000 kcals and the HEI provides an objective measurement of dietary quality with a score from 0-100, 100 indicating the highest dietary quality. For this sample, the food items from lunches containing plain milk had the highest HEI-2010 *total score* (55/100), followed by flavored milk and 100% fruit juice. This finding is similar to previous research suggesting the association of milk and fruit juice consumers with higher dietary quality [131, 139, 145].

It has been established that food preferences and eating habits are established during the preschool years and track into adulthood. The findings relating beverage choice to differences in food group presence and dietary quality of lunches packed by parents of preschool children have important implications for the development of interventions and dietary guidelines. Furthermore, milk consumption in childhood has been associated with lower BMI, and there has been mixed evidence for 100% fruit juice, whereas SSB consumption has been associated with higher BMI. Further research is needed to understand the implications of beverage choice on the food packing habits of parents of preschool children.

Water consumption was not recorded consistently because ECE centers provided water when no beverage was provided; therefore, water packing was not part of the analysis. Other limitations in this study include ECE center policies, which could have prohibited SSB as beverage choices. However, we found a high prevalence of SSB as beverage choice. Beverages that were packed in reusable containers were difficult to categorize and lacked information; fat content of milk could not be consistently recorded. Nevertheless, observers were thoroughly trained to adequately categorize and record food items and the data were cleaned meticulously.

CONCLUSIONS

There is a significant association of beverage choice and dietary quality of meals packed by parents for their preschool children. Lunches containing plain milk had the highest dietary quality as measured by the HEI-2010 total scores; additionally they were more likely to include vegetables and less likely to include refined grains and chips. Meals containing 100% fruit juice had the second to highest dietary quality, followed by flavored milk, and SSB. More research is needed to understand parental packing behaviors and the use of beverages as indices of dietary quality.

Chapter 6: Conclusions and Implications

The aims of this research were to 1) analyze the nutrient composition of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler; 2) analyze the dietary quality of the individual sack lunches that parents in the LIITB Efficacy Trial packed for their preschool child and the proportion consumed by the preschooler using the Healthy Eating Index; and 3) to examine the contribution of beverage choice to the nutrient composition of the parent-packed meal, and to examine whether the presence of these predicts the dietary quality of the meal as well as the presence or absence of other specific food groups included in parent-packed sack lunches.

Thirty ECE centers in Central Texas participated in the LIITB Efficacy trial and 607 parent-child dyads were recruited. Parental packed lunches were observed and recorded for two random nonconsecutive days by trained data collectors. Dietary records were analyzed with the Food Intake Analysis System (FIAS) to obtain nutrient content and coding to compute the Healthy Eating Index. Demographic and anthropometric data were also collected. The mean age of parents was 36.5 years and mostly female (90%).).

Sack lunches packed by parents had a mean of 602.5 kcals and consisted, on average of 6.5 food items. Preschool children consumed 66% of the kcals packed and nutrient consumption ranged from 61-71%. Macronutrient distribution was adequate but lunches contained high amounts of sugars (29% of energy) and saturated fat (11% of energy). Dietary fiber and potassium content did not meet the recommendation (33% of DRI); sodium, sugar and saturated fat present in lunches exceeded the recommendation. The dietary quality of preschoolers' sack lunches packed by their parents is low when measured with the HEI-2010. Mean HEI total score was 58/100 possible points for lunches packed and 52 for the portion consumed. Scores for the portion consumed were significantly different from the score of the lunch paced for total vegetables, greens and beans, total fruit, whole fruit, whole grains, seafood and plant proteins, refined grains, empty calories and total score. The most popular beverage choices were sugar sweetened beverages (SSBs), 100% fruit juice, milk and flavored milk. The HEI score for meals containing milk were highest when beverage was considered in the analysis (62.8/100) and when the HEI was computed without beverages (55/100); followed by 100% fruit juice, flavored milk and SSB. Beverage choice significantly predicted the probability of meals including at least some vegetables, refined grains and chips.

This study provides guidance for further studies. The dietary quality of preschoolers' sack lunches after the LIITB intervention should be evaluated. Data from the LIITB Efficacy trial could be used to determine the effect of food group modification on the overall dietary quality of a lunch. Dietary quality differences by anthropometric, demographic and psychosocial characteristics could be analyzed to further elucidate trends and dietary patterns. More data is needed to validate beverage choice as predictors of dietary quality, and studies should evaluate if the modification of parental beverage choice would increase the dietary quality of the rest of the lunch packed. Other factors could be used as predictors of dietary quality such as main entrée choice.

In conclusion, the nutrient content of preschoolers' sack lunches is deficient and lacks calcium, potassium, vitamin A and dietary fiber. The high amounts of sodium, sugar and saturated fat in lunches are inadequate and a cause for concern. The HEI-2010 is a useful tool to measure the dietary quality of children's meals and provides statistical advantages over nutrient analysis. Specific food choices such as beverages can be used to predict the dietary quality of a meal, beverage choice is a viable intervention target to increase the dietary quality of parental packed meals. These findings suggest that parents of preschool children need more guidance in order to provide better foods and beverages to promote the development of healthy food preferences and eating habits. Collaboration of parents, educators and care providers in ECE centers is vital to ensure that preschoolers receive high dietary quality meals that will promote their preference and knowledge of a healthy diet they grow and develop.

Appendix

APPENDIX A: LUNCH BOX AND LUNCH TIME OBSERVATION PROTOCOL

Lunch is in the Bag 2011

Lunch Box and Lunch Time Observation Protocol

I. **Purpose**: The purpose of the Lunch Box and Lunch Time Observation is to objectively and accurately record the type and quantity of food items in the parent packed lunch boxes of preschool aged children.

II. **Data Collectors**: Each data collector will undergo a training period and will complete a posttest. In the field 10% of the lunches recorded will be verified by a "gold standard" observer.

III. **Materials Needed**:
- Pencil
- Tape measure
- Food Observation Records
- Temperature gun
- Gloves

IV. **Sampling**:
- Lunch Box observations and Lunch Time observations take place for 2 nonconsecutive random days for each registered child. The Lunch Box observation is from 9:00 – 10:30 and the Lunch Time observation is from 11:00 – 12:30 (or during the center's scheduled lunch time.
- All lunches of 3-5 year olds that are registered in the study will be observed.

V. **Preparation**:
1. The Lunch Box and Lunch Time observations must be prearranged with the facility to avoid conflicts in schedule such as holidays, vacations, and field trips.
2. Consent must be obtained from the center in order for the observation to be completed.

VI. **General Guidelines**:
1. Child/Observer Interaction
- Attempt to minimize conversation and contact with all children. The children will be aware of the observer's presence and will be told that a visitor is at the facility to watch the children eat and see what they brought for lunch. The children will undoubtedly be curious at first and will try to interact with the observer.

Discourage interaction by avoiding eye contact and minimizing conversation in a curt but pleasant manner. Observers should not interject themselves into the interactions between children and/or staff.

2. Confidentiality

- All data collected should be treated in a confidential manner. Do not leave notes, names, IDs, or forms unattended. Do not discuss the Food Observation Data Collection Form with the facility staff or children.

3. Dress

- Field staff should dress comfortably and comfortable shoes should be worn as well. Name tags and any visitors IDs provided by the facility should be worn at all times.

VII. **Data Collection**:

1. Advanced preparation
   - Prior to arriving at the facility the Director will be contacted in order to set up the scheduled one-two week observation period. The teachers and directors will be told that observers can show up on random days for observation. Have Director identify any days that would include a field trip, special holiday/party meal or snack, or “pizza” day.
2. Observation
   - All 3-5 year old children enrolled in the study will be observed.
   - Based on number of children enrolled at each center 1 observer should record the contents of 10-15 lunch boxes and 1 observer should observe 5-6 children during lunch time.
   - The entire lunch time should be observed

VIII. **Quality Control**:

Quality control is needed to ensure that all observation data are collected in a standardized and reliable manner. All data collectors will be assessed for inter-observer reliability prior to beginning the data collection at baseline and follow-up. A comparison rate of 85% must be met among observers.

APPENDIX B: FOOD OBSERVATION RECORD

Food Observation Record **Page ____ of _____**

Data Collector Name ____________________
Center ________________________
Child's ID #: _____________________
Lunch Container (Shape/Material): ________________________

Date: __________ **Lunchbox Obs time:** ________ **Time Lunch Started**____________
Ice pack: Yes / No (Circle) Number______ Gel Pack / Hard (Circle) Small /Medium/ Large (Circle)
Insulated? Yes / No (Circle)

Food Group	Food item (w/brand name)	Amount packed	Amount Eaten**	Served for Lunch? Yes/No	# of servings	Method packed	Cooked or Raw (F/V)	Color	Shape	Texture	Temperature

** **Indicate amount of food NOT available for child to eat: e.g., spilled half OR teacher removed all**

Food Group: M = Meat & beans
D = Dairy
O = Oils/Fats
F = Fruit
V = Vegetables
G = Grains
C = Condiments
Ch = Chips
S = Sweets
WG= Whole grains

Amount: c = cup
oz = ounce
fl oz = fluid ounce
piece (pc) = individual piece

Method packed:
PB = plastic bag
PW = plastic wrap
W = wax paper*
P = paper*
RC = reusable container *
AF = aluminum foil*
Cb = cardboard
IP= individual packaging
T= Thermos
*Unwrap to take temperature

Cooked or Raw- F/V: C = cooked
R = raw

Color: B = brown
G = green
R = red
O = orange
BL = blue
Y = yellow
W = white
P = purple
M = mixed

Shape: C = circles
Sq = Square
S = Star
R = Rectangle
T = triangle
Rg = Ring
Cy = cylinder
A = animal or novelty
Cb = cubed
M = mixed

Texture: Ch = chewy (dried fruit)
WC = wet & crisp (apple, celery)
DC = dry & crunchy
SM = smooth
Sf = soft (cheese, rice)
L = liquid
T = tender (meat)
M = mixed
O = other
J = juicy (grapes)

APPENDIX C: SERVING CHEAT SHEET

Food Group	Food Components	Volume oz	Cup	Tablespoon	Teaspoon	Piece	Serving	
Dairy (D)	**Milk (Cow's, soy, almond, etc)**	4.0	1/2	8	24	N/A	**0.66**	
		5.0	5/8	10	30	N/A	**0.83**	
		6.0	3/4	12	36	N/A	**1.00**	
		8.0	1	16	48	N/A	**1.33**	
		9.0	1 1/8	18	54	N/A	**1.5**	
		11.0	1 3/8	22	66	N/A	**1.83**	
	Yogurt / Yogurt Drinks	2.0	1/4	4	12	**1 Danonino**	**0.33**	Greek yogurt and Activia are not in the database. Enter them as low fat yogurt and in the comment space write down either greek or probiotic if that's the case.
		2.3	2/7	4 1/2	13 1/2	**1 gogurt**	**0.33**	
		3.1	2/5	6 1/5	18 3/5	**1 drinkable**	**0.50**	
		4.0	1/2	8	24	N/A	**0.66**	
		6.0	3/4	12	36	N/A	**1.00**	
		8.0	1	16	48	N/A	**1.33**	
	Cheese Sauce	0.5	0	1	3	N/A	**0.04**	If you see cheese or cheese sauce double check yourself
		1.0	1/8	2	6		**0.08**	
		2.0	1/4	4	12		**0.17**	
		4.0	1/2	8	24		**0.33**	
		8.0	1	16	48		**0.66**	
		10.0	1 1/4	20	60		**0.83**	
		12.0	1 1/2	24	72		**1.00**	
	Cheese, solid	0.3	0	1	3	N/A	**0.20**	
		0.5	1/7	2	6		**0.33**	
		1.0	1/4	4	12	1 **String Cheese** / 1 **regular slice**	**0.66**	
		1.16	1/3	5	15	N/A	**0.75**	
		1.5	2/5	6	18		**1.00**	
		1.8	1/2	8	24	1 **baby bell** cheese, 1 **laughing cow** wedge	**1.16**	Enter Laughing Cow as swiss cheese, spreadable if relevant
		3.5	1	16	48	N/A	**2.31**	
Dairy (D) / Sugar (S)	**Yogurt** with toppings such as oreo (YoCrunch)	4.0	1/2	8	24	1 small YoCrunch	**.66 D / .66S**	
		6.0	3/4	12	36	1 large YoCrunch	**1.00 D / 1S**	
	Flavored Milk (Chocolate, Vanilla, Strawberry)	4.0	1/2	8	24	N/A	**0.66 / 0.66**	
		6.0	3/4	12	36	N/A	**1.00 / 1.00**	
		8.0	1	16	48	N/A	**1.33 / 1.33**	
Food Group	**Food Components**	**Volume oz**	**Cup**	**Tablespoon**	**Teaspoon**	**Piece**	**Serving**	
Fruits and Vegetables	Cooked or Raw fresh; 100% Juice (**Apple and Eve Fruitables are F, not F+V**)	0.5	0	1	3	Tomato sauce,	**0.12**	
		1.0	1/8	2	6	Tomato sauce	**0.25**	
		2.0	1/4	4	12	1 **date** (8.38g)	**0.50**	
		3.2				**1 gogo squeeze**	**0.80**	
		4.0	1/2	8	24	8 baby carrots 6-7 3" stalks celery 10 grapes 4 strawberries 1 **Small** whole (2 2/3" dia) **Corn on the cob** 2-3" dia	**1.00**	All **fruit cups** (fruit in syrup) light, reduced sugar, 100% juice or regular are the **SAME Enter as NS sweetener**
		N/A	*3 cups of pickles	N/A	N/A	3 large whole (4"), 7 medium whole **pickles**		**Sweet pickles**, look at Sweets **(S)**
		6.0	3/4	12	36	1 **medium** whole (3" dia) 1 6-7" banana	**1.50**	
		6.75	5/6	13 1/2	40.5	**1 of 100% juice pouch**	**1.50**	
		8.0	1	16	48	1 **large** whole (3 1/4 " dia) 1 8-9" banana	**2.00**	
		12	1 1/2	24	72	N/A	**2.5**	
	Dried Fruits and Vegetables (**Raisins**)	0.25	1/8	2	6	N/A	**0.50**	
		0.5	1/4	4	12	**Sun maid raisins**	**1.00**	
		1.0	1/2	8	24	N/A	**2.00**	
		1.5	3/4	12	36	N/A	**3.00**	Record **BRAND** when possible. Enter exact weight in database when possible
		2.0	1	16	48	N/A	**4.00**	
(F) (S)	Fruit Snacks	0.8	N/A	N/A	N/A	1 Roll up or package	**.5F + .75S**	
		1					**.5F + 1S**	
		2.25					**1F + 1.75S**	
	Yogurt coverd raisins	0.5	N/A	N/A	N/A	1 package	**.5 F + .5 S**	Yogurt covered fruit snacks are all **SWEET** no fruit
		1.5					**1.5 F + 1.5 S**	
F + O	French fries	1	1/2	8	24	10 pcs	**1 V + 1 O**	Use this for any fried vegetable
		2	1	16	48	20 pcs	**2 V + 2O**	

Food Group	Food Components	Volume oz	Cup	Tablespoon	Teaspoon	Piece	Serving	
Grains (G)	White bread slice, honey bread (sliced bread)	N/A	N/A	N/A	N/A	1/2	**1.00**	If bread slice was packed **without crust**, enter it to the database as (85% of slice).
						1	**2.00**	
						2	**4.00**	
						1/2 slice no crust	**0.85**	
						1 slice no crust	**1.70**	
						2 slices no crust	**3.40**	
	Cold, Dry Cereal	N/A	1/4	4	12	N/A	**0.75**	
			1/3	5	16		**1.00**	
			1/2	8	24		**1.50**	
			2/3	11	32		**2.00**	
			3/4	12	36		**2.25**	
			1	16	48		**3.00**	
	Hot Cooked cereal	N/A	1/4	4	12	N/A	**1.00**	
			1/3	5	16		**1.33**	
			1/2	8	24		**2.00**	
			2/3	11	32		**2.66**	
			3/4	12	36		**3.00**	
			1	16	48		**4.00**	
	Bread; Burger bun (has 2 slices), Cornbread, Biscuit, Roll or Muffin	N/A	N/A	N/A	N/A	1/4	**0.50**	
						1/2	**1.00**	
						3/4	**1.50**	
						1 slice	**2.00**	
						1 1/4	**2.50**	
						1 1/3	**2.66**	
						1 3/4	**3.50**	
						2	**4.00**	
						3	**6.00**	
	Regular size Bagel	0.25	N/A	N/A	N/A	1/8	**0.50**	
		0.5				1/4	**1.00**	
		1.0				0.5 regular, 1 thin, 1.5 mini	**2.00**	
		1.5				3/4	**3.00**	
		2				1 regular, 2 thin, 3 minis	**4.00**	
	Pasta, Noodles, Rice, or Grains, couscus	N/A	1/8	2	6	N/A	**0.50**	**Quinoa**, use these serving sizes but FG is WG. Also, enter as amaranth in website. 1 cup of quinoa = 0.75 cup of amaranth
			1/4	4	12		**1.00**	
			1/3	5	16		**1.33**	
			1/2	8	24		**2.00**	
			2/3	11	32		**2.66**	
			3/4	12	36		**3.00**	
			1	16	48		**4.00**	
	Rice Cakes	0.3	N/A	N/A	N/A	1 regular pc	**1.00**	
Grains (G)	Crackers	0.09	0	1	4	1 pc (2.5-3")	**0.50**	Multigrain crackers are G not WG. Only WG crackers are all bran, triscuit, special k
		0.17	1/6	3	8	2	**1.00**	
		0.25	1/4	4	12	3 crackers, 6 mini bread sticks	**1.50**	
		0.50	1/2	8	24	6 circular pc	**3.00**	
		0.67	2/3	11	33	8 (2 fig newtons)	**4.00**	
		0.84	5/6	13	40	10	**3.33**	
		1.00	1	16	48	**12 circular pc**	**4.00**	
	Tortilla / Pita pockets	N/A	N/A	N/A	N/A	1/3 pc (6-7 in diameter)	**0.66**	
						1/2 pc (6-7 in diameter)	**1.00**	
						2/3 pc (6-7 in diameter)	**1.33**	
						1 pc (6-7 in diameter)	**2.00**	
						1/3 pc (12-13 in diameter)	**1.33**	
						1/2 pc (12-13 in diameter)	**2.00**	
						2/3 pc (12-13 in diameter)	**2.66**	
						1 pc (12-13 in diameter)	**4.00**	
	Pretzels	0.39	1/4	4	12	8 minis	**1.00**	
		0.51	1/3	5	15	10 minis, 7 sticks, 1.5 regular	**1.33**	**Any 100 kcal pack of grains will be 2.33G**
		0.77	1/2	8	24	15 minis	**2.00**	
		0.9	3/5	9	27	**1 of 100 Kcal pack**	**2.33**	
		1	2/3	11	33	20 minis, 14 sticks, 3 regular	**2.66**	
		1.16	3/4	12	36	22 minis	**3.00**	
		1.54	1	16	48	30 minis	**4.00**	
	Pancakes	N/A	N/A	N/A	N/A	1 pc 4"	**2.00**	
						1 pc 6"	**3.00**	
Whole Grain (WG)	Grains with 3g of fiber per serving	N/A	N/A	N/A	N/A	N/A	**1WG**	
	Plain Popcorn	0.1	1/4	4	12	N/A	**0.8**	
		0.2	1/2	8	24		**0.17**	**Pirate's Booty** is **NOT a WG**, treat it as a **CHIP** item
		0.4	1	16	48		**0.33**	
		0.58	1 1/2	24	72		**0.5**	
		1.16	3	48	144		**1**	
	Flatbread (**circle or goldfish shape**)	N/A	N/A	N/A	N/A	1/4	**0.50**	
						1/2	**1.00**	**ALL flat breads are 100% Whole Grain**
						3/4	**1.50**	
						1	**2.00**	
						1 1/4	**2.50**	
						1 1/3	**2.66**	
						1 3/4	**3.50**	
						2	**4.00**	
						3	**6.00**	
Grains (G) / Sugar (S)	Cake	2.0	1/2	8.0	24.0	1 regular slice	**2G + 2S**	
		4.0	1.0	16.0	48.0	1 large slice	**4G + 4S**	
	Quaker Chewy Granola Bars, chewy bars in general	0.84	N/A	N/A	N/A	1 bar	**1G + 1S**	
	Granola Bar, **nutri-grain bar** (fruit filled bar), **nature valley** bar, **fiber one** chewy bar, **clif kids** bars	N/A	N/A	N/A	N/A	1 bar	**2WG + 1S**	
	Annie's Organic **Berry Berry Bar**	N/A				1 bar	**2G + 1/2S**	
	Graham Crackers	N/A				1 whole cracker	**1G + 0.5S + 0.25O**	
	Cheese Crackers (peanut butter **sandwich**)	1.23				1 pack (8 crackers)	**1G + 1S + .8M**	
	Cheese Crackers (cheese **sandwich**)					1 pack (8 crackers)	**1G + 1S + 2O**	
	Animal Crackers / **Teddy** Grahams	1	1/2	8	24	18 pc not frosted	**1G + 0.5S**	
		0.5	0.25	4	12	9 pc not frosted	**.5G + .25S**	
		1	1/2	8	24	13 pc **frosted**	**1G + 1.5S**	
		0.5	1/4	4	12	9 pc **frosted**	**0.5G + 0.75S**	
	Chocolate covered / **Yogurt** flavored **pretzels**	0.5	1/4	4	12	1.25 regular, 8 minis, 6 sticks	**.25G + .25S + .25O**	
		1	1/2	8	24	**1 Snyder's pack,** 2.5 regular pcs, 16 minis, 11 sticks	**.5G + .5S +.5O**	
		1.94	1	16	48	5 regular pcs, 33 minis, 23 sticks	**1G + 1S + 1O**	
W Grain (WG)+ Sugar(S)	Loose Granola	N/A	1/4	N/A	N/A	N/A	**2WG + 1S**	
		N/A	1/3	N/A	N/A	N/A	**2.66WG + 1.33S**	
		N/A	1/2	N/A	N/A	N/A	**4WG + 2S**	Enter as **"handi" cheese pack** + 6 mini bread sticks
G + D	Handi - snacks	1	N/A	N/A	N/A	1 snack size	**0.33 D + 1 G**	
Grain (G) + Oil (O)	**Cheese flavored / Butter** Popcorn	0.1	1/4	4	12	N/A	**0.8 WG / 0.17 O**	**Pirate's Booty** is **NOT a WG**, treat it as a **CHIP** item
		0.2	1/2	8	24		**0.17 WG / 0.33 O**	
		0.4	1	16	48		**0.33 WG / 0.66 O**	
		0.58	1.5	24	72		**0.5 WG / 1 O**	
		1.16	3	48	144		**1 WG / 2 O**	

Food Group	Food Components	Volume oz	Cup	Tablespoon	Teaspoon	Piece	Serving	
Meat and Beans (M)	Meat, turkey, poultry, fish, alternative protein product	1.0	1/6	3	8	N/A	**0.66**	
		1.5	1/4	4	12		**1.00**	
		2.0	1/3	5	15		**1.33**	
		2.5	2/5	7	20		**1.66**	
		3.0	1/2	8	24	1 chicken leg	**2.00**	
		4.0	2/3	11	32		**2.66**	
		4.5	3/4	12	36	N/A	**3.00**	
		6.0	1	16	48		**4.00**	
	Hot Dog	1.0	1/6	3	8	N/A	**0.66**	
		1.5	1/4	4	12		**1.00**	
		2.0	1/3	5	15	1 pc standard size	**1.33**	
						1 pc standar size with cheese	**1.33M + 0.08D**	
						2 pc standard size with cheese	**2.66M + 0.16D**	
		4.0	2/3	11	32	2 pc standard size	**2.66**	
	Chicken **Nuggets** / Chicken Popcorn	0.5	0	1.5	4.5	1 pc small (1-1.5")	**0.33**	
		1.0	1/6	3	8	1 pc medium (2-2.5")	**0.66**	
		1.5	1/3	5	15	1 pc large (3-4") **Dinosaurs**	**1.00**	
	Whole Egg	N/A	1/8	2	6	3/8	**0.50**	
			1/4	4	12	3/4	**1.00**	
			1/3	5	15	1	**1.33**	
			1/2	8	24	1 1/2	**2.00**	
	Egg Whites	N/A	1/8	2	6	1	**0.50**	
			1/4	4	12	2	**1.00**	
			1/3	5	15	2 2/3	**1.33**	
			1/2	8	24	4	**2.00**	
	Cooked Dry **Beans or Peas**	0.30	1/4	4	12	N/A	**0.66**	
		0.39	1/3	5	15		**0.90**	
		0.44	3/8	6	18		**1.00**	
		0.59	1/2	8	24		**1.33**	
		0.89	3/4	12	36		**2.00**	
		1.18	1	16	48		**2.66**	
	Nuts and / or seeds	0.375	0	1.5	4.5	12 almonds	**0.5**	
		0.75	1/6	3	8	24 almonds	**1.00**	
		1.5	1/3	6	18	48 almonds	**2.00**	
		2.25	1/2	8	24	72 almonds	**3.00**	
	Nuts and / or seed **Butters**	0.25	0	1	3	N/A	**#VALUE!**	
		0.375	0	1.5	4.5		**0.5**	
		0.5	1/9	2	6		**0.66**	
		0.75 nut or 1.5 nut butter	1/6	3	8		**1.00**	
		1.5	1/3	6	18		**2.00**	
		2.25 nut or 4 nut butter	1/2	8	24		**#VALUE!**	
	Hummus	0.295	1/4	4	12	N/A	**0.50**	
		0.59	1/2	8	24		**1.00**	
		1.18	1	16	48		**2.00**	
Food Group	**Food Components**	**Volume oz**	**Cup**	**Tablespoon**	**Teaspoon**	**Piece**	**Serving**	
Sweets (S)	Sweet Drinks, Kool-Aid, Hi-C Orange Drink Lemonade	2.00	1/4	4	12	**1/2 caprisun pouch**	**0.50**	
		4.00	1/2	8	24	N/A	**1.00**	
		6.75	5/6	13 1/2	40.5	**1 caprisun pouch**	**1.50**	
		8.00	1	16	48	N/A	**2.00**	
		9.00	1 1/8	18	54	N/A	**2.25**	
	Cookie Standard (**Nilla wafers**)	1.00	N/A	N/A	N/A	1/2 (2-2.5") pc	**0.50**	
		2.00				1 (2-2.5") pc	**1.00**	
		4.00				2 (2-2.5") pc	**2.00**	
	Skittles / candy	0.7	1/9	2	5.6	1 Fun Pack	**1.40**	
		1.50	1/4	4	12	N/A	**3.00**	
	Pudding or Gelatin	3.9	1/2	8	12	1 Jell-o Pack	**1.50**	
		4.00	1/2	8	12	N/A	**1.50**	
	Jelly, Honey	N/A	0	1	3	N/A	**1.00**	
		N/A	1/8	2	6		**2.00**	
	Marshmallows	0.74	1/4	4	12	3 regular, 30 minis	**1.00**	
		1	1/3	6	18	4 regular, 40 minis	**2.00**	Sweet pickles, look at Sweets (S)
	Sweet pickle	N/A	1/2	8	12	N/A	**2.00**	
	Yogurt chips	0.5					**1.00**	
	Fun size chocolates **(musketeers, snickers, m&m's, etc)**					1 Fun Pack	**1**	
Mixed Sweets (S) / Grains (G) / Oils (O)	**Rice Krispy Treats**	1.3	N/A	N/A	N/A	1 pc (3" * 1")	**2.25S + .5O**	
	Strawberry Wafers	0.63				1 pack	**1 G + 1 S**	
	Donut, Standard	2.25				1 regular	**1 G + 1.5S + 1O**	
	Kellogg's Mini Poptarts / Poptarts Mini crisps	1				1 serving / 1 100 kcal bag	**2G + 1S**	
	Kellogg's Poptarts	1.83				1 regular pastry	**4G + 2S**	
	Peach cobbler	N/A	1/2			N/A	**1G + 2S + 1F**	
	Crepe	N/A	N/A			1/2 pc	**0.5G + 0.25S**	
	Nutella	0.65	N/A	1	2		**1.5S + 1O**	
		1.3		2	6		**3S + 2O**	

Food Group	Food Components	Volume oz	Cup	Tablespoon	Teaspoon	Piece	Serving	
Oils / Fats (O)	Mayo, Oil, Ranch, Dressing	0.17	0	0	1	N/A	**0.33**	
		0.50	0	1	3		**1.00**	
	Cream Cheese	0.50	0	1	3		**0.50**	**Cream Cheese**
	Olives	N/A	1/4	4	12	N/A	**1.00**	
			1/2	8	24		**2.00**	
Condiments ('C)	Ketchup, Mustard	0.17	0	0	1	N/A	**0.33**	
		0.50	0	1	3		**1.00**	
Food Group	**Food Components**	**Volume oz**	**Cup**	**Tablespoon**	**Teaspoon**	**Piece**	**Serving**	
Chips (CH)	Chips, Standard (***pirate´s booty***, ***chex mix***, *Pringles, tortilla chips, blue corn chips, baked chips, Fritos, cheez-its,* ***cheese puffs***)	0.13	1/8	2	6	N/A	**0.25**	
		0.25	1/4	4	12		**0.50**	
		0.5	1/2	8	24		**1.00**	
		0.75	3/4	12	36		**1.50**	
		1	1	16	48		**2.00**	
	cheese dip w/ crackers	N/A	N/A	N/A	N/A	1 pack	**3.00**	
Food Group	**Food Components**	**Volume oz**	**Cup**	**Tablespoon**	**Teaspoon**	**Piece**	**Serving**	
Lunchables	**Lunchables** - Ham, Cheddar, Crackers	N/A	N/A	N/A	N/A	1 Lunchable (5 pcs of cheese, ham and crackers)	**1D + .66M + 3G**	
		N/A	N/A	N/A	N/A	1 Lunchable (6 pcs of cheese, ham and crackers)	**1.2D + .8M + 3G**	
		N/A	N/A	N/A	N/A	1 Lunchable (8 pcs of cheese, ham and crackers)	**1.5D + 1.1M + 4G**	
		N/A	N/A	N/A	N/A	1 Lunchable Snack duo (12 mini pieces)	**0.6D + .4M + 1.5G**	
	Lunchables Pizza	4.5	N/A	N/A	N/A	1 Lunchables	**1M + 2D + 3G +1O**	
	Lunchables with Sub bun, turkey, cheddar, etc	3.36	N/A	N/A	N/A	1 Lunchables	**1M + 1D + 3G**	
Mixed / Other	Chef Boyardee Mini spaghetti Rings and Meatballs	7.5	N/A	N/A	N/A	1 IP serving	**1M + 3G + 2V**	**Broth** by itself doesn't have enough nutrients to count as a food group
	Gerber graduate ravioli	6 oz				1 package	**0.7M + 2G + 1.4V**	
	Kid Cuisine Twist and Swirl Spaghetti with mini meatballs	N/A	N/A	N/A	N/A	1 Kid Cuisine	**1M + 1V + 4WG + 2S**	
	Macaroni and Cheese	N/A	1/2	N/A	N/A	N/A	**2G + 1D**	Enter separete!
	Twister - Beverage	N/A	1/2	N/A	N/A	N/A	**0.5F + 0.5V**	
	Dried Veggie Mix - banana, chips, beans, potato	0.75		N/A	N/A	N/A	**1F + 1.5O**	
	Sushi	N/A	N/A	N/A	N/A	1 package	**3G + 2V + 1O**	
	Chinese Dumplings	N/A	N/A	N/A	N/A	1 package PF Chang's	**3V + 1G + 1O**	
	Corn Dog	N/A	N/A	N/A	N/A	1 regular hotdog, breaded	**1G + 1.33M + 1O**	
	Tamales	N/A	N/A	N/A	N/A	3-4" * 3-4"	**3G + 1M + 1O**	
	Pizza or hot pocket	N/A	N/A	N/A	N/A	5-6" pizza serving Pepperoni 5-6" pizza serving	**2G + 0.5V + 1D** **2G + 0.5V + 1D + 0.44M**	1 French bread pizza or double serbings for 1 slice, or 6 pizza bites
	Bagel-ful (Kraft)	2.5	N/A	N/A	N/A	1 pc cream cheese and jam	**3G + 1S + 1O**	
						1 pc flavoured cream cheese	**3G + 1S + 1.5O**	
	Mini chocolate covered doughnuts	0.5	N/A	N/A	N/A	1 pc mini doughnut	**1G / 1O / 1S**	
	Cupcake with iceing	N/A	N/A	N/A	N/A	1 regular or 2 mini	**4S + 2O**	
	Cupcake without iceing						**2S**	
	Brownie	1				1 regular pc	**3S + 1O**	
	Cinnamon toast pretzel	1	N/A	N/A	N/A	5-6" pizza serving	**1G + .5S**	
	Individual Package PB&J sanwich	2	N/A	N/A	N/A	1 piece (bread in circle with out crust)	**3G + 0.66M + 1S**	
	Jammy Sammy	1.03				1 pkg	**1G 9+ 1S**	Enter as Breakfast bar, cereal crust with fruit filling, lowfat
Food Group	**Food Components**	**Volume oz**	**Cup**	**Tablespoon**	**Teaspoon**	**Piece**	**Serving**	
Water (W)	Sweet Drinks (<5 kcals/ serving), plain water	2.00	1/4	4	12	N/A	**0.50**	
		4.00	1/2	8	24	N/A	**1.00**	
		6.75	5/6	13 1/2	40.5	N/A	**1.50**	
		8.00	1	16	48	N/A	**2.00**	

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