HEALTHY EATING INDEX-2010 SCORES OF PRESCHOOL-AGED CHILDREN IN SAN MARCOS, TEXAS, RELATIONSHIPS BETWEEN SCORES AND FOOD ENVIRONMENT FACTORS, AND COMPARISON TO AGE-MATCHED SCORES FROM A NATIONAL SAMPLE (NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY 2009-2012)

by

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LIST OF ABBREVIATIONS

Abbreviation **Description**

AHA - American Heart Association

AAP - American Academy of Pediatrics

CDC - Centers for Disease Control and Prevention

CNPP - Center for Nutrition Policy and Promotion

CSFII - Continuing Survey of Food Intakes by Individuals

DGA - Dietary Guidelines for Americans

DRI - Dietary Reference Intake

FITS - Feeding Infants and Toddlers Study

HEI - Healthy Eating Index

NAR - Nutrient Adequacy Ratio

NDSR - Nutrition Data System for Research

NHANES - National Health and Nutrition Examination Survey

RDA - Recommended Dietary Allowance

SNAP - Supplemental Nutrition Assistance Program

SSB - Sugar-sweetened beverages

TANF - Temporary Assistance for Needy Families

USDA - United States Department of Agriculture

WIC - Special Supplemental Nutrition Program for Women, Infants, and Children

I. INTRODUCTION

Best Food FITS

Best Food for Families, Infants, and Toddlers (Best Food FITS) is a community-oriented research initiative funded initially by the Texas Department of State Health Services and directed by faculty in the Texas State University Nutrition and Foods program. Launched in 2010, Best Food FITS is dedicated to improving the health of children in central Texas by reducing their risk of obesity. The primary strategies of Best Food FITS projects are to increase children's intake of fruits and vegetables and decrease their intake of sugar-sweetened beverages (SSBs).

One of the earliest Best Food FITS endeavors involved funding the construction of four teaching kitchens in the San Marcos Chapultepec Adult Learning Center. Best Food FITS has since used the center to educate San Marcos residents through regular hands-on cooking classes that emphasize healthy, fresh ingredients.[1] These classes also emphasize the importance of preventing excess weight gain, particularly among young children. To ensure the sustainability of this community intervention, the delivery of these classes by students has been incorporated into the undergraduate nutrition and foods curriculum at Texas State University.[1] Another Best Food FITS project aimed at improving the health of children in and around San Marcos, Texas engaged community partners to improve children's menus in area restaurants.[1] Ongoing Best Food FITS research initiatives involve area childcare facilities, parents of preschoolers, and investigation of the use of mobile technology to improve health behaviors among participants in the Texas Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Regional Importance

The focus of Best Food FITS research efforts is the population of San Marcos, Texas, a mid-sized city in South Central Texas with approximately 60,684 residents.[2] San Marcos is located in Hays County, and is situated approximately midway between the second and fourth largest cities in Texas, San Antonio and Austin, respectively. The population of San Marcos is ethnically diverse, with 37.8% of residents identifying as Hispanic or Latino.[2] The poverty rate is high; at 37.1%, the proportion of residents living below the poverty level is more than double the rates in Texas (15.9%) and in the US (13.5%).[2] Demographic information for San Marcos is summarized in Table 1.

Table 1. Demographic and socioeconomic information for the city of San Marcos, Hays County, the state of Texas, and the United States[2,3]

	San Marcos	Hays County	Texas	US
Demographic Background				
Population	60,684	194,739	27,469,114	321,418,820
Males, %	49.7	49.8	49.6	49.2
Females, %	50.3	50.2	50.4	50.8
Population, percent change: April 1, 2010 – July 1, 2015	34.6	23.9	9.2	4.1
Racial and ethnic origin, %				
White, non-Hispanic	53.7	55.5	43.0	61.6
Black/African American	5.5	4.2	12.5	13.3
American Indian/Alaska Native	0.9	1.2	1.0	1.2
Asian	1.6	1.6	4.7	5.6
Native Hawaiian or Pacific Islander	0.1	0.2	0.1	0.2
Hispanic or Latino	37.8	37.6	38.8	17.6
Two or more races	3.1	2.1	1.9	2.6
Persons under 5 years, %	4.4	5.9	7.2	6.2
Socio-Economic Circumstances				
Median household income	$27,261	$58,878	$52,576	$53,482
Persons below poverty level, %	37.1	17.5	15.9	13.5
Individuals age 25 years+ with Bachelor's degree or higher, %	32.2	36.8	27.1	29.3
Unemployment rate	3.5%	3.4%	4.2%	5.1%

Rates of overweight and obesity among children in San Marcos are higher than those of children across the state of Texas and the nation as a whole. According to 2013 data from the Texas Youth Fitness Study led by The Cooper Institute, 38.5% of San Marcos Consolidated Independent School District (CISD) students have body mass indices that place them at high risk for future health complications.[4] Sixteen percent of low-income preschoolers in Hays County are obese, compared to 15.7% across the state and approximately 14% throughout the US.[3,5]

In 2015, San Marcos was named the fastest-growing mid-sized city in the country for the third year in a row.[6] From 2010 – 2020, the population in Hays County is expected to increase by 41%.[7] This projected increase in population will significantly affect the demand for the health care and social services necessary to support a healthy and successful community. Thus, the future economic growth of South Central Texas will depend upon the improvement of its health care system and the overall health of its residents.[7] Consistent with this need, Best Food FITS researchers are working to address child obesity by investigating avenues of prevention.

Study Trajectory

In 2012-2013, Best Food FITS researchers worked with San Marcos childcare centers to assess their health-related environmental features as well as practices affecting children's diets and physical activity.[8] During a workshop intervention, focus group discussions with childcare center staff suggested that parents of enrolled children were not always supportive of the centers' efforts to provide healthy foods (data not published). Based on these findings, researchers determined that the next phase of Best Food FITS research efforts should involve San Marcos parents of young children in order to better understand their home food environments, including barriers to healthy eating.

The first stage of the Best Food FITS Parents study involved the administration of a survey to parents of children ages 2-5 enrolled in area childcare centers that asked for information about subjects' home food environments and feeding practices. Questions focused on five main themes, including parent feeding practices, parent nutrition knowledge, parent self-efficacy, parent perceptions, and the home food environment.

In the next phase of the Best Food FITS Parents study, a research team conducted 24-hour dietary recalls with parents who had expressed interest in participating, using the computer software program Nutrition Data System for Research (NDSR). The 24-hour dietary recalls were completed by parents regarding the intakes of one preschool-aged child in the family. Following the first round of 24-hour recalls, a multiple-component intervention was conducted among the parents. The intervention involved the distribution of an informational packet, Facebook postings that provided education and support, and educational updates posted on the Best Food FITS website. Additionally, 41 of the parents completed a separate photo texting intervention. The photo texting method was derived from PhotoVoice, a method of qualitative data collection whereby participants take photographs and reflect upon them.[9] In this case, participants were asked to take and reflect on photographs of their home food environments. By including the participants' point of view, the photo texting intervention enabled researchers to identify concepts that could be missed using more traditional data collection methods. The photo texting process was also intended to empower participants as they reflected critically about their home environments.[9] Finally, post-intervention assessments included administration of a second round of parent surveys and collection of another 24-hour recall of the preschooler's diet.

Position of Thesis Project within Best Food FITS

This thesis project commenced with an analysis of data collected from the Best Food FITS Parents study, including the raw NDSR output from the 24-hour recalls of preschoolers and the responses collected from administration of the parent surveys. The goal of this project was to contribute to a community needs assessment by highlighting areas of concern within the diets of this high-risk population and identifying potential foci for future nutrition interventions. Healthy Eating Index (HEI) scores were generated from the dietary recall data, and overall and component scores were compared to national scores. Select parent survey data were also analyzed for the purpose of investigating relationships between the quality of the children's diets and their home food environments.

II. LITERATURE REVIEW

Childhood Obesity Statistics

The prevalence of overweight and obesity among childhood in the United States is a serious problem. For children ages 2-19 years, "overweight" is defined as having a body mass index (BMI) between the 85^{th} and 95^{th} percentiles for children of the same age and sex. "Obesity" is defined as having a BMI-for-age at or above the 95^{th} percentile.[10] These BMI-for-age and sex percentiles are determined using Centers for Disease Control and Prevention (CDC) growth charts. Definitions of "overweight" and "obesity" are not used in the same way to describe children under two years of age; rather, "overweight" or "excess weight" is identified within this age group using sex-specific weight-for-recumbent-length CDC growth charts.[11] A weight-for-recumbent-length at or above the 95^{th} percentile denotes "overweight" or "excess weight" status.[11] As early childhood is a critical period of development for physical growth and weight-for-stature, rates of overweight and obesity among preschool-aged children are particularly alarming.[12,13]

According to data from the 2013–2014 National Health and Nutrition Examination Survey (NHANES), approximately 33.4% of US children and adolescents ages 2–19 years are overweight or obese.[14] Although the age cutoff values for Texas data (ages 10-17 years) differ from those of the NHANES group, at 36.6%, the rate of childhood overweight and obesity in Texas does appear to be higher than this national average.[15] While rates of obesity among preschool-aged children (ages 2-5 years) in the US have declined slightly since 2010, the most recent NHANES data still indicate that 9.4% of preschoolers are obese.[14] In Texas, as many as 15.3% of children ages 2-5 may be obese.[16] Obesity rates are generally worse among low-income preschoolers, at 14% nationally, 15.7% across the state of Texas, and 16% in Hays County.[3,5]

Childhood Obesity Consequences

The ramifications of such high rates of obesity among young children are troubling, as childhood overweight and obesity are associated with significant short-term and long-term health consequences. For example, obese youth are at greater risk of experiencing bone and joint problems such as Blount's disease and slipped capital femoral epiphysis; breathing problems such as obstructive sleep apnea and asthma; and one or more cardiovascular disease risk factors, such as high blood pressure and high cholesterol.[17] Childhood obesity is also associated with higher rates of impaired glucose tolerance, insulin resistance, type 2 diabetes mellitus, fatty liver disease, gallstones, and gastro-esophageal reflux.[10] Finally, childhood obesity is associated with myriad social and psychological problems, including stigmatization, depression, poor self-esteem, and weakened life goals.[18] These emotional problems have far-reaching consequences; for example, they have been shown to lead to poor educational outcomes such as difficulty learning, lower test scores, and increased truancy.[19]

Childhood obesity is a strong predictor of obesity in adulthood; obese children have more than a 66% chance of being overweight by the age of 35.[20,21] Overweight and obese children are at increased risk for adult morbidity and mortality related to weight status.[22] They are more likely to experience serious health conditions as adults, such as cardiovascular disease, type 2 diabetes, stroke, many types of cancer, and osteoarthritis.[10,17] These risks highlight the need for early obesity interventions. The Institute of Medicine has described childhood obesity as a largely preventable disease;

thus, addressing its many causes and establishing strategies to reverse the dangerous health trends associated with childhood obesity are national public health imperatives.[21]

Causes of Childhood Overweight/Obesity

Early childhood is a critical period of development, and is thus the most appropriate time for targeted interventions to prevent obesity.[12] Childhood overweight and obesity are associated with complex factors across the individual, interpersonal, industrial, and societal levels of the socio-ecological model, as illustrated in Figure 1.

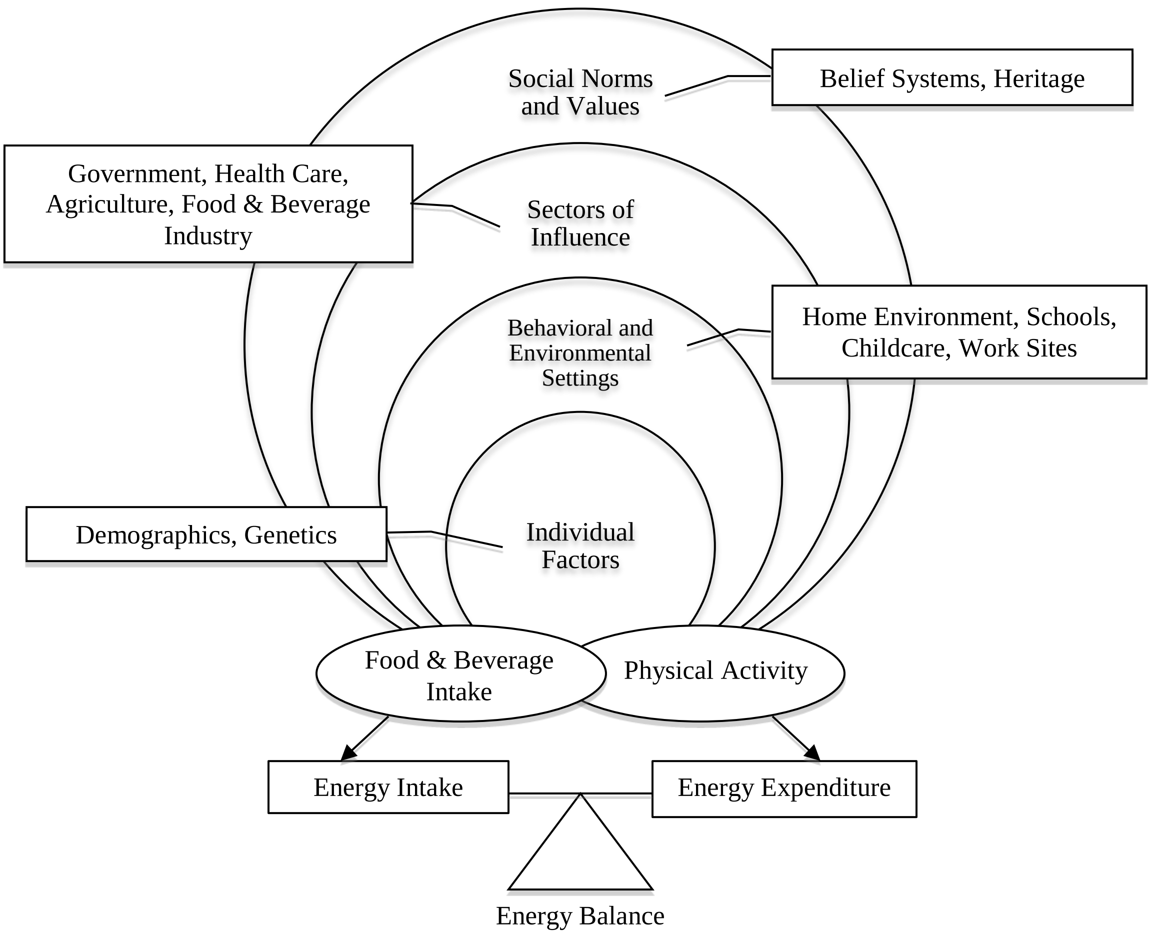

Figure 1. A socio-ecological model of obesity risk, adapted from the Institute of Medicine and Story, et al., "Creating Healthy Food and Eating Environments: Policy and Environmental Approaches," with examples provided for each category.[23–25] This framework provides a valuable multilevel approach to address the causes of obesity.[26]

Individual Factors

Race and ethnicity are significant factors associated with increased obesity risk. According to NHANES 2011-2014 data, obesity rates for children ages 2-5 were higher among Hispanic (15.6%) and black (10.4%) children than among white (5.2%) children.[27] Likewise, Hispanic children in Texas also have the highest rates of overweight and obesity of any other racial/ethnic group. According to the most recently published data from the National Survey of Children's Health (NSCH), 46.8% of Hispanic children ages 10-17 in Texas are obese, compared to 26.3% of black non-Hispanic children and 22.9% of white non-Hispanic children.[28] These statistics are particularly concerning given that the proportion of Hispanic children in Texas is rapidly growing.[7,28]

Socioeconomic status is also related to rates of childhood obesity. Obesity is more prevalent among preschoolers from lower-income families, and an inverse correlation has been observed between family income-to-poverty ratio and rate of childhood obesity.[29] According to data from the CDC's Pediatric Nutrition Surveillance System, 14.7% of low-income preschool-aged children in the US are obese, compared to approximately 9.4% of preschool-aged children across the general population.[30] At 15.3%, the percentage of low-income preschoolers in Texas who are obese is slightly higher than the national average.[31]

Biological factors such as an individual's genetic makeup, unique micro-biome, and hormone levels also influence childhood weight status. Polymorphisms within individual genes, such as the fat-mass and obesity-associated (FTO) gene, have been linked to childhood obesity.[32] Hormones that regulate satiety, such as leptin and ghrelin, play significant roles not only in the development of obesity in childhood, but also in the determination of weight set points that are defended throughout adult life.[33]

Early life is a critical period for the programming of appetite and the regulation of energy balance.[12] Exposure to obesogenic influences during this time may have lifelong consequences related to the risk of excess weight gain. For example, many modifiable early-life risk factors, such as maternal obesity, have been associated with increased risk of childhood overweight and obesity.[12] Investigations of this association in the south central Texas region include a 2012 study of low-income Mexican-American mothers and their children, which found that maternal BMI was a significant predictor of child weight.[34] Other maternal characteristics frequently associated with child overweight and obesity include low maternal vitamin D status and maternal smoking during pregnancy.[35] Although discordant, research also strongly suggests that breastfeeding provides some protection from the risk of obesity. Both breastfeeding duration and exclusivity have been inversely associated with the rate of weight gain in infants as well as adiposity and risk of overweight in toddlers and preschoolers.[36]

Exposure to common environmental toxins may also play a role in the development of childhood overweight and obesity. Evidence suggests that many ubiquitous chemicals, such as bisphenol A, which is used to produce plastics, and polycyclic aromatic hydrocarbons (PAHs), which are found in cigarette smoke, vehicle exhaust, grilled and charred meats, pickled foods, and many processed foods, are obesogenic.[37] Clearly, the number of individual-level factors that contribute to the development of obesity cannot be overestimated.

Behavioral/Environmental Settings

Many studies have investigated the environmental and interpersonal factors that affect health behaviors associated with childhood obesity.[38] These include the effects of interpersonal relationships, i.e. family dynamics and parent influences, as well as factors related to the built environment and the home food environment.

The home food environment, including food accessibility and mealtime structure, is a fundamental cause of poor dietary choices and obesity in children.[39,40] The concept of food accessibility may describe multiple elements related to the availability of food, from the ability to meet the expense of groceries to the physical reachability of food items to children in the home.[40] Mealtime structure refers to the frequency at which home-cooked versus ready-made foods are served, the location and timing of meals, and whether or not meals are consumed while watching television.[41]

Parents and caregivers are important role models, and their feeding practices are crucial in shaping children's emerging food preferences, development of self-regulation, and potentially, lifelong eating habits.[42] Elements of parent feeding practices that significantly affect the diets and weight status of children include the use of pressure to encourage children to eat, the use of food to control behavior, restriction of the amount of food that may be eaten, positive involvement in child eating, and mealtime strategies such as modeling healthy eating behaviors and eating together as a family.[43–45] Perhaps counter-intuitively, the increased use of pressure and control by parents at mealtime often has unintended negative effects on children's behavioral responses, food selection, and intake.[45] For example, studies have shown that restricting children's access to particular foods increases their subsequent selection and consumption of those items.[42,45]

Conversely, encouragement and positive role modeling of eating behaviors is associated with better quality diets.[44,46] Thus, parental awareness of healthy modeling behaviors is essential in promoting appropriate child weight status.

Factors related to parent knowledge and beliefs also affect child weight status. Evidence suggests that parents may modify their child-feeding practices based on their perceptions of the child's current weight status and risk of overweight.[47] Interestingly, the accuracy of parent perceptions of their own weight status also appears to reflect their children's weight status. Specifically, results from the USDA Continuing Survey of Food Intakes by Individuals (CSFII) have shown that children of parents who underestimate their own weight status have a greater probability of being overweight, compared to children of parents who correctly estimate their own weight status.[48] Research also suggests that greater parent nutrition knowledge corresponds to a lower incidence of child overweight and obesity.[48]A basic understanding of nutrition information is vital for monitoring children's eating patterns, identifying energy-dense foods, and recognizing the long-term risks of obesity.

The school environment may also play a critical role in influencing the dietary and physical activity behaviors of children. Schools have the opportunity to provide safe and supportive environments in which students can learn about and practice healthy eating and physical activity behaviors. The American Academy of Nutrition and Dietetics recommends that all schools integrate nutrition services as a component of their health programs in order to improve the nutritional status, overall health, and academic performance of children in the U.S.[49] Nutrition services may include educational classroom activities, the availability of healthy food choices throughout the school environment, and efforts to promote the reinforcement of these habits at home and within the community.[49]

For younger children in center-based programs, childcare staff members have an important responsibility to introduce healthy foods and activities. According to the most recent national data available, 61% of children under the age of 5 regularly participate in some form of childcare outside the home, and nearly 5 million, or 23.5%, are enrolled in organized care facilities such as preschools or daycare centers.[50] Children enrolled in center-based care spend an average of 24.8 hours per week in this setting.[51] Because a significant number of their meals and snacks are consumed at these centers, it is essential that the food environments of childcare facilities are designed to promote healthy habits.

The aforementioned Best Food FITS childcare center study focused on combating childhood obesity by improving the policies and food environments of childcare centers in central Texas. Best Food FITS researchers first conducted environmental assessments of the centers, reviewed their menus, and observed mealtime interactions between childcare center staff and children. Researchers then implemented an educational intervention in the form of a workshop to improve staff nutrition knowledge, thereby supporting improved nutrition and education to children enrolled in the centers. The workshop included lectures and interactive activities related to childhood obesity, child nutrition and physical activity, healthy food environments, and the impact of childcare center policies on these issues. A post-intervention assessment of the childcare centers found significant improvements in both the types of foods offered (for example, fewer discretionary calories and more dark green vegetables) and in child nutrition education (for example, more pictures and posters about physical activity and nutrition and increased encouragement by staff to try new or less favorite foods).[8]

Sectors of Influence

Sectors of influence refer to the organizations and institutions that shape communities; examples include government, health care systems, agriculture, media, and the food industry.[25] These sectors can influence society's norms and values related to healthy behaviors and can be important determinants of the accessibility of healthy foods within a community.[25] In particular, the influence of the food, beverage, and restaurant industries on nutrition and health cannot be overstated. In recent decades, they have contributed to changes in the national food environment that corresponded to rising rates of childhood obesity.[52]

In busy contemporary society, convenience is often a necessary factor in dietary decision-making. Consequently, in the last forty years, the number of fast-food restaurants in the country has more than doubled and the proportion of calories obtained from foods consumed outside the home has steadily increased.[52] On average, foods from both full-service and fast-food restaurants tend to be more energy-dense and less nutrient-dense than foods prepared at home.[52] Per eating occasion, away-from-home foods have been shown to contain more calories, total fat, saturated fat, and sodium, and less fiber, calcium, and iron than foods prepared at home.[53] Research suggests that children who eat at restaurants with their families at least once per week consume more SSBs, more sweet and savory snacks, and less water, and are more likely to be overweight than children whose families do not frequent restaurants as often.[54,55]

A recent Best Food FITS research initiative focused on the restaurant industry in order to improve the health of local children. This San Marcos, Texas community-based intervention sought to improve the children's menus of local restaurants, thereby increasing children's access to healthy foods.[1] As a result of these efforts, many local businesses eliminated SSB options for children, reduced the number of energy-dense entrees offered, and incorporated more fruit and vegetable options into their children's menus.[1]

The advertising industry is another significant sector of influence affecting rates of childhood overweight and obesity. In 2009, children ages 2-5 viewed an average of 10.9 television food advertisements per day.[56] An alarming 97.8% of food advertisements aimed at children promote products that are high in fat, sugar, or sodium.[56] A 2006 study by Wiecha and colleagues found that for every hour of television a child watches per day, he or she is likely to consume 167 more calories.[55] These calories generally come from fast food, salty snacks, and SSBs.[55] While the establishment of the Children's Food and Beverage Advertising Initiative (CFBAI) in 2006 aimed to reduce direct advertising to young children and to shift the types of foods advertised to them to encourage healthier dietary choices, food company compliance is voluntary and control is accomplished via self-regulation.[56] However, over 28% of all food and beverage advertisements aimed at children come from companies that do not participate in the CFBAI, and research has shown that under this system of self-regulation, overall improvements in the nutritional quality of foods advertised to children have been negligible.[57]

Thus, further policy initiatives addressing business participation and monitoring are necessary to improve the landscape of food advertising presented to young children.

Societal Factors

The overarching elements of the socio-ecological model are social and cultural norms and values that may govern the attitudes and behaviors of society. These factors are tremendously influential in nutrition and physical activity decision-making. For example, cultural norms may guide the varieties of foods and beverages consumed, the amount and types of physical activity performed, and the ranges of body weight deemed acceptable.[25]

Hispanic culture is pervasive in South Central Texas, and Hispanic food-related norms and values may contribute to differences in diet quality and nutrient intake compared to non-Hispanic individuals.[40] Nearly 38% of San Marcos residents and over 70% of San Marcos CISD students are Hispanic.[58] Hispanic children across the nation suffer disproportionately from overweight and obesity, and while genetics and environmental influences undoubtedly contribute to this elevated risk, certain popular Hispanic dietary practices likely also influence childhood obesity rates in San Marcos.[39,59] For example, a recent study of dietary patterns of middle school-aged children in Austin, TX found that the consumption of unhealthy foods was considerably higher among Hispanic and black children than white children.[39] The Viva la Familia Study, which assessed the diet quality of low socioeconomic status (SES) Hispanic children in Houston, TX, found that 68% of the children's dietary energy came from "sodas, desserts, pizza, snack chips, fruit drinks, fruit juice, processed meats, and burgers that [were] high in fat, sugar, and/or sodium."[60] Although the diets were often adequate in most nutrients, they generally exceeded guidelines for total fat, saturated fat, cholesterol, added sugar, and sodium.[60] Studies of traditional Mexican diets have revealed that dairy products, leafy green vegetables, and fruit are among the food items consumed the least often, and these patterns appear to continue after immigration to the United States.[61] Conversely, the consumption of flavored, sweetened beverages and the significant use of fat in food preparation are common in traditional Mexican diets, and these patterns have been shown to contribute to the elevated rates of overweight and obesity among Mexican-American children.[61,62] Thus, the Best Food FITS goals of reducing child SSB intake and increasing consumption of whole fruits and vegetables in order to lower the risk of obesity are particularly important given the dietary patterns common throughout the South Central Texas region.

In summary, the habits associated with childhood overweight and obesity are influenced by numerous factors across the individual, interpersonal, industrial, and societal levels. Research supports the use of a comprehensive approach, ideally targeting multiple contributors within the socio-ecological model, to prevent childhood obesity and its related comorbidities.[63,64] Early childhood is a critical period of development, so it is the most appropriate time for targeted interventions to improve diet quality and prevent obesity.[12,13]

Diets of Preschool-Aged Children

While a variety of factors play a role in the development of obesity in childhood, poor diet and inadequate physical activity are recognized as central causal factors. Children are predisposed to consume obesogenic diets.[65] From birth, infants tend to reject bitter foods and accept sweet foods, and a fondness for salty foods is generally apparent by 4 months.[66] Sweet and salty foods do not require familiarization in order to be accepted.[66] However, early life exposures to sugar and sodium can determine lasting taste preferences and influence lifelong health outcomes. Excess intake of added sugar is strongly associated with obesity and chronic diseases.[67] Accordingly, the 2015-2020 Dietary Guidelines for Americans (DGAs) have recommended limiting the consumption of added sugars and solid fats to no more than 10% of total calories each, and the American Academy of Pediatrics suggests encouraging food choices with no added salt or sugar.[67,68] Still, a 2010 National Cancer Institute study found that nearly 40% of the total calories consumed by children and adolescents ages 2-18 came from solid fats and added sugars, and a more recent CDC study found that added sugars alone make up at least 13% of the total energy intake of US children ages 2-5.[69,70]

A potential relationship between childhood obesity and protein intake has emerged in recent decades. Indeed, some research has supported Koletzko and colleagues' "early protein hypothesis": the premise that high protein intake in the first year of life causes weight gain in infancy and increases the risk of obesity in childhood and adulthood.[71] The mechanism underlying this hypothesis is likely that high protein intake increases the secretion of insulin and insulin-like growth factor-I, resulting in increased body fat deposition and weight gain.[72,73] Greater early growth velocity is an important predictor of overweight in childhood and adulthood.[73] Unsurprisingly, multiple empirical studies have found that higher protein intake around age two is positively associated with BMI at ages seven[74] and eight.[75]

Variety in children's diets is imperative. Exposing young children to a variety of healthy foods can facilitate the acceptance of new foods. Literature suggests that the number of different foods that children enjoy remains fairly constant between the ages of 2-3 years and 8 years.[76] New foods are more likely to be accepted by children ages 2-3 years than by older children.[76] Thus, offering an assortment of healthy foods to young children encourages the establishment of healthy preferences, which is vital to the prevention of obesity and its associated comorbidities.

Dietary Recommendations for Children Ages 2-5

Familiarity with official dietary guidelines is important for parents and caregivers of toddlers and preschool-aged children. Overestimating children's energy requirements may lead to childhood obesity, while underestimating them could result in parents and caregivers offering inadequate energy to support children's normal growth and development.[77] Clearly defined guidelines and Dietary Reference Intakes (DRIs) are also imperative for researchers, as they provide a point of reference for evaluating whether observed dietary practices meet the needs of an individual or group.

Recommended Dietary Allowances (RDAs) are the category of DRIs that represent the average daily intake levels sufficient to meet the requirements of almost all healthy individuals in a group. RDAs of key micro- and macronutrients for US toddlers and preschoolers are outlined in Table 2.

Table 2. Recommended Dietary Allowances (RDAs) of key micro- and macronutrients for US children ages 2-5[78,79]

	Ages 2-3 years	**Ages 4-5 years**
Micronutrients		
Calcium (mg/day)	700	1,000
Iron (mg/day)	7	10
Vitamin A (µg RAE[a]/day)	300	400
Vitamin B_6 (mg/day)	0.5	0.6
Vitamin B_{12} (µg/day)	0.9	1.2
Vitamin C (mg/day)	15	25
Vitamin D (µg/day)	15	15
Folate (µg DFE[b]/day)	150	200
Macronutrients		
Carbohydrates (g/day)	130	130
Total Fiber[c] (g/day)	19	25
Protein (g/day)	13	19
Linoleic Acid[c] (g/day)	7	10
α-Linolenic Acid[c] (g/day)	0.7	0.9

a Retinol activity equivalents
b Dietary folate equivalents
c No RDA available. Recommendations reflect Adequate Intakes, which are believed to meet the needs of all healthy individuals in a population group.

In addition to the above DRIs, the American Heart Association (AHA) and the 2015-2020 DGAs have offered more general recommendations for energy and food group intake for children ages 2-5. These guidelines are outlined in Table 3.

Table 3. Calorie and food group recommendations for US toddlers and preschoolers ages 2-5 years by age and sex[68,80]

	Ages 2-3 years		Ages 4-5 years	
	Female	**Male**	**Female**	**Male**
Total calories (kcal)	1,000	1,000	1,200	1,400
Milk/dairy (cups)	2	2	2	2
Lean meat/beans (oz.)	2	2	3	4
Fruits (cups)	1	1	1.5	1.5
Vegetables (cups)	1	1	1	1.5
Grains (oz.)	3	3	4	5

The AHA has offered further guidance regarding portion sizes and other considerations. They recommend keeping total fat intake between 30-35% of total kilocalories for children ages 2-3, and between 25-35% of total kilocalories for children and adolescents ages 4 and older.[80] Most fat should come from sources rich in polyunsaturated and monounsaturated fatty acids, such as seafood, nuts, seeds, and vegetable oils. The AHA also recommends that children consume less than 6 teaspoons (the equivalent of about 100 calories) of added sugars per day and limit intake of SSBs to no more than 8 ounces per week.[81] Children under 2 years of age should not consume foods or beverages containing added sugars, including SSBs.[81]

National guidelines also emphasize the importance of whole grains, recommending that at least half of the grains consumed are whole, rather than refined grains.[25,80] Examples of whole grains include amaranth, barley, buckwheat, millet, quinoa, and wild rice.[82] Whole grains are rich sources of vitamins, minerals, dietary fiber, and many phytochemicals.[83] Research indicates that, in addition to promoting healthy weight maintenance, whole grains in the diets of adults may reduce the risk of stroke by 30-36%, of type 2 diabetes by 21-30%, and of cardiovascular disease by 25-28%.[84,85]

The AHA recommends that children consume a variety of colorful fruits and vegetables daily, and their suggestions for achieving this goal include aiming for at least one fruit or vegetable per meal while limiting juice intake.[80] The recommended serving sizes for fruits and vegetables are 1/3 cup for children ages 2-3 and ½ cup for children ages 4 and older.[80]

The current dairy recommendation for toddlers and preschoolers ages 2-5 is two cups of milk or other dairy products per day.[80] The American Academy of Pediatrics (AAP) does not recommend low fat or reduced fat milk before 2 years because of the need for more dietary fat at that age to support rapid growth, but by age 2, the AHA, AAP, and DGAs agree that toddlers should consume lower-fat milks and other dairy products.[25,80,86]

According to the AAP, the micronutrients that are most commonly deficient in children's diets are calcium, iron, folic acid, and vitamins A, C, and B6.[87] The American Medical Association, Academy of Nutrition and Dietetics, and AAP do not support routine supplementation of vitamins or minerals for normal, healthy children, instead recommending that children receive the nutrients they need from whole foods.[87]

Efforts to understand and improve the diets of young children are critical, as lifelong food preferences and eating habits develop early in life.[65] Multiple national and local studies have explored the diets of preschool-aged children. In general, evidence suggests children in America consume diets too high in energy and too low in nutrients.[25]

National Studies on Preschool Diets

Perhaps the most significant source of national dietary intake data is NHANES, an ongoing program of federally funded, epidemiologic studies that combine personal interviews with standardized physical examinations, diagnostic procedures, and lab tests to assess the health and nutritional status of adults and children of all ages.[88] NHANES data are released every two years, allowing researchers to monitor changes in health problems such as childhood obesity and their associated comorbidities over time.[88]

The 2002 and 2008 Feeding Infants and Toddlers Studies (FITS) are another important source of information on the food consumption patterns of young children in the US. Although NHANES and other large national surveys such as the Continuing Survey of Food Intakes by Individuals (CSFII) had provided dietary intake data for young children for decades, the sample sizes for infants and toddlers were small and data on breastfed infants were often excluded.[89] The FITS studies were therefore the first to offer detailed information about feeding during the first months of life, and the 2008 FITS was among the first to explore and quantify the diets of preschool-aged children.[89,90] The FITS methodology involved telephone interviews with random samples of US households and the collection of 24-hour dietary recalls using a food model booklet to facilitate portion size estimation.[90]

Findings from both the 2002 and 2008 FITS raised concerns, as approximately 25% of children were found to consume no distinct servings of fruits or vegetables in a given day.[86,91] Around the age of 2, not one of the top five vegetables reportedly eaten was a dark green leafy vegetable.[86] Instead, at around 15 months, the most commonly consumed vegetable was French fries.[86] While less commonly consumed, the other top-five vegetables included cooked broccoli, mashed potatoes, cooked green beans, and cooked corn.[86] According to the most recent CDC Vital Signs™ report on the subject, the amount of vegetables consumed by children did not change from 2003-2010, and 90% of children did not meet vegetable recommendations during that time.[92]

Rates of fruit intake among preschoolers are somewhat better than those of vegetable intake. The 2008 FITS found that roughly 73% of children ages 2 and 3 years consumed fruit at least once on the day studied, and about 60% drank 100% fruit juice.[86] The five most commonly consumed fruits were fresh apples, bananas, grapes, strawberries, and either canned applesauce (among 2-year-olds) or raisins (among 3-year-olds).[86] The most recent CDC Vital Signs™ report stated that although children ages 2-18 ate 67% more whole fruit in 2010 than in 2003, 60% still did not meet daily recommendations for fruit.[92]

According to 2008 FITS data, at least 97% of 2- and 3-year olds consumed a grain or grain product on the day studied.[86] Whole grain consumption varied widely by type of grain food. For example, 40% of children consumed whole grain breakfast cereals, but only 9% ate whole grain bread, and the frequency of whole grains in categories such as crackers, pretzels, and rice cakes was very low.[86] Between 83 and 98% of toddlers and preschoolers consumed milk at least once on the day studied, and 2% milk was the most commonly consumed type of milk.[86]

Perhaps the greatest area of concern regarding the diets of toddlers and preschoolers is the significant consumption of SSBs, desserts, and salty snacks.[86] The FITS study findings revealed that over 40% of children ages 2-3 years consumed SSBs, over 70% consumed desserts and candy, and over 26% ate salty snacks, most of which did not include whole grains.[86] Thus, on the day studied, more children consumed SSBs, desserts, and snacks than distinct portions of fruits or vegetables. These patterns hinder the development of healthy taste preferences and eating habits. Also, the nutrient requirements of preschoolers are high relative to their energy needs, so there is very little room in their diets for these nutrient-poor, energy dense foods.[86]

Another area of concern, both nationally and locally, is the excessive consumption of pizza among children. A recent study by Powell and colleagues found that pizza is a top contributor to the caloric intake of US children and adolescents, and despite an overall decline in its consumption, pizza is still the second highest source of daily energy among those ages 2-18 years.[93] Unsurprisingly, pizza consumption was found to be significantly associated with higher net daily total energy intake as well as higher intakes of saturated fat and sodium.[93] In fact, the CDC currently ranks pizza as the top source of sodium in the diets of US children and adolescents ages 2-19 years.[94]

Finally, FITS 2008 findings revealed that micronutrient intakes for children ages 2-3 years were often outside ideal ranges, a finding that is not surprising given the food intake patterns that have been observed. For example, the diets of many toddlers and preschoolers did not meet the estimated average requirement (EAR) for vitamin E, and mean potassium and fiber intakes were below recommended adequate intake (AI) levels. Intakes of folate, preformed vitamin A, zinc, and sodium, on the other hand, were particularly excessive compared to the DRIs, and often exceeded tolerable upper intake levels (UL).[95]

Local Studies on Preschool Diets

Findings from a study on the effects of WIC package changes in south central Texas echoed these disappointing FITS discoveries. In 2012, Reat and colleagues found that consumption of fruits and vegetables among infants and toddlers in San Marcos was disappointingly low.[96] For example, 31.6% of children ages 1-2 years had zero exposures to fruits or vegetables on the days studied.[96] Worse, of the vegetables reported, French fries were the most commonly consumed. Eighty percent of the toddlers studied consumed fruit juice, with nearly half consuming more than 6 fluid ounces, although the AAP recommends that fruit juice consumption should be limited to 4-6 fluid ounces per day for children 1-6 years old.[96,97] Although the literature is discordant, excessive fruit juice consumption in early childhood has been associated with tooth decay as well as increased risks of overweight and obesity.[97–99]

Another recent local study, which evaluated the dietary quality of preschoolers' packed lunches, found that many children ages 3-5 years enrolled in early care and education centers across South and Central Texas are sent to school with packed lunches of low dietary quality.[100] Overall, the children's lunches lacked vegetables, plant proteins, and whole grains; 49% of meals packed did not include any vegetables, over 90% did not include any greens, beans, or peas, and 48% did not include any whole grains.[100] These studies highlight a need for further attention to the quality of young children's diets in South Central Texas.

Methods of Assessing Diet Quality

Two broad methods are generally used to study relationships between diet quality and health. First, statistical techniques may be employed to identify dietary patterns and then relate those patterns to particular health outcomes.[101,102] These methods include procedures such as the analyses of usual nutrient intakes. The second general method for assessing the diets of individuals or groups involves scoring the diets using a particular set of standards in order to create a composite index of diet quality.[101,102]

Myriad diet quality indices have been developed to assess intake and categorize individuals according to the healthfulness of their diets. Examples include the Diet Quality Index Revised (DQI-R), the Mediterranean Diet Score (MDS), the Alternate Healthy Eating Index (AHEI), and the HEI.[103] The majority of dietary indices were developed based on adult dietary recommendations, making them inappropriate for studies with child subjects. Because dietary intakes used for HEI scoring are measured on a density (per kilocalorie) basis, this method is appropriate for all subjects 2 years of age and older. The HEI has been determined to be a valid and reliable method of evaluating compliance with the recommendations of the 2010 DGAs and the USDA Food Patterns, and will be used in this study to assess diet quality.[104]

Healthy Eating Index

The original HEI was created in 1995 by the USDA Center for Nutrition Policy and Promotion (CNPP) as a tool to assess diet quality in terms of compliance with federal dietary guidelines.[105] The HEI can be used with any defined collection of foods, such as dietary intake data, menus, or market baskets.[105] The instrument was updated to the HEI-2005 in 2008, in order to reflect the 2005 DGAs and the food patterns of the USDA's food guidance system, MyPyramid.[106] In 2012, the index was revised again. The new HEI-2010 evaluates dietary compliance with the recommendations of the 2010 DGAs and the USDA Food Patterns, which outline specific amounts of foods from each of the major food groups and subgroups that should be consumed daily for various total calorie levels in order to help individuals meet Dietary Guidelines recommendations.[105,107] The HEI-2010 is comprised of nine "Adequacy Components" that assess recommended foods and nutrients to increase, such as Total Fruit and Whole Grains, and three "Moderation

Components” that assess recommended foods and nutrients to decrease, such as Refined Grains.[108]

Changes to the HEI from the 2005 to the 2010 version are summarized in Table 4. The first significant change was the replacement of the “Dark Green and Orange Vegetables and Legumes” category with “Greens and Beans;” this increased specificity better captures the vegetable subgroups for which average intakes tend to be furthest from recommended levels.[108] Second, a “Seafood and Plant Proteins” category was added to capture the Dietary Guidelines’ new attention to the benefits of seafood consumption and vegetarian diets. Third, a “Fatty Acids” category, focusing on the ratio of poly- and monounsaturated to saturated fatty acids, replaced “Oils and Saturated Fat” in an effort to acknowledge recommendations to use oils to replace solid fats when possible. Finally, a new moderation component, “Refined Grains,” was added to replace the adequacy component “Total Grains,” in order to better assess the overconsumption of refined grains.

Table 4. Comparison of HEI-2005[a] and HEI-2010[b] components[108]

	HEI-2005	HEI-2010
Adequacy Components:		
1	Total Fruit	Total Fruit
2	Whole Fruit	Whole Fruit
3	Total Vegetables	Total Vegetables
4	Dark Green and Orange Vegetables and Legumes	Greens and Beans
5	Total Grains	Whole Grains
6	Whole Grains	Dairy
7	Milk	Total Protein Foods
8	Meat and Beans	Seafood and Plant Proteins
9	Oils	Fatty Acids
Moderation Components:		
10	Saturated Fat	Refined Grains
11	Sodium	Sodium
12	Calories from SoFAAS[c]	Empty Calories[d]

a Healthy Eating Index-2005
b Healthy Eating Index-2010
c Includes solid fats, alcoholic beverages, and added sugars.
d Includes calories from solid fats, alcohol, and added sugars.

Healthy Eating Index-2010 Scoring System

The scoring system of the HEI-2010 uses "scoring standards" as a method of evaluating diets. The system follows a density approach, in which scoring standards are expressed as either a percent of total kilocalories (as with Empty Calories) or amount per 1,000 kilocalories (as with Total Fruit and Sodium).[109] This method is appropriate because dietary recommendations for amounts of food groups, oils, and empty calories are expressed in terms of absolute quantities that vary according to energy intake. Fats are handled differently in this system. They are assessed as a ratio of unsaturated to saturated fatty acids. For the adequacy components of the index (see Table 4), a score of zero is assigned for no intake, and scores increase proportionately as intake increases up to the standard for a maximum score.[109] Reverse scoring is used for the moderation components, such as refined grains.[108] For the moderation components, intakes at a standard level receive the maximum score, and scores decrease as intakes increase.[108,109] Thus, for all components, higher scores indicate greater compliance with dietary guidelines. The maximum HEI-2010 score is 100.[108] Generally, scores greater than 80 indicate a good diet, scores between 51 and 80 suggest a need for improvement, and scores below 51 denote a poor diet.[110,111] The components and scoring standards of the HEI-2010 are outlined in Table 5.

Table 5. HEI-2010[a] components and scoring standards[109,112]

HEI Component	Maximum Points	Standard for Maximum Score	Standard for Minimum Score of 0
Total Fruit	5	≥ 0.8 cup/1000 kcal	No fruit
Whole Fruit	5	≥ 0.4 cup/1000 kcal	No whole fruit
Total Vegetables	5	≥ 1.1 cup/1000 kcal	No vegetables
Greens and Beans	5	≥ 0.2 cup/1000 kcal	No dark green vegetables or beans & peas
Whole Grains	10	≥ 1.5 oz./1000 kcal	No whole grains
Dairy	10	≥ 1.3 cup/1000 kcal	No dairy
Total Protein Foods	5	≥ 2.5 oz./1000 kcal	No protein foods
Seafood & Plant Proteins	5	≥ 0.8 oz./1000 kcal	No seafood or plant proteins
Fats	10	(PUFAs[b] + MUFAs[c])/SFAs[d] > 2.5	(PUFAs + MUFAs)/SFAs < 1.2
Refined Grains	10	≤ 1.8 oz./1000 kcal	≥ 4.3 oz./1000 kcal
Sodium	10	≤ 1.1 g/1000 kcal	≥ 2.0 g/1000 kcal
Empty Calories	20	≤ 19% of energy	≥ 50% of energy

a Healthy Eating Index-2010
b Polyunsaturated fatty acids
c Monounsaturated fatty acids
d Saturated fatty acids

Use of the HEI in Research

The HEI is a useful tool for healthcare professionals, including nutrition and dietetics practitioners, as it helps them to recognize and monitor trends in eating habits and nutrition-related areas of concern.[113] The HEI is also invaluable for researchers. A primary use of the HEI is to monitor the diet quality of the US population as a whole; it has also been used to assess diets of various subpopulations, such as low-SES Americans.[114] Studies of the effects of SES on diet quality have repeatedly found that higher SES is associated with higher HEI scores.[114–116] Researchers have also used HEI scores to assess the quality of food assistance packages for low-SES Americans. In a recent study, Nguyen and colleagues used HEI scores computed from NHANES data as part of a key outcome variable to determine whether participation in the Supplemental Nutrition Assistance Program (SNAP) affects associations between food insecurity, diet quality, and weight among US adults.[117] Results of this study indicated that SNAP recipients with marginal, low, and very low levels of food security had higher HEI scores than income-eligible non-participants, indicating that for those most in need, SNAP benefits do improve diet quality.[117] Other research that may inform policies related to income and access to healthy foods includes studies using HEI scores to explore correlations between diet cost and quality. Several studies have found strong positive relationships between diet costs and HEI scores.[118,119] Lower diet costs have been linked to lower consumption of nutrient-dense foods, particularly vegetables, fruits, whole grains, and seafood, and to higher consumption of refined grains, solid fats, alcohol, and added sugars.[118]

Of course, effective steps to promote healthier diets at low cost depend on accurate analyses of the current food environment. To this end, HEI scores have been used to evaluate the US food supply at both the community and macro level.[120] HEI scores have also been used to explore specific characteristics of the home food environment, such as parent feeding practices, as they relate to healthy dietary patterns.[121,122] The HEI is also frequently used to study relationships between dietary intake and health outcomes, such as cancer risk, obesity, and type 2 diabetes, as well as to analyze the efficacy of nutrition interventions and nutrition education programs.[101,123–126] Analyzing correlations between HEI scores and blood nutrient concentrations has allowed researchers to identify nutritional biomarkers associated with diet quality and patterns of healthy dietary intake.[127] Finally, studies using the HEI have provided informative data on grocery shopping habits, such as using a grocery list, that contribute to the healthfulness of dietary patterns.[128,129]

HEI Studies and Results Across Child Populations

A relative dearth of HEI research with preschool-aged children exists in the US, especially prior to 2013. A review of the studies that have estimated HEI scores among this age group in order to assess the healthfulness of children's diets is presented in Table 6. International studies with subjects within the age group relevant to this study (ages 2-5) have been included as well. Most US researchers utilize NHANES data, so information on small, individual communities is currently scarce.

Table 6. Review of studies that have used HEI[a] scores to assess the diets of preschool-aged children

Reference	Methods	Population	Results
Kennedy et al., 1995[130]	Original HEI[a] developed based on 10-component system of 5 food groups, 4 nutrients, and a measure of variety in food intake. Frequency analysis, correlation coefficients, and means were used to analyze the HEI[a] for a representative US sample.	7,463 people ages 2 years and older, surveyed in the 1989 and 1990 CSFII[b]	Mean HEI[a] score: 63.9. People were most likely to score poorly in the fruit, saturated fat, grains, vegetable, and total fat categories. The HEI[a] correlated positively and significantly with most nutrients.
Knol et al., 2005[131]	Dietary patterns assessed using variables from the Pyramid Servings Database within the CSFII[b] 1994-1996, 1998. HEI scores were used to validate identified dietary patterns.	Two subsamples of low-income children, aged 2-3 years (n=1,242) and 4-8 years (n=1,506), who participated in CSFII[b]	Distinct dietary patterns identified for both younger and older children. Four patterns similar for both age groups. For 2-3 year olds, energy intake, overall HEI[a] scores, and 9/10 HEI[a] component scores differed among the 4 most common dietary patterns. Among 4-8 year olds, energy intake and 6 HEI[a] component scores differed between the 4 most common clusters.
LaRowe et al., 2007[132]	Beverage patterns formed using 24-hour dietary recall diet variables from the 2001-2002 NHANES[c]. Diet quality assessed using energy, micronutrient intakes, and HEI scores.	541 children ages 2-5 and 793 children ages 6-11 who participated in the 2001-2002 NHANES[c]	In preschoolers, mean HEI[a] differed between fruit juice cluster vs. high-fat milk cluster; however, both fruit juice and high-fat milk clusters had highest micronutrient intakes. Mean HEI[a] differed significantly across beverage patterns for older children, with best diet quality in high-fat milk cluster. Adjusted mean body mass index differed significantly across beverage clusters only in older children.
Fungwe et al., 2009[133]	Subjects divided into 3 age groups (2-5, 6-11, 12-17). Intakes of various dietary components estimated using the population ratio method. HEI-2005 component and total scores calculated and used to analyze children's diets.	3,286 children ages 2-17 who participated in the 2003-2004 NHANES[c]	Children ages 2-5 had better diets than children ages 6-11 in regard to Total Fruits, Whole Fruits, Milk, & Extra Calories, and better diets than those ages 12-17 in regard to Total Fruits, Whole Fruits, Whole Grains, Milk, Sodium, & Extra Calories (but worse in regard to Meats & Beans and Oils).
Manios et al., 2009[134]	Dietary intake data obtained using a combination of techniques, including weighed food records, 24-hour recalls, and food diaries. HEI[a] scores calculated by summing individual scores (0 to 10) assigned to each of 10 index components.	A representative sample of 2,287 Greek children ages 2-5 years from the GENESIS[d] Study	80% of participants had HEI[a] scores <50, 0.4% had scores >80, overall mean score was 59. Scores significantly higher among boys, children ages 4-5, children participating in moderate to vigorous physical activities for >3 hours/week, children living in rural or small towns, and those whose mothers were employed & had higher educational status. HEI[a] score strongly associated with several macro- and micronutrient intakes.

Table 6. Continued. Review of studies that have used HEI[a] scores to assess the diets of preschool-aged children

Reference	Methods	Population	Results
Nunn et al., 2009[135]	HEI[a] used to measure dietary quality of children ages 2-5. Logistic regression analysis used to examine association between diet quality and prevalence of early childhood caries.	3,912 children ages 2-5 who participated in the 1988-1994 NHANES[c]	Children with the best dietary practices (those within the uppermost HEI[a] tertile) were 44% less likely to exhibit severe early childhood caries compared to children with the worst dietary practices (those within the lowest HEI[a] tertile).
Freedman et al., 2010[136]	Population distribution of usual HEI-2005 total and component scores estimated. Monte Carlo method used to estimate distribution of the 5 episodically consumed HEI components: total fruit, whole fruit, whole grains, dark-green/orange vegetables and legumes, and milk.	17,311 persons ages 2 years and older who participated in the 2001–2004 NHANES[c]	The distributions of 3 critical components were presented: Total Vegetables (range 0–5; population mean 3.21), Whole Grains (range 0–5; mean 1.0), and SoFAAS[e] (range 0–20; mean 8.41). Among those ≤18 years, a particularly high percentage of the population (46-71%) had total vegetable scores <2.5.
O'Neil et al., 2011[137]	24-hour dietary recalls used to determine intake. Diet quality determined using the HEI-2005. Covariate-adjusted means, standard errors, and prevalence rates determined for each candy consumption group. Odds ratios used to determine likelihood of associations with weight status and diet quality.	7,049 children ages 2-13 and 4,132 adolescents ages 14-18 who participated in the 1999-2004 NHANES[c]	Overall diet quality was very poor in all groups, regardless of whether candy was consumed. Although total candy consumers had higher intakes of total energy and added sugars than non-consumers, candy consumption did not adversely affect health risk markers such as blood pressure, blood lipid levels, and cardiovascular risk factors in children and adolescents.
Rauber et al., 2012[138]	Diet quality was evaluated according to the HEI[a]. Statistical analysis was performed using SPSS[f]. Chi-squared analysis was used to identify independent variables associated with higher dietary quality (total HEI[a] score >80 and individual HEI[a] component scores >75th percentile).	345 low-SES[g] children ages 6 months and 3-4 years old from Sao Leopoldo in southern Brazil	The mean total HEI[a] score was 65.7. Only 9.6% of the children had a "good" diet. No significant associations were detected between overall diet quality and the maternal/family characteristics studied. Variables of importance included family income, paternal employment, and level of maternal education.
Erinosho et al., 2013[112]	Foods and beverages offered or served to children were entered into the NDSR[h] software to generate ingredients, food groups, calories/energy, and nutrients. Each HEI-2005 component was generated and averaged across 2 days.	120 children ages 3-5 in 20 North Carolina child-care centers	All centers met maximum score for Milk. A majority also met max scores for Total Fruit, Whole Fruit, & Sodium. Mean scores for Total Vegetables, Dark Green/Orange Vegetables & Legumes, Total Grains, Whole Grains, Oils, and Meat/Beans were significantly lower than max scores. Mean scores for saturated fat and calories from solid fats & added sugars were troubling.

Table 6. Continued. Review of studies that have used HEI[a] scores to assess the diets of preschool-aged children

Reference	Methods	Population	Results
Hiza et al., 2013[139]	HEI-2010 scores were estimated using 1 day of dietary intake data. Intakes of energy, fatty acids, sodium, and alcohol were calculated. Food group intakes for 2003-08 were calculated using the MyPyramid Equivalents Database, CNPP[i]'s addendum to that database, and the CNPP[i] 2003-04 fruit database.	2,996, 3,237, and 2,703 children ages 2-17 who participated in the 2003-2004, 2005-2006, and 2007-2008 NHANES[c], respectively	In all years, total scores ranged from 47-50% of maximum. Scores for Dairy and Total Protein Foods were closest to standards, while scores for Greens & Beans and Whole Grains were farthest from standards. Total Fruit and Whole Fruit intakes were significantly higher in 2007-2008 than in the other time periods, and empty calories intakes were significantly lower in 2007-2008, resulting in increased scores.
Carroll, 2014[140]	Dietary intake data was used to calculate the 12 HEI-2005 components + energy. Variables analyzed included age, gender, race & interaction terms. 2 dummy variables were employed: (1) whether the recall was for a weekend day, and (2) whether the recall was the first or second collected.	US children ages 2-8 who participated in the 2001-2004 NHANES[c]	Children's diets, on average, are far from ideal. Only about 5% of children have a score of 69 or greater and another 10% have scores of 41 or lower. This analysis suggests that virtually all children in the US have suboptimal diets and that a sizeable fraction (10%) have alarmingly low scores (41 or lower).
Johnson et al., 2014[141]	Relationships between feeding and mealtime behaviors, repetitive and ritualistic behaviors, sensory behaviors, and externalizing and internalizing behaviors were examined. Whether or not feeding habits were predictive of nutritional adequacy (determined by individual HEI[a] scores) was also explored.	256 children with autism spectrum disorders, ages 2-11, recruited from 5 Autism Speaks Autism Treatment Network sites	Strong associations were found between parent reported feeding habits and 1) repetitive and ritualistic behaviors, 2) sensory features, and 3) externalizing and internalizing behavior. There was a lack of association between feeding behaviors and the social and communication deficits of ASD and cognitive levels. Increases in the degree of problematic feeding behaviors predicted decreases in nutritional adequacy.
Kong et al., 2014[142]	Dietary intake data were collected via 24-hour dietary recalls in the summer of 2009, immediately before WIC[j] food package revisions occurred in Chicago IL, and at 18 months following the food package change. Generalized estimating equation models were used to compare diet quality using HEI[a] scores at these two time points.	Hispanic and African American parent-child dyads: 209 mothers and 164 children ages 2-3.5 at baseline who were enrolled in WIC[j] in Chicago, IL	18 months after WIC[j] food package revisions, significant decreases in total fat & saturated fat and increases in dietary fiber & overall diet quality were observed among Hispanic children. No significant changes were observed for any other group. Reduced-fat milk intake significantly increased for African American & Hispanic children, whereas whole milk intake significantly decreased for all groups.

Table 6. Continued. Review of studies that have used HEI[a] scores to assess the diets of preschool-aged children

Reference	Methods	Population	Results
Leal et al., 2015[143]	Food intake data was collected via FFQ[k]. Dietary quality was measured according to an adapted HEI.	556 children ages 2-5 living in the urban area of Pelotas, Brazil	Mean HEI score was 74.4, indicating the children's diets need improvement. Mean scores were significantly higher among girls and in children from families with income between 1-3 minimum wages. Vegetable intake was below the recommended level, while foods categorized as oils and fats, sugars, candies, chocolates, and snacks were consumed in excess.
Romo-Palafox et al., 2015[100]	The dietary quality of preschoolers' sack lunches were evaluated using the HEI-2010 in order to provide the children's parents with guidance to increase the healthfulness of their child's lunches.	607 parent–child dyads (children ages 3-5 years) from 30 early care and education centers in Central and South Texas	Mean HEI-2010 total scores were 58 for lunches packed and 52 for lunches consumed. Mean HEI[a] component scores for packed and consumed lunches were lowest for Greens and Beans, Total Vegetables, Seafood and Plant Proteins, and Whole Grains; and highest for Empty Calories, Total Fruit, Whole Fruit, and Total Protein Foods.
O'Neil et al., 2015[144]	Dietary intake data collected via one 24-h recall. Diet quality measured using HEI-2010. Regression analyses performed to determine demographic, nutrient intake, diet quality, and weight/adiposity differences between oatmeal consumers and non-consumers. Logistic regression used to calculate odds ratios for weight measures and obesity.	14,690 children ages 2-18 who participated in the 2001-2010 NHANES[c]	Oatmeal consumption was associated with better nutrient intake, better diet quality, and lower risks for central adiposity and obesity.
Tester et al., 2016[145]	Dietary intake data collected via two 24-h recalls. Diet quality measured using HEI-2010. Linear regression used to examine differences in HEI-2010 scores attributable to 2009 WIC[j] package change.	1197 low-income children ages 2-4 who participated in the 2003-2008 and 2011-2012 NHANES[c]	The WIC[j] package changes were associated with an adjusted average of 3.7 additional HEI-2010 points for WIC[j] participants compared to nonparticipants. In particular, the revisions were associated with a 3.4-fold increase in the Greens and Beans component score for participants compared to nonparticipants.

a Healthy Eating Index
b Continuing Survey of Food Intakes by Individuals
c National Health and Nutrition Examination Survey
d Growth, Exercise, and Nutrition Epidemiological Study In preSchoolers
e Solid fats, alcoholic beverages, and added sugars
f Statistical Package for the Social Sciences
g Socio-economic status
h Nutrition Data System for Research
i Center for Nutrition Policy and Promotion
j Special Supplemental Nutrition Program for Women, Infants, and Children
k Food Frequency Questionnaire

The most recent comprehensive national data on HEI-2010 scores of children's diets are represented by the results of the 2013 study by Hiza and colleagues reported in Table 6.[139] Dietary intake data from the 2003-04, 2005-06, and 2007-08 NHANES were used to generate HEI-2010 scores for children and adolescents ages 2-17 years. Overall, the diet quality of the population studied fell far short of national guidelines. Total HEI-2010 scores ranged from 47-50 out of a maximum score of 100, and average scores for all individual components fell below the standards. The highest component scores (i.e. those that were closest to the standards) were found for Dairy and Total Protein Foods, and, perhaps unsurprisingly, the lowest scores were found for the Greens and Beans and Whole Grains components. The component scores were generally similar across the three time periods studied, with a few exceptions. The slight increase in total HEI-2010 scores is attributable to significantly higher intakes of Total Fruit and Whole Fruit and lower consumption of Empty Calories in 2007-08 compared to previous years.[139]

Objectives

The primary objective of this thesis was to use the HEI-2010 to assess the diet quality of a sample of children ages 2-5 enrolled in childcare centers in San Marcos, Texas. The population of San Marcos is of interest because the average income and ethnic makeup of the city place its children at increased risk of obesity and malnutrition. This project is intended to contribute to a community needs assessment. Previous studies in this geographic region have found that many toddlers and preschoolers are not meeting dietary recommendations either at childcare centers or at home.[96,146] Based on the results of these regional studies, current knowledge of national trends, the demographics and socioeconomic status of San Marcos, and preliminary data on the nutrient intakes of this population, the author hypothesized that the foods and beverages consumed by children ages 2-5 in San Marcos would be of below-average quality and would not meet the maximum scores for any HEI-2010 components.[59,96,100]

The secondary objective of this thesis project was to investigate relationships between HEI-2010 scores and data collected through a parent survey, such as participants' demographic information. Understanding these relationships may be particularly helpful in shaping future nutrition interventions in south central Texas.

The third objective of this thesis was to calculate HEI-2010 scores for a national sample of children ages 2-5 in order to compare the scores of children in San Marcos to those of a more representative sample.[1]

[1] This third objective was added after the original thesis proposal.

III. METHODS

In spring 2014, the research team recruited a convenience sample of 173 parents of children ages 2-5 from childcare centers and one pre-kindergarten center in Hays County, TX. Centers were located primarily within the city of San Marcos. Parents were recruited outside of centers when picking their child up from care. After providing informed consent, parents completed a survey that collected information about their home food environments and feeding practices. Questions, adapted from existing assessment tools, were intended to collect data on 5 main constructs, including: 1) parent feeding practices, including monitoring/modeling of healthy eating behaviors, pressure to eat, and child involvement in preparation; 2) parent nutrition knowledge, including causes and risks of obesity and recommendations for child intake; 3) parent self-efficacy, including food selection, meal planning, and self-confidence in choosing healthy foods; 4) parent perceptions, including child weight status, self-weight status, and barriers to healthy eating habits; and 5) the home food environment, including mealtime structure and the availability/accessibility of food. These constructs and the general survey design are outlined in the Appendix.

Of the 173 parents who completed the survey, 124 parents agreed to participate in 24-hour recall interviews. During the telephone interviews, which were conducted by trained graduate and undergraduate nutrition students, researchers used Nutrition Data System for Research 2013 (NDSR) software, which employs a multiple-pass 24-hour recall method to obtain and record all dietary intake data from the previous day.[147] NDSR was developed by the Nutrition Coordinating Center (NCC) of the University of Minnesota, Minneapolis, MN.[147] Output from NDSR allows researchers to examine nutrient intakes, as well as patterns of eating behavior, such as the number of meals and snacks consumed, and food group intake, such as the amounts of fruits and vegetables consumed.[26] A booklet containing two-dimensional images of food models, issued to parents during recruitment, was used to help facilitate the estimation of portion size during the phone calls. Parents were given a $5 grocery store gift card for completing the survey and an additional $5 grocery gift card for completing the 24-hour diet recall. All aspects of this study were approved by the Texas State University Institutional Review Board.

Assessment of San Marcos Children's Diets Based on the HEI-2010

NDSR output was imported into Microsoft® Excel 2013 software,[148] which was used to create the variables necessary to determine HEI-2010 component scores for each child (for components and scoring criteria, see Table 5).[108] Component scores were calculated by adding together specific NDSR subgroups, and the final measures for each component conformed to the units specified by the index (see Table 5).[149] The subgroups for some components, such as those for Whole Grains and Total Protein Foods, were generated by NDSR in the appropriate units.[149] Others had to be converted to the units required by the HEI-2010 before component scores could be calculated. The subgroups for Total Fruit, Whole Fruit, Total Vegetables, and Greens and Beans were divided by 2 because the servings for these subgroups in the NCC Food Serving Count System used by NDSR were in ½ cup equivalents rather than 1 cup equivalents.[149] The sodium output from NDSR output file 04 (sodium intake in milligrams) was divided by 1,000 in order to present the HEI-2010 Sodium component in terms of grams per 1,000 kilocalories.[149] Finally, the Dairy subgroup DOT0100 (frozen dairy desserts) was divided by three because 1.5 cups of a frozen dairy dessert is considered a cup equivalent in the dairy group, but 0.5 cups of frozen dairy dessert is considered a serving in the NCC Food Serving Count System.[149]

Due to the average protein content of the VEG0700 (legumes) subgroup, its assignment to the appropriate HEI-2010 components depended on whether the Total Protein Foods standard was met without it.[149] Specifically, if the Total Protein Foods estimate for a participant was less than 2.5 ounce equivalents per 1,000 kilocalories, the VEG0700 subgroup was included in the Total Protein Foods and Seafood and Plant Proteins groups and excluded from the Total Vegetables and Greens and Beans groups.[149] Conversely, if the Total Protein Foods standard of 2.5 ounce equivalents per 1,000 kilocalories was met without the inclusion of the VEG0700 subgroup, the VEG0700 subgroup was included in both the Total Vegetables and Greens and Beans components instead of in the Total Protein Foods and Seafood and Plant Proteins components.[149]

In order to estimate the “solid fats” subgroup of the Empty Calories component, intake of saturated fatty acids and *trans* fatty acids were summed and used as a proxy. This was necessary because solid fats were not added as an NDSR subgroup until the 2014 version of the software (and the 2013 version was used during data collection).[149] This approach is consistent with the 2015 Dietary Guidelines, which recommend that polyunsaturated and monounsaturated fatty acids make up the primary source of dietary fat; saturated fatty acids should make up no more than 10% of daily caloric intake, and *trans* fatty acids should be consumed as infrequently as possible.[67,146] The detailed plan used to quantify the 12 HEI-2010 component scores is outlined in Table 7.

Table 7. Methods for calculating HEI-2010[a] component scores[149]

Component	NDSR[b] Output Subgroups Used	Method
Total Fruit	FRU0100, FRU0200, FRU0300, FRU0400, FRU0500, FRU0600, FRU0700[d]	(Subgroup total / 2) / (total daily energy intake[c] / 1,000)
Whole Fruit	FRU0300, FRU0400, FRU0500, FRU0600, FRU0700[d]	
Whole Grains	Whole grains in ounce equivalents[c]	Subgroup total / (total daily energy intake[c] / 1,000)
Refined Grains	Refined grains in ounce equivalents[c]	
Dairy	DMF0100, DMR0100, DML0100, DMN0100, DMF0200, DMR0200, DML0200, DML0300, DML0400, DCF0100, DCR0100, DCL0100, DCN0100, DYF0100, DYR0100, DYL0100, DYF0200, DYR0200, DYL0200, DYN0100, DOT0100 / 3, DOT0300, DOT0400, DOT0500, DOT0600[d]	
Total Protein Foods	MRF0100, MRL0100, MRF0200, MRL0200, MRF0300, MRL0300, MRF0400, MRL0400, MCL0200, MRF0500, MPF0100, MPL0100, MPF0200, MFF0100, MFL0100, MFF0200, MSL0100, MSF0100, MCF0100, MCL0100, MOF0100, MOF0200, MOF0300, MOF0400, MOF0500, MOF0600, MOF0700[d]	Subgroup total[e] / (total daily energy intake[c] / 1,000)
Seafood and Plant Proteins	MFF0100, MFL0100, MFF0200, MSL0100, MSF0100, MOF0500, MOF0600, MOF0700[d]	
Total Vegetables	VEG0100, VEG0200, VEG0300, VEG0400, VEG0800, VEG0450, VEG0600, VEG0900, VEG0500[d]	(Subgroup total[f] / 2) / (total daily energy intake[c] / 1,000)
Greens and Beans	VEG0100[d]	
Fatty Acids	Total monounsaturated fatty acids (MUFAs), total polyunsaturated fatty acids (PUFAs), and total saturated fatty acids (SFAs)[c]	Sum of total PUFAs and MUFAs / total SFAs
Sodium	Sodium intake in milligrams[c]	(Sodium variable / 1,000) / (total daily energy intake[c] / 1,000)
Empty Calories	Saturated fat in grams, *trans* fat in grams, added sugars in grams, and alcohol in grams[c]	[(Saturated fat x 9) + (trans fat x 9) + (sugars x 4) / total daily energy intake[c]] x 100

a Healthy Eating Index-2010
b Nutrition Data System for Research
c From NDSR output file 04
d From NDSR output file 09
e If the Total Protein Foods estimate for a participant is ≤ 2.5 ounce equivalents per 1,000 kilocalories, include the VEG0700 (legumes) subgroup, multiplied by 2, in the calculations for these components.
f If the Total Protein Foods standard was met without including subgroup VEG0700, then VEG0700 should be included in the calculation for these components.

Statistical Analysis

After individual and overall sample HEI scores were calculated, the scores were imported into IBM SPSS Statistics, version 23.0.[150] Children's diets were then categorized into the appropriate HEI-2010 score category ("Poor," "Needs Improvement," and "Good").[111] Differences in mean HEI-2010 component scores between these three score categories were evaluated using one-way analysis of variance (ANOVA). Post hoc multiple comparison tests (Tukey HSD or Games-Howell, depending on the significance of the Levene's tests) were used to further analyze significant ANOVA *F* results.

One-way ANOVA was used to assess differences between the mean intakes of 7 micronutrients (vitamins A, B_6, B_{12}, C, and folate, and minerals calcium and iron), carbohydrates, fiber, protein, linoleic acid (an ω-6 polyunsaturated fatty acid [PUFA]), and α-linolenic acid (an ω-3 PUFA) from NDSR output file 04. *F*-tests were used to assess significant differences in mean intake of these nutrients between the three HEI score category groups. Post hoc Tukey HSD tests were used to further analyze significant ANOVA *F* results. Nutrient adequacy ratios (NARs) were calculated to assess the adequacy of the micro- and macronutrient intakes.[151] This method of determining nutrient adequacy of the diet is supported for children in this age range.[151] NARs were calculated by dividing the child's intake of each nutrient by the nutrient's RDA, or if no RDA exists, by the nutrient's AI, and then multiplying by 100.

Because previous research with this sample[152] indicated that protein intake far exceeded recommendations, and because high protein intake, particularly protein from animal sources, has been associated with increased risks of overweight and obesity in young children, differences in mean intakes of animal and plant-based protein between the three HEI-2010 score categories were evaluated using one-way ANOVA.[71,73–75] The relationships between animal and plant-based protein intake and HEI-2010 scores were explored using bivariate Pearson correlations. Pearson correlations were also calculated to examine the relationships between diet quality and total protein intake in grams as well as protein intake as a percentage of total calories.

As the primary goals of Best Food FITS projects are to increase children's intake of fruits and vegetables and decrease intake of SSBs, intakes of these items were investigated further. To compare total HEI-2010 scores of those that met the maximum score for the Total Vegetables component to those that did not, we first created dichotomous (dummy) variables (e.g. met recommendations, did not meet recommendations). Then, we compared the mean HEI-2010 scores using independent samples t-tests. This same protocol was also used for the Total Fruit component. Fruit and vegetable servings for this analysis were determined by adding the NDSR subgroups used to calculate the Whole Fruit and Total Vegetables components of the HEI-2010 (see Table 7).

Sugar sweetened beverages were handled differently because NDSR output does not include defined subgroups to reflect SSB intake. To calculate daily servings of SSBs, data from 10 NDSR output file 04 subgroups were added together (see Table 8). Although the Dairy-based Sweetened Meal Replacement/Supplement (DOT0500), Sweetened Flavored Milk Beverage Powder with Non-fat Dry Milk (DML0300), and Sweetened Flavored Milk Beverage Powder without Non-fat Dry Milk (SWT0600) subgroups are not NDSR beverage categories, they were included in this analysis because current literature includes sweetened milks and non-dairy beverage concentrates under the umbrella of SSBs.[153,154]

Table 8. Nutrition Data System for Research (NDSR) subgroups used in sugar-sweetened beverage analysis[155]

Subgroup	Name	Example	Serving Size
BVS0100	Sweetened Coffee		8 fluid ounces
BVS0200	Sweetened Coffee Substitutes		8 fluid ounces
BVS0300	Sweetened Fruit Drinks	Capri-Sun®	8 fluid ounces
BVS0400	Sweetened Soft Drinks	Sprite®	8 fluid ounces
BVS0500	Sweetened Tea		8 fluid ounces
BVS0600	Sweetened Water		8 fluid ounces
BVS0700	Nondairy-based Sweetened Meal Replacement/Supplement	Gatorade®	8 fluid ounces
DOT0500	Dairy-based Sweetened Meal Replacement/Supplement	Carnation Instant Breakfast®	1 cup
DML0300	Sweetened Flavored Milk Beverage Powder with Non-fat Dry Milk	Cocoa packets	1 cup prepared
SWT0600	Sweetened Flavored Milk Beverage Powder without Non-fat Dry Milk	Nestle Nesquik®	1 cup prepared

Dummy variables were created for SSB intake (i.e., 0 servings, less than 1 serving, and 1 or more servings). Then, the variance in the children's total HEI-2010 scores by SSB intake was explored using one-way ANOVA. Finally, the children's total fruit, total vegetable, and total SSB intake in servings were analyzed as predictors of HEI scores using a multivariate linear regression model.

Analysis of Relationships Between Survey Variables and Individual Diet Scores

Parent survey questions organized by construct are itemized in the Appendix. Subsequent confirmatory factor analysis (data not reported) revealed that the survey questions do not adequately measure the five constructs. Thus, objective 2 was modified to investigate relationships between individual survey questions and HEI-2010 scores. The survey questions selected for inclusion in this analysis are outlined by theme in Table 9. Answers for these questions were given either as multiple-choice selections or indications on five-point Likert scales. When self-reported height and weight values for parents and children were available, these data were used to calculate BMI.

Table 9. Parent survey questions selected for inclusion in diet quality analysis

Theme	Survey Question
Socio-demographic information	What race/ethnicity do you consider yourself?
	What is the highest education you have completed or are in the process of completing?
	What is your annual household income? Are you currently working? If so, how much?
Food environment: accessibility	Do you use any of the following resources? (WIC, SNAP, Temporary Assistance for Needy Families [TANF], food bank or food pantry, reduced or free school meals)
Food environment: mealtime structure	How often are home-cooked foods served to the members of your household for dinner?
	How often are fast foods served to the members of your household for dinner?
	How often is sit down restaurant food served to the members of your household for dinner?
Parent knowledge related to health behaviors	How many hours does your child watch TV per day?
Parent feeding practices	How often do you model healthy eating for your child by eating healthy foods yourself?
	How often do you eat together as a family?
	If your child says, "I'm not hungry," how often do you try to get him/her to eat anyway?
	How often do you offer your child his/her favorite foods in exchange for good behavior?
	How often do you encourage your child to eat less?
	How often to you plan to have vegetables at dinner?
Parent self-efficacy	I am sure I can find time to prepare healthy meals.
	I am sure I can plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains.

Statistical Analysis

Differences in HEI scores between dichotomous variables were analyzed using independent samples t-tests. One-way ANOVA was used to explore differences in HEI scores by parent BMI category and the survey questions listed above. Post hoc multiple comparison tests (Tukey HSD) were used to further analyze significant ANOVA F

results. After reviewing the mean differences in HEI-2010 scores among the survey responses, correlations were calculated to further examine select variables that appeared to have notable trends, specifically parent education, frequency of fast-food meals, and responses to the question, “How often do you model healthy eating for your child by eating healthy foods yourself” (hereafter, “healthy modeling”). Parent education and frequency of fast-food meals were relatively normally distributed, so Pearson correlations were computed to examine the associations between these variables and diet quality as measured by the HEI-2010. Responses to the healthy modeling survey question skewed left, violating the assumption of normality, so the Spearman rho statistic was calculated.

The survey question, “Do you use any of the following resources: WIC, SNAP, TANF, food bank or food pantry, or reduced or free school meals,” could not be analyzed in the same way as the other survey variables because responses were not mutually exclusive. Responses were recoded to reflect the number of resources used (i.e., 0, 1, or > 1) and differences in mean HEI scores between these groups were analyzed using one-way ANOVA. Participation or non-participation in individual food assistance programs was also coded as dichotomous variables, and differences in mean HEI-2010 scores between participants and non-participants of each resource were tested using independent samples t-tests. Finally, mean differences in mean HEI-2010 scores between WIC participants, SNAP recipients, and individuals participating in both WIC and SNAP were analyzed using one-way ANOVA.

Comparison of Local HEI-2010 Scores with National Scores

In order to compare the HEI-2010 scores of San Marcos preschoolers with those of a national sample of preschoolers, it was necessary to first calculate national HEI-2010 scores using age-matched NHANES data. NHANES datasets from the 2009-2010 and 2011-2012 survey cycles were downloaded from the CDC NHANES website[156] and imported into Statistical Analysis System (SAS) University Edition software (SAS Institute Inc., Cary, NC, Version 9.4 M3). The NHANES data files used were DR1TOT_G (2009-2010) and DR1TOT_F (2011-2012), which detailed one day's total nutrient intake for each participant, and DEMO_G (2009-2010) and DEMO_F (2011-2012), which contained the participants' demographic data. The nutrient intake files were merged with Food Patterns Equivalents Database (FPED) files, which translated the amounts of foods eaten into cup and ounce equivalents consistent with the units of measurement used for HEI scoring standards (see Table 5). The HEI-2010 SAS macro, available at the National Cancer Institute website, was used to calculate the component and total scores from the NHANES datasets.[157] Using SAS coding, the demographic and dietary intake data used was limited to children ages 2-5. Finally, to compare local and national HEI scores, means and 95% confidence intervals were calculated.

IV. RESULTS

Demographic information for the San Marcos children and caregivers is reported in Table 10.

Table 10. Socio-demographic characteristics of children and caregivers sampled from childcare centers in San Marcos, TX

Child (n=124)	**Frequency (% of total)**		
Female	68 (54.8)		
BMI[b] category (n=70)[a]			
Underweight	5 (7.1)		
Normal weight	38 (54.3)		
Overweight	9 (12.9)		
Obese	18 (25.7)		
Caregiver (n=124)			
Age (mean = 32.5 ± 6.8)		Employment status	
18-25	21 (16.9)	Unemployed	30 (24.2)
26-40	92 (74.2)	Employed part-time	22 (17.7)
41-65	11 (8.9)	Employed full-time	72 (58.1)
Race/ethnicity		BMI[b] category (n=120)[a,c]	
White	63 (50.8)	Underweight	5 (4.2)
Hispanic/Latino	54 (43.5)	Normal weight	48 (40.0)
Black	6 (4.8)	Overweight	35 (29.2)
Asian	1 (0.8)	Obese	32 (26.7)
Household income (n=122)[a]		Use of food assistance resources	
$0 – 10,000	18 (14.8)	WIC[d]	26 (21.0)
$10,001 – 20,000	20 (16.4)	SNAP[e]	34 (27.4)
$20,001 – 40,000	22 (18.0)	TANF[f]	2 (1.6)
$40,001 – 75,000	23 (18.9)	Food bank or food pantry	2 (1.6)
$75,001+	39 (32.0)	Reduced or free school meals	31 (25.0)
		More than one resource used	27 (21.8)
Role in household		Number of children in household	
Mother	115 (9.3)	1-2	79 (63.7)
Father	7 (5.6)	3-4	37 (29.8)
Grandparent	2 (1.6)	5+	8 (6.5)
Level of education (n=111)[a]			
Less than high school	10 (9)		
High school/GED	31 (28)		
College degree	41 (37)		
Graduate degree	29 (26)		

a Lower sample number due to missing data
b Body mass index
c Mean parent BMI = 26.6 ± 5.6
d Special Supplemental Nutrition Program for Women, Infants, and Children
e Supplemental Nutrition Assistance Program
f Temporary Assistance for Needy Families

Assessment of San Marcos Children's Diets Based on the HEI-2010

Mean HEI-2010 component and total scores for subjects in San Marcos are included in Table 11. The mean total HEI-2010 score (62.1) was lower than the optimal score of 100, and average scores for all components were below the standards. The lowest total score was 33.3 and the highest score was 93.5, indicating that no child met the recommendations for all components. Still, over half the children met the maximum component scores for Total Fruit, Whole Fruit, Dairy, and Total Protein Foods. Mean scores for Dairy and Empty Calories were closest to meeting the standards (8.78/10 or 87.8% and 17.5/20 or 87.5%, respectively). Mean scores for Greens and Beans and Fatty Acids were furthest from meeting the standards (0.98/5 or 19.6% and 3.16/10 or 31.6%, respectively), indicating the children ate far less than the recommended amounts of dark-green vegetables, beans, and unsaturated fatty acids.

Table 11. HEI-2010[a] component and total scores for participating San Marcos children ages 2-5

HEI-2010 Component	Optimum Score	Mean Score ± Standard Deviation	% Meeting Recommendation (n)
Total Fruit	5	3.79 ± 1.58	50.8 (63)
Whole Fruit	5	3.95 ± 1.59	58.9 (73)
Total Vegetables	5	2.21 ± 1.54	10.5 (13)
Greens and Beans	5	0.98 ± 1.80	12.1 (15)
Whole Grains	10	4.97 ± 3.69	16.9 (21)
Dairy	10	8.78 ± 2.32	66.9 (83)
Total Protein Foods	5	4.00 ± 1.42	50.8 (63)
Seafood & Plant Proteins	5	1.97 ± 2.34	32.3 (40)
Fatty Acids	10	3.16 ± 3.44	8.90 (11)
Refined Grains	10	5.83 ± 3.55	22.6 (28)
Sodium	10	4.95 ± 3.60	15.3 (19)
Empty Calories	20	17.5 ± 3.25	33.9 (42)
Total HEI-2010 Score	**100**	**62.1 ± 12.1**	**0 (0)**

a Healthy Eating Index-2010

Only 8% of the children's diets met the USDA CNPP's criteria for a "Good" diet (scores above 80).[110] Approximately 17% fell below the standard for a "Poor" diet (scores below 50), while nearly 75% fell in the category, “Needs Improvement” (see Figure 2).

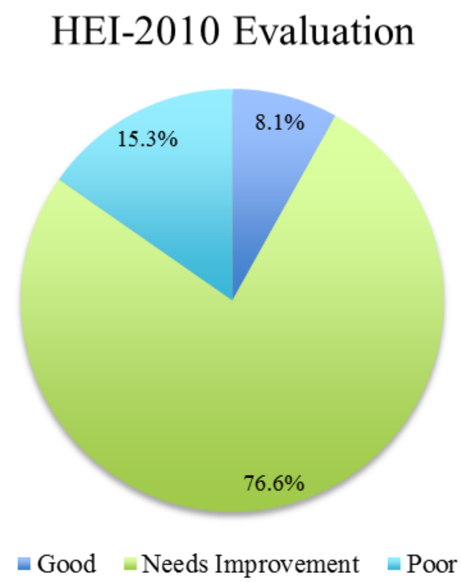

Figure 2. Evaluation of Healthy Eating Index-2010 scores based on USDA Center for Nutrition Policy and Promotion (CNPP) diet quality standards[110]

Mean HEI-2010 component scores by HEI-2010 score category are detailed in Table 12. Statistically significant differences were found among the three levels of HEI-2010 score quality for all HEI-2010 components, except Dairy. In general, individual component scores of children whose diets were classified as “Good” were significantly higher than those of children in the other score categories. Once again, Dairy was the exception; it was the only component for which mean scores were lower among children whose diets were considered “Good” than children in either of the other two diet quality categories.

Table 12. Mean HEI-2010[a] component scores of a sample of San Marcos preschoolers by score category

		HEI-2010 Score Quality Ranges							
		0-50 (n=22) "Poor"		51-80 (n=92) "Needs Improvement"		81-100 (n=10) "Good"			
HEI-2010 Component	**Optimum Score**	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***F***	***p***
Total Fruit	5	$2.60^{b,c}$	1.71	4.01^{b}	1.44	4.45^{c}	1.24	9.08	$<.001^{***}$
Whole Fruit	5	$2.62^{b,c}$	1.90	4.18^{b}	1.41	4.76^{c}	0.76	11.58	$<.001^{***}$
Total Vegetables	5	$1.38^{b,c}$	1.09	2.30^{b}	1.55	3.13^{c}	1.59	5.54	$.005^{**}$
Greens and Beans	5	0.29^{b}	0.98	0.92^{c}	1.71	$3.13^{b,c}$	2.44	10.14	$<.001^{***}$
Whole Grains	10	2.37^{b}	2.85	5.17^{b}	3.58	8.87^{b}	1.76	13.48	$<.001^{***}$
Dairy	10	8.77	2.68	8.82	2.20	8.38	2.83	0.16	.850
Total Protein Foods	5	3.32^{b}	1.76	4.10	1.34	4.60^{b}	0.78	3.84	$.024^{*}$
Seafood and Plant Proteins	5	0.60^{b}	1.53	1.99^{b}	2.34	4.88^{b}	0.39	13.87	$<.001^{***}$
Fatty Acids	10	2.03^{b}	2.70	3.02^{c}	3.32	$6.89^{b,c}$	3.80	7.92	$.001^{**}$
Refined Grains	10	3.59^{b}	3.35	6.02^{b}	3.44	9.04^{b}	1.55	9.84	$<.001^{***}$
Sodium	10	3.53^{b}	2.85	4.90^{c}	3.68	$8.52^{b,c}$	1.70	7.31	$.001^{**}$
Empty Calories	20	$14.13^{b,c}$	4.55	18.16^{b}	2.43	18.98^{c}	1.42	19.03	$<.001^{***}$
Total HEI-2010 Score	100	45.24^{b}	5.03	65.58^{b}	7.66	85.64^{b}	3.37	121.59	$<.001^{***}$

* p < .05
** p < .01
*** p < .001
a Healthy Eating Index-2010
b, c Means identified with the same alphabetic superscript are significantly different based on Tukey HSD or Games-Howell post hoc comparisons.

Nutrient Intakes and HEI-2010 Scores

Mean nutrient intakes by HEI-2010 category are detailed in Table 13. Statistically significant differences were found among the three categories of HEI-2010 scores on mean intakes of vitamin B_6, $F(2, 121) = 3.54$, $p = .035$, vitamin B_{12}, $F(2, 121) = 3.10$, $p = .049$, vitamin D, $F(2, 121) = 3.41$, $p = .036$, and dietary fiber, $F(2, 121) = 9.42$, $p < .001$. Post hoc Tukey HSD tests indicated that children in the highest HEI-2010 score category

(“Good”) and the middle HEI-2010 score category (“Needs Improvement”) differed significantly in their intakes of vitamin B_{12} (p = .046) and vitamin D (p = .028). Interestingly, mean intakes of both of these vitamins were significantly *lower* among those in the “Good” category than those in the “Needs Improvement” category. Post hoc tests also indicated that significant differences existed between the highest (“Good”) category and both the middle (“Needs Improvement”) and lowest (“Poor”) HEI-2010 categories for dietary fiber (p = .020 and p < .000, respectively). Post hoc analysis for vitamin B_6 intake did not reveal statistically significant differences among HEI-2010 score categories.

NAR percentages for calcium, iron, vitamins A, B_6, B_{12}, C, and D, folate, total carbohydrates, fiber, protein, linoleic acid, and α-linolenic acid are included in Table 13. The only nutrient on which all children fell short of the recommended intake was vitamin D. Children whose diets were classified as “Poor” or “Needs Improvement” consumed 43.7% and 46.3% of the RDA for vitamin D, respectively, while children whose diets were classified as “Good” consumed only 27.4% of the RDA for vitamin D. Children whose diets were classified as “Good” met the recommendation for fiber, but those in the “Needs Improvement” and “Poor” categories did not. Particularly high NAR percentages were observed for protein intake in all HEI score categories, with average protein intake falling between 356-421% of the RDA.

Table 13. Mean micronutrient and macronutrient intakes of a sample of San Marcos preschoolers by HEI-2010[a] score category

	RDA[b]		HEI-2010[a] Score Quality Ranges: 0-50 (n=22) "Poor"		51-80 (n=92) "Needs Improvement"		81-100 (n=10) "Good"			
	Ages 2-3 y	Ages 4-5 y	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*F*	*p*
Micronutrients										
Calcium (mg)	700	1,000	1158.6	483.6	1081.6	417.5	831.6	184.1	2.15	.121
Calcium NAR[c]%			*135.7*	*63.8*	*127.6*	*49.3*	*101.2*	*31.5*	*1.61*	*.205*
Iron (mg)	7	10	10.7	4.1	11.7	5.6	9.1	1.5	1.31	.273
Iron NAR%			*126.2*	*60.6*	*138.8*	*67.9*	*110.7*	*27.5*	*1.06*	*.350*
Vitamin A (µg RAE[d])	300	400	614.3	323.8	712.3	357.1	706.8	469.4	0.66	.519
Vitamin A NAR%			*176.3*	*106.7*	*202.5*	*103.5*	*211.9*	*158.1*	*0.59*	*.554*
Vitamin B_6 (mg)	0.5	0.6	1.1	0.6	1.5	0.8	1.3	0.5	3.54	.032*
Vitamin B_6 NAR%			*204.2*	*112.9*	*278.4*	*124.2*	*245.6*	*104.9*	*3.45*	*.035**
Vitamin B_{12} (µg)	0.9	1.2	4.2	2.1	4.8	2.9	2.6	1.6	3.10	.049*
Vitamin B_{12} NAR%			*395.9*	*209.4*	*461.5*	*307.0*	*252.6*	*156.0*	*2.68*	*.073*
Vitamin C (mg)	15	25	57.2	43.0	78.3	62.7	97.9	101.9	1.61	.204
Vitamin C NAR%			*287.3*	*246.1*	*418.0*	*400.2*	*582.9*	*705.7*	*1.89*	*.155*
Vitamin D (µg)	15	15	6.5	3.8	7.0	3.4	4.1	2.4	3.41	.036*
Vitamin D NAR%			*43.7*	*25.5*	*46.3*	*22.9*	*27.4*	*15.9*	*3.07*	*.050*
Folate (µg DFE[e])	150	200	444.0	233.4	430.3	201.2	291.4	105.6	2.30	.105
Folate NAR%			*255.0*	*159.3*	*245.8*	*117.7*	*176.2*	*83.6*	*1.57*	*.211*
Macronutrients										
Carbohydrates (g)	130	130	201.0	59.1	203.9	70.6	190.2	54.4	0.19	.829
Carbohydrates NAR%			*154.6*	*45.4*	*156.8*	*54.3*	*146.3*	*41.8*	*0.19*	*.829*
Fiber (g)[f]	19	25	10.9	5.1	15.6	7.2	21.7	5.1	9.42	<.001***
Fiber NAR%			*49.0*	*27.2*	*70.8*	*33.3*	*102.6*	*36.4*	*9.57*	*<.001****
Protein (g)	13	19	65.2	27.3	66.3	22.2	55.1	14.8	1.10	.337
Protein NAR%			*400.6*	*176.7*	*421.2*	*161.5*	*356.1*	*115.0*	*0.80*	*.450*
Linoleic Acid (g)[f]	7	10	9.6	3.9	8.7	4.7	10.9	3.9	1.33	.270
Linoleic Acid NAR%			*112.1*	*52.0*	*104.7*	*62.8*	*134.6*	*53.1*	*1.16*	*.318*
α-Linolenic Acid[f] (g)	0.7	0.9	1.1	0.5	1.1	0.6	1.3	0.5	0.62	.539
α-Linolenic Acid NAR%			*134.2*	*72.4*	*132.3*	*69.1*	*157.9*	*59.2*	*0.62*	*.540*

a Healthy Eating Index-2010
b Recommended Dietary Intakes
c Nutrient Adequacy Ratio
d Retinol Activity Equivalents
e Dietary Folate Equivalent
f No RDA available. Adequate Intakes used.
* p < .05
*** p < .001

Average animal protein intake on the day reported was 45.1 grams, and average plant-based protein intake was 20.1 grams. Children in the highest HEI-2010 score category consumed significantly less animal protein and significantly more plant-based protein than children in either of the other two score categories (see Table 14). A significant positive correlation was found between plant-based protein and HEI-2010 scores, $r(122) = .277$, $p = .002$, indicating that children with higher plant-based protein intake tend to have better quality diets and vice versa. However, no significant correlations were found between HEI-2010 scores and animal protein intake, protein intake as a percentage of total calories, or total protein intake in grams.

Table 14. Mean intakes of animal and plant-based protein from a sample of San Marcos preschoolers by HEI-2010[a] score category

	HEI-2010 Score Quality Ranges							
	0-50 (n=22) "Poor"		51-80 (n=92) "Needs Improvement"		81-100 (n=10) "Good"			
	Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***	***F***	***p***
Animal protein (g)	46.95[b]	26.38	46.62[c]	18.35	26.99[b,c]	17.00	4.51	.013*
Plant-based protein (g)	18.25[b]	7.84	19.64[c]	9.73	28.07[b,c]	6.43	4.29	.016*

* p < .05
a Healthy Eating Index-2010
b, c Means identified with the same alphabetic superscript are significantly different based on Tukey HSD post hoc comparisons.

Best Food FITS Goals for Improving Children's Diets: Fruit, Vegetables, and Sugar-Sweetened Beverages

Children who met the HEI-2010 Total Fruit component criteria had significantly better total HEI-2010 scores than those who did not meet the component's maximum score ($p < 0.001$), indicating that adequate fruit intake is a predictor of overall diet quality (see Table 15). The average HEI-2010 score of children who met the Total Fruit maximum was 67.2, compared to only 56.6 for children who did not meet the component maximum. Mean HEI-2010 scores for children who met the Total Vegetables component criteria (66.4) were also better than those of children who did not (61.6), although this difference was not statistically significant.

Table 15. Mean HEI-2010[a] scores for San Marcos children ages 2-5 by whether or not they met fruit and vegetable recommendations

Variable	M ± SD	*t*	*df*	*p*
Fruit				
Met maximum Total Fruit component score (n=63)	67.2 ± 11.2	-5.29	121	<.001*
Did not meet maximum Total Fruit component score (n=60)	56.6 ± 10.7			
Vegetables				
Met maximum Total Vegetables component score (n=13)	66.4 ± 11.8	-1.35	121	.180
Did not meet maximum Total Vegetables component score (n=110)	61.6 ± 12.1			

* $p < .001$
a Healthy Eating Index-2010

Over 30% of the San Marcos preschoolers consumed any SSBs on the day reported and 14% consumed one or more full servings. Statistically significant differences were found among mean HEI-2010 scores between children who consumed no SSBs at all, children who consumed some but less than 1 serving of SSBs, and children who consumed 1 or more servings, $F(2, 120) = 8.35$, $p < .001$ (see Table 16). Post hoc Tukey HSD tests indicated that children who consumed no SSBs had significantly higher HEI-2010 scores than children who consumed at least 1 serving of SSBs on the day recorded ($p < .001$).

Table 16. Differences in mean HEI-2010[a] scores for San Marcos children ages 2-5 by SSB[b] servings

SSB[b] Servings	M ± SD	*F*	*p*
0 servings (n=85)	64.5[c] ± 12.0	8.35	<.001*
Between 0-1 servings (n=21)	59.9 ± 10.9		
1 or more servings (n=17)	52.4[c] ± 8.9		

*$p < .001$
a Healthy Eating Index-2010
b Sugar sweetened beverage
c Means identified with the same alphabetic superscript are significantly different based on Tukey HSD post hoc comparisons.

The means, standard deviations, and intercorrelations of fruit, vegetable, and SSB servings can be found in Table 17. The combination of variables to predict HEI-2010 scores from fruit servings, vegetable servings, and SSB servings was statistically significant, $F(3,119) = 14.2$, $p < .001$. The beta coefficients are presented in Table 18. Note that higher fruit servings and lower SSB servings significantly predict HEI-2010 score when all 3 variables are included. The adjusted R^2 value was .244, indicating that 24% of the variance in HEI-2010 scores is explained by this model.

Table 17. Means, standard deviations, and intercorrelations for HEI-2010[a] scores and predictor variables (n=123)

Variable	M	SD	Fruit servings	Vegetable servings	SSB servings
HEI-2010 total score	62.1	12.1	.42**	.25**	-.34**
Predictor variables					
Fruit servings	2.0	2.4	--	.26**	-.16*
Vegetable servings	1.5	1.3	.26**	--	-.18*
SSB[b] servings	0.3	0.6	-.16*	-.18*	--

* *p* < .05; ** *p* < .01
a Healthy Eating Index-2010
b Sugar-sweetened beverage

Table 18. Regression analysis summary for servings of fruit, vegetables, and SSBs[a] predicting HEI-2010[b] scores of San Marcos preschoolers (N=123)

Variable	B	*SE B*	β	*t*	*p*
Fruit servings	1.74	.41	.34	4.20	<.001
Vegetable servings	1.12	.79	.12	1.42	.16
SSB servings	-5.70	1.73	-.27	-3.29	.001

Note: $R^2 = .26$; $F(3,119) = 14.2$, $p < .001$.

a Sugar-sweetened beverages
b Healthy Eating Index-2010

Analysis of Relationships Between Survey Variables and Individual Diet Scores

Mean HEI-2010 scores of the San Marcos preschoolers based on variables of interest from the parent survey are detailed in Table 19.

Table 19. Mean HEI-2010[a] scores based on variables of interest from survey distributed to parents of San Marcos preschoolers

Variable/Survey Question	Child HEI-2010 Score Mean ± SD	*F*	*p*
Child sex			
Male (n=56)	61.0 ± 12.8	.91	.343
Female (n=68)	63.0 ± 11.5		
Caregiver age			
18-25 (n=21)	61.6±12.2	.48	.619
26-40 (n=92)	61.8±12.1		
41-65 (n=11)	65.5±12.5		
Caregiver employment status			
Unemployed (n=30)	61.3±14.1	.15	.859
Employed part-time (n=22)	61.6±11.8		
Employed full-time (n=72)	62.6±11.4		
Caregiver BMI category			
Underweight (n=5)	60.9 ± 10.4	.13	.942
Normal weight (n=48)	62.4 ± 14.1		
Overweight (n=34)	61.8 ± 10.9		
Obese (n=32)	60.8 ± 10.1		
Caregiver race/ethnicity			
White (n=63)	63.9 ± 12.4	1.83	.164
Hispanic/Latino (n=54)	59.8 ± 11.8		
Other[b] (n=7)	64.1 ± 9.0		
Household income			
$0 – 10,000 (n=18)	60.2 ± 9.7	1.29	.280
$10,001 – 20,000 (n=20)	58.7 ± 11.1		
$20,001 – 40,000 (n=22)	59.2 ± 13.8		
$40,001 – 75,000 (n=23)	64.0 ± 10.0		
$75,001+ (n=39)	64.2 ± 13.1		
Caregiver education level			
Less than high school (n=10)	59.6 ± 14.3	1.87	.120
High school/GED (n=31)	58.2 ± 11.2		
Associate's degree (n=12)	58.9 ± 7.8		
College degree (n=41)	63.9 ± 11.9		
Graduate degree (n=29)	65.1 ± 12.8		
Do you use any of the following resources: WIC[c], SNAP[d], TANF[e], food bank or food pantry, reduced or free school meals?			
None of these used (n=66)	63.3 ± 12.8	.71	.494
One of these used (n=31)	60.4 ± 11.7		
More than one of these used (n=27)	61.2 ± 10.9		
How often are home-cooked foods served for dinner?			
Rarely (n=1)	58.0	.04	.989
Sometimes (n=22)	62.2 ± 13.2		
Most times (n=76)	62.0 ± 11.7		
Always (n=24)	62.3 ± 13.3		

Table 19. (Continued) Mean HEI-2010[a] scores based on variables of interest from survey distributed to parents of San Marcos preschoolers

How often are fast foods served for dinner?			
Never (n=24) Rarely (n=80) Sometimes (n=18) Most times (n=1)	66.2 ± 14.8 61.7 ± 11.4 58.7 ± 10.5 51.9	1.69	.172
How often is sit down restaurant food served for dinner?			
Never (n=22) Rarely (n=74) Sometimes (n=26) Most times (n=1)	64.5 ± 11.1 61.6 ± 12.2 61.1 ± 13.1 69.5	.50	.685
How many hours does your child watch TV per day?			
0 hours (n=9) 0.5 hours (n=16) 1 hour (n=36) 1.5 hours (n=24) 2.0 hours (n=34) 3.0 hours (n=40	67.4 ± 12.2 69.3 ± 14.8 59.0 ± 11.2 60.5 ± 12.0 62.0 ± 10.9 58.9 ± 9.1	2.17	.062
How often do you model healthy eating for your child by eating healthy foods yourself?			
Never (n=2) Sometimes (n=24) Most times (n=67) Always (n=29)	59.6 ± 8.3 58.0 ± 10.0 61.8 ± 11.8 66.8 ± 13.5	2.45	.067
How often do you eat together as a family?			
Never (n=1) Sometimes (n=16) Most times (n=39) Always (n=66)	74.0 56.9 ± 10.5 62.1 ± 12.0 63.1 ± 12.5	1.47	.226
If your child says, I'm not hungry, how often do you try to get him/her to eat anyway?			
Never (n=9) Rarely (n=52) Sometimes (n=28) Most times (n=16) Always (n=18)	58.1 ± 6.6 62.3 ± 11.3 61.9 ± 14.4 65.8 ± 12.5 60.5 ± 12.6	.69	.599
How often do you offer your child his/her favorite foods in exchange for good behavior?			
Never (n=43) Rarely (n=52) Sometimes (n=13) Most times (n=10) Always (n=5)	64.9 ± 10.8 60.4 ± 13.0 57.5 ± 10.6 62.7 ± 14.5 65.9 ± 9.5	1.45	.222
How often do you encourage your child to eat less?			
Never (n=99) Rarely (n=18) Sometimes (n=5) Always (n=1)	62.1 ± 12.3 61.5 ± 13.4 60.9 ± 4.5 70.4	.18	.909

Table 19. (Continued) Mean HEI-2010[a] scores based on variables of interest from survey distributed to parents of San Marcos preschoolers

How often do you plan to have vegetables at dinner?			
Never (n=5)	55.8 ± 12.7		
Sometimes (n=35)	58.6 ± 11.6	3.23	.043*
Often (n=83)	63.9 ± 12.0		
I am sure I can find time to prepare healthy meals.			
Strongly disagree (n=5)	49.2[f] ± 12.6		
Disagree (n=3)	52.7 ± 5.9		
Neither agree nor disagree (n=10)	65.8 ± 10.6	3.58	.009**
Agree (n=61)	60.5 ± 11.1		
Strongly agree (n=45)	65.5[f] ± 12.6		
I am sure I can plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains.			
Strongly disagree (n=5)	44.9[f,g] ± 9.1		
Disagree (n=7)	60.9 ± 5.1		
Neither agree nor disagree (n=9)	62.9 ± 12.7	3.21	.015*
Agree (n=52)	61.5[f] ± 11.9		
Strongly agree (n=50)	64.4[g] ± 12.2		

a Healthy Eating Index-2010
b Black and Asian combined
c Special Supplemental Nutrition Program for Women, Infants, and Children
d Supplemental Nutrition Assistance Program
e Temporary Assistance for Needy Families
f, g Means identified with the same alphabetic superscript are significantly different based on Tukey HSD post hoc comparisons.
* $p < .05$
** $p < .01$

Significant variance was observed for 3 of the selected parent survey questions: "How often does your family plan to have vegetables for dinner?" (p = .043), "I am sure I can find time to prepare healthy meals" (p = .009), and "I am sure I can plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains" (p = .015). Post hoc Tukey HSD tests indicated that HEI-2010 scores were significantly lower among children whose parents strongly disagreed with the statement, "I am sure I can plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains," than children whose parents agreed (p = .025) or strongly agreed (p = .005) with the statement. Tukey HSD tests also revealed that HEI-2010 scores were significantly lower among children whose parents strongly disagreed with the statement, "I am sure I can find time to prepare healthy meals," than children whose parents strongly agreed (p = .027) with the statement. Post hoc multiple comparisons tests did not reveal significant differences between responses to the question, "How often do you plan to have vegetables at dinner?"

Although the F tests conducted were not statistically significant, trends were observed among parent education, frequency of fast-food meals, and healthy modeling. A significant positive correlation was observed between parental level of education and child HEI-2010 scores, $r(121) = .21$, $p = .017$. This means that children with highly educated parents tended to have higher HEI-2010 scores. A significant negative correlation was observed between frequency of fast-food meals and total HEI-2010 scores, $r(121) = -.20$, $p = .027$, indicating that children who ate fast-food meals more often tended to have lower HEI-2010 scores. Finally, a significant positive correlation was found between responses to the healthy modeling survey question and children's HEI-2010 scores, $r_s(120) = .233$, $p = .010$, indicating that children whose parents modeled healthy eating behaviors more frequently tended to have higher HEI-2010 scores.

Mean differences in HEI-2010 scores among participants in food assistance programs are outlined in Table 20. No significant differences were found between mean HEI-2010 scores of WIC participants compared to nonparticipants, TANF recipients compared to non-recipients, food bank/food pantry participants compared to nonparticipants, or reduced/free school meal recipients compared to non-recipients. It is interesting to note, though, that WIC was the only food assistance program associated with higher mean HEI-2010 scores among participants compared to non-participants.

Participation in SNAP did appear to be related to diet quality. SNAP recipients had significantly lower HEI-2010 scores than non-recipients (*p* = .046). The mean HEI-2010 score for SNAP recipients was 58.6, while the mean score for non-recipients was 63.4. Differences were also observed between WIC and SNAP users, although these results were not statistically significant. The mean HEI-2010 score of individuals participating only in WIC was 65.3, compared to 56.3 for individuals participating only in SNAP and 61.5 for individuals participating in both WIC and SNAP.

Table 20. Mean HEI-2010[a] scores for San Marcos children ages 2-5 by parents' participation in food assistance programs

Variable	M ± SD	*t*	*df*	*p*
WIC[b]				
Participants (n=26)	63.1 ± 12.5	-.47	122	.638
Non-participants (n=98)	61.8 ± 12.0			
SNAP[c]				
Participants (n=34)	58.6 ± 10.9	2.01	122	.046*
Non-participants (n=90)	63.4 ± 12.3			
TANF[d]				
Participant (n=2)	55.3 ± 16.3	.81	122	.422
Non-participant (n=122)	62.2 ± 12.1			
Food Bank or Food Pantry				
Participant (n=2)	52.8 ± 11.0	1.10	122	.275
Non-participant (n=122)	62.3 ± 12.1			
Reduced or Free School Meals				
Participant (n=31)	61.5 ± 10.3	.342	122	.733
Non-participant (n=93)	62.3 ± 12.7			

a Healthy Eating Index-2010
b Special Supplemental Nutrition Program for Women, Infants, and Children
c Supplemental Nutrition Assistance Program
d Temporary Assistance for Needy Families
* $p < .05$

Comparison of Local HEI-2010 Scores with National Scores

The mean total HEI-2010 score for the national sample of preschoolers (59.9) was considerably lower than the optimal score of 100, and average scores for most components were below the standards (see Table 21). Children in the national sample did meet optimal mean component scores for Total Fruit, Whole Fruit, and Dairy, indicating that recommended daily servings were reached for these food groups. As observed among the San Marcos preschoolers, the components with scores furthest from the standards were Greens and Beans and Fatty Acids.

Table 21. HEI-2010[a] component and total scores for national sample of children ages 2-5: NHANES[b] 2009-2012 (n=25,425)

HEI-2010 Component	Optimum Score	Mean Score ± Standard Deviation
Total Fruit	5	5.00 ± 0.04
Whole Fruit	5	5.00 ± 0.00
Total Vegetables	5	1.94 ± 11.3
Greens and Beans	5	0.66 ± 14.2
Whole Grains	10	2.94 ± 23.9
Dairy	10	10.0 ± 0.00
Total Protein Foods	5	4.06 ± 17.4
Seafood and Plant Proteins	5	2.82 ± 33.0
Fatty Acids	10	2.32 ± 46.3
Refined Grains	10	6.38 ± 25.9
Sodium	10	5.88 ± 24.5
Empty Calories	20	12.9 ± 44.4
Total HEI-2010 Score	**100**	**59.9 ± 140**

a Healthy Eating Index-2010
b National Health and Nutrition Examination Survey

Means and 95% confidence intervals for local and national HEI-2010 scores are shown in Figure 3. Confidence intervals do not overlap for the Total Fruit, Whole Fruit, Whole Grains, Dairy, or Empty Calories components, indicating those component means are significantly different. The similarities among mean scores for the Total Vegetables, Greens and Beans, Total Protein Foods, Seafood and Plant Proteins, Fatty Acids, Refined Grains, and Sodium components indicate that children across the US are largely struggling with the same nutritional inadequacies as children in San Marcos, TX. These common trends are illustrated in Figure 4.

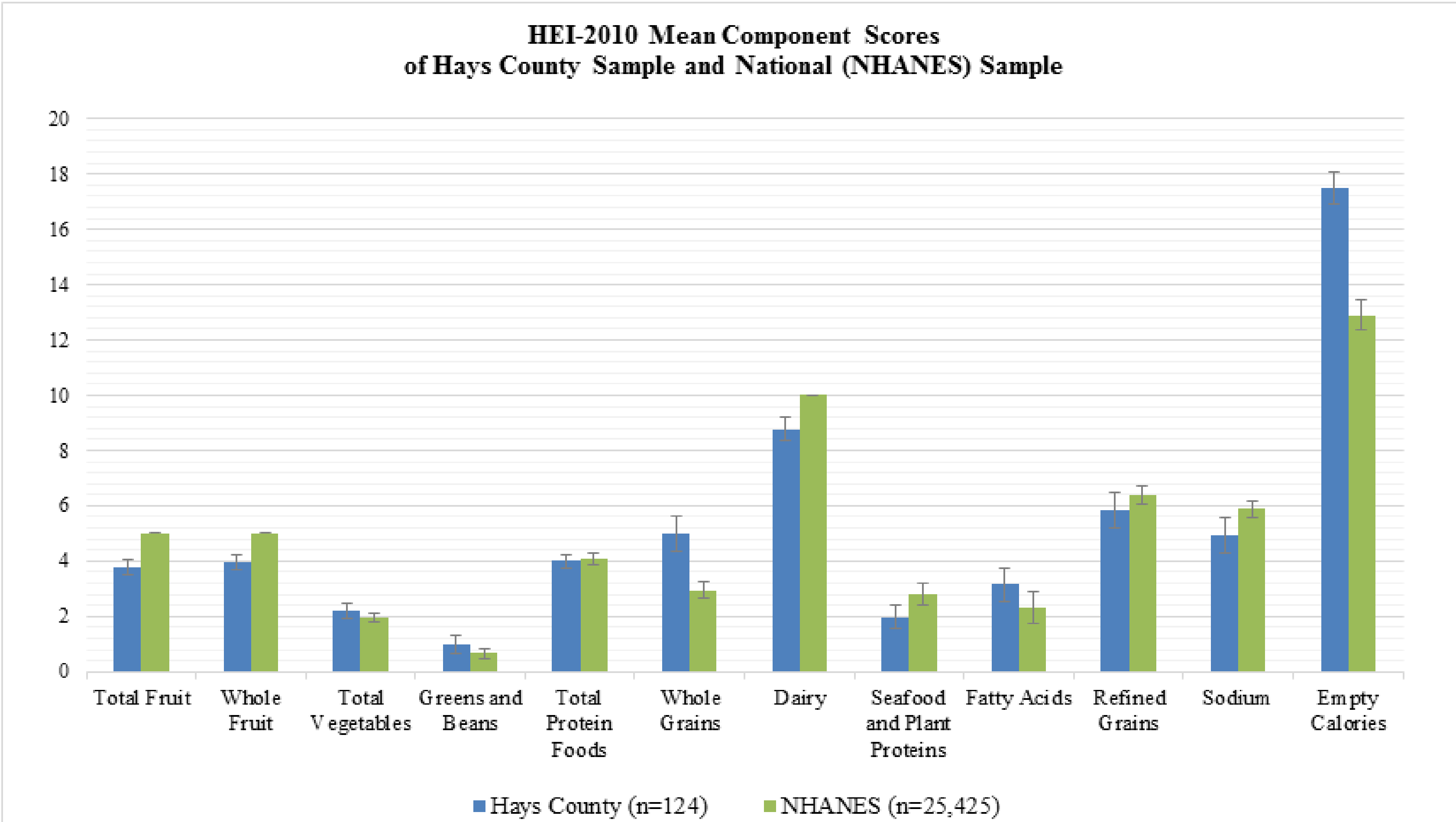

Figure 3. Comparison of mean Healthy Eating Index-2010 scores between local sample of San Marcos preschoolers and national sample of preschoolers (NHANES 2009-2012). Error bars represent 95% confidence intervals for component scores.

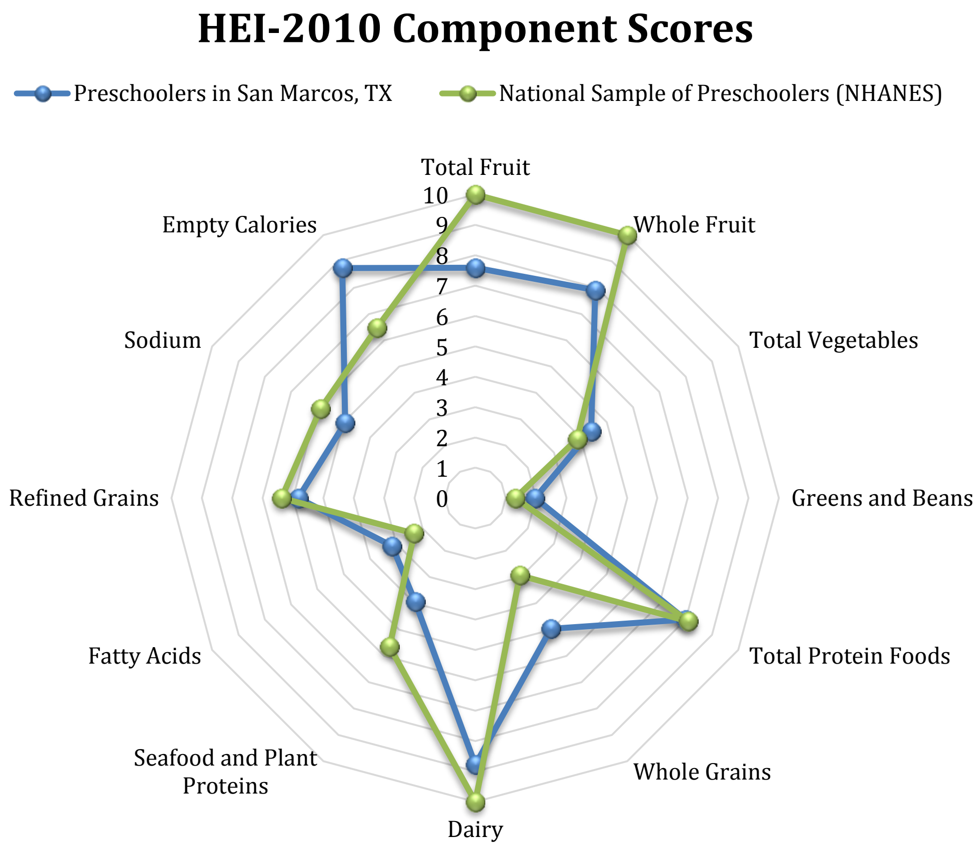

Figure 4. Radar chart visualization of Healthy Eating Index-2010 component scores between local sample of San Marcos preschoolers and national sample of preschoolers (NHANES 2009-2012). Component scores were normalized to fit a 10-point scale. The Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Total Protein Foods, and Seafood and Plant Proteins components were multiplied by 2 and the Empty Calories component was divided by 2. Points on the axes of the graph represent the two samples' mean scores for each component. The overall shape of the plots is an indicator of dietary quality, with larger shapes suggesting better HEI-2010 scores (and, thus, better adherence to the 2010 DGAs).

V. DISCUSSION

This study addressed three research questions: 1) What is the diet quality of preschool-aged children in San Marcos, TX, as measured by the HEI-2010? 2) How are socio-demographic and food environment factors related to the children's diet quality? 3) How does the diet quality of children in San Marcos, TX compare to that of children across the US?

Diet Quality of Children in San Marcos, TX

As we predicted, the mean total HEI-2010 score (62.1) was much lower than the optimal score of 100, all mean component scores were below the standards, and no child met the recommendations for all components. To date, the only other study using the HEI-2010 to assess the diets of preschoolers in this geographic region is the University of Texas *Lunch is in the Bag Trial*. Although the socio-demographic characteristics of those participants differed from those of this San Marcos sample (they were predominantly white, over 80% of parents had at least a bachelor's degree, and mean household income was much higher), that study also found very low component scores for Total Vegetables, Greens and Beans, Whole Grains, Seafood and Plant Proteins, Fatty Acids, and Sodium.[100] Similarly, Erinosho and colleagues found low HEI-2005 component scores for Total Vegetables, Dark Green and Orange Vegetables and Legumes, Total Grains, Whole Grains, Oils, and Saturated Fat among preschool-aged children at child-care centers in North Carolina.[112]

Almost all of the NAR percentages calculated were higher than 100%, indicating that preschoolers in San Marcos, TX are consuming adequate amounts of most micro- and macronutrients, likely because of fortified processed foods. The notable exception is vitamin D consumption. Levels of vitamin D intake among the San Marcos preschoolers sampled were less than half of the RDA for all three HEI-2010 score categories and were significantly lower among children whose diets were classified as “Good” than among children whose diets “Need Improvement.” Similarly, disappointingly low vitamin D intake was found among young children in Hays County in a 2014 study by Thornton and colleagues investigating the effects of WIC package changes on nutrient intake.[158] Sufficient vitamin D is necessary for bone health and the prevention of osteomalacia and rickets.[159] Vitamin D also regulates calcium and phosphorous metabolism and plays important roles in cell growth, immune function, and the reduction of inflammation.[159,160] Vitamin D insufficiency is common among children; a 2009 study by Kumar and colleagues found that roughly 9% of US children and adolescents were vitamin D-deficient and another 61% were vitamin D-insufficient.[161] Although vitamin D can be synthesized endogenously when the skin is exposed to sunlight, and the ultraviolet rays of the sun are relatively strong at the latitude of Hays County, Texas,[162] efforts to protect skin against sun damage and generally low intakes of vitamin D-rich foods may mean many Texans are at risk for vitamin D insufficiency.

We expected this odd trend in vitamin D intake across HEI-2010 score categories to be reflected in the Dairy component scores. However, although the mean Dairy score was lowest among those in the “Good” category compared to the other score categories, this difference was not significant and thus does little to explain the disparity in vitamin D intake. It is likely that children whose diets were categorized as “Poor” or “Needs Improvement” consumed more of the types of vitamin D-fortified foods that would not contribute to higher HEI-2010 scores (such as fortified, refined breakfast cereals) than children whose diets are categorized as “Good.”

Another exception among the generally high NAR percentages calculated was that of dietary fiber. Children in the “Good” score category were the only group that met the DRI for dietary fiber, and they consumed significantly more fiber than children in either of the other two score categories. Numerous studies suggest a need to encourage more dietary fiber consumption among children, as it has been associated with beneficial effects on bowel function, weight management, and reductions in chronic disease risks in both children and adults.[163,164]

Although children in all score categories met the RDA for vitamin B_{12}, mean intakes of the vitamin were much lower in the “Good” HEI-2010 score category than in either of the other two categories. As with vitamin D, this difference is probably a result of higher consumption of the types of foods that would not contribute to higher total HEI-2010 scores by children in the lower score categories. Vitamin B_{12} is found in animal products and fortified foods, so the significantly higher animal protein intake among children in the lower two score categories compared to children in the “Good” category is likely related to the disparity in vitamin B_{12} intake.

Previous research with this sample indicated that the children’s protein intake was particularly high,[152] and as expected, we found that average protein intake was high, falling between 356-421% of the RDA across all HEI-2010 score categories. Surprisingly, while this intake seems excessive, further analysis revealed very little of significance with regard to relationships between total protein intake and diet quality. However, we did find strong trends among types of protein intake. Children in the highest

HEI-2010 score category consumed significantly less animal protein and significantly more plant-based protein than children in either of the other two score categories, and a significant positive relationship existed between consumption of plant-based protein and diet quality. Seafood and Plant Protein component scores of children in the highest HEI-2010 score category were more than double those of children in the middle category and six times higher than those of children in the lowest category, yet even those with “Good” diets did not meet the standard for this component. Consumption of both vegetarian sources of protein and low-mercury seafood are associated with positive health outcomes such as reduced risk of cardiovascular disease, yet intakes of these foods by children are often low relative to land animal sources of protein.[165]

Relationships Between Parent Survey Variables and Children’s Diet Scores

We found several revealing relationships between the children’s HEI-2010 scores and survey variables related to their food environments and parent feeding practices. Significant differences in diet quality as measured by the HEI-2010 were observed among responses to the questions, “I am sure I can plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains” and “I am sure I can find time to prepare healthy meals.” These questions were intended to assess the self-efficacy of parents to plan and prepare healthful meals for their families. As predicted, significantly higher diet quality scores were found among children of parents whose responses indicated they “strongly agreed” with the self-efficacy statements. Of course, this relationship must be interpreted with caution, as the self-efficacy survey construct is not strong. The literature linking parental self-efficacy to dietary quality in children is relatively scarce, but a 2010 study by Campbell and colleagues found that maternal self-efficacy to promote healthy eating had a significant positive association with the vegetable intake of 1-year-old children and with the fruit, vegetable, and water intake of 5-year-old children.[166] Future interventions aimed at removing barriers related to self-efficacy may have important effects on diet quality.

Children whose parents reported participating in WIC had higher HEI-2010 scores than those whose parents did not report WIC participation. In fact, WIC was the only food assistance program associated with higher mean HEI-2010 scores among participants compared to non-participants. This is consistent with national studies on the effects of WIC participation on diet quality, particularly after the 2009 WIC food package changes. Recently, Tester and colleagues found that participation in WIC was significantly associated with higher total HEI-2010 scores, with the largest component increases observed among Greens and Beans, Whole Grains, and Fatty Acids (which are generally among the lowest-scoring components).[145] Before the 2009 package changes, Cole and Fox found that although WIC participation was not associated with significantly higher total HEI-2005 scores, it was associated with lower intakes of solid fats and added sugars.[167]

Participation in SNAP appeared to have an inverse relationship with diet quality, in contrast to participation in WIC. Children in our San Marcos sample whose parents reported participating in SNAP had significantly lower HEI-2010 scores than those whose parents did not report SNAP participation. In general, evidence on the relationships between SNAP participation and diet quality has been mixed. In 2013, Leung and colleagues found that children whose parents participated in SNAP consumed more SSBs, processed meats, and high-fat dairy products and fewer nuts, seeds, and legumes than children of income-eligible non-participants.[168] These (and our) results differ from those of Nguyen and colleagues (discussed previously), who found higher HEI scores among SNAP recipients than income-eligible non-recipients.[117] Unlike other food assistance programs, SNAP benefits are not restricted to a defined list of relatively healthful, nutrient-rich foods. Alarming rates of obesity in the US have increased the need to emphasize healthful dietary patterns, and policy changes to make SNAP benefits more consistent with the DGAs could have positive effects on the diet quality of low-income families.

Although more generalizable research is needed, this study contributes to the body of literature on the home food environment, parent feeding practices, and children's diet quality. A more thorough understanding of the complex factors that affect the diet quality of this and other high risk populations may inform future nutrition interventions and policies.

Comparison of Local HEI-2010 Scores with National Scores

Both local and national mean HEI-2010 scores fell at the lower end of the "Needs Improvement" category. Because eating patterns established in childhood track into adulthood and overweight and obesity are associated with significant short-term and long-term health consequences, these low total HEI-2010 scores observed among preschoolers are troubling.

Children in San Marcos scored significantly better on the Whole Grains and Empty Calories components than children in the national sample, while children in the national sample scored significantly better on the Total Fruit, Whole Fruit, and Dairy components. However, perhaps more interesting than the differences are the similarities between the two groups. Children across the US are all struggling to meet recommendations for Total Vegetables, Greens and Beans, Seafood and Plant Proteins, Fatty Acids, Whole Grains, Refined Grains, and Sodium. The diet quality scores of both the local and national samples would be improved by increasing vegetable intake, particularly dark green vegetables and legumes; replacing refined grains with whole grains; substituting seafood for some other animal sources of protein; and decreasing sodium intake.

Strengths and Limitations

One limitation of this study is its use of convenience sampling, meaning our analysis of San Marcos children's HEI-2010 scores is not generalizable. Also, the inability of the survey tool to measure its intended constructs hindered our ability to analyze general characteristics of the home food environment as predictors of diet quality. Therefore, further research is needed to explore the relationships between the food environments and feeding practices of children and the quality of their diets.

Strengths of this study include its attention to a population whose average income and ethnic makeup place it at increased risk of obesity and malnutrition. Additionally, the use of the multiple pass 24-hour recall method minimizes (to the extent possible) the measurement error inherent in all dietary intake assessment tools, and using parents as proxy reporters has been shown to be an accurate method for collecting intake data in young children.[103,169] Finally, the use of the HEI-2010 to assess diet quality is a major strength of this research effort. The HEI-2010 is valid and reliable, with a score distribution that is wide enough to reveal meaningful differences in diet quality between individuals, and its use with children in this age range is supported by the literature.[104,139]

Summary

Research on the prevention of childhood overweight and obesity is important to inform public health interventions and policies. This study provides insight into the diet quality of preschoolers attending childcare centers in San Marcos, TX and identifies specific components of children's diets that need attention. These results could contribute to future dietary interventions targeted at preschool-aged children, especially those in low-income and minority communities. Of particular interest would be interventions aimed at increasing vitamin D intake and consumption of dark green vegetables, legumes, whole grains, and unsaturated fats among this age group. Also, improving education of parents and other care providers may help them to encourage children's preferences for nutritious foods and ensure children receive more healthful meals. To this aim, future Best Foods FITS research efforts intend to utilize media and technology to educate parents on appropriate feeding practices for young children.

Additional research is needed to explore San Marcos parents' barriers and facilitators to feeding their children higher-quality diets. A deeper understanding of these factors could help to shape other interventions in this at-risk community.

APPENDIX

Studies from which the constructs and overall design of the Best Food FITS parent survey instrument were derived

Survey Constructs Adapted from Existing Studies				
Authors	**Title**	**Tool**	**Constructs Used**	**Sample Questions**
Birch et al, 2001[42]	Confirmatory Factor Analysis of the Child Feeding Questionnaire: A Measure of Parental Attitudes, Beliefs and Practices About Child Feeding and Obesity Proneness	*Children's Eating Behavior Questionnaire (CEBQ)*	Parent perception of self- and child- weight	"What is your child's weight status?"
Campbell et al, 2006[170]	Family Food Environment and Dietary Behaviors Likely to Promote Fatness in 5–6 Year-Old Children	*Food Frequency Questionnaire (FFQ)*	Parent self-efficacy: barriers	"My child eats enough fruits and vegetables to keep him/her healthy."
Musher-Eizenman et al, 2007[171]	Comprehensive Feeding Practices Questionnaire: Validation of a New Measure of Parental Feeding Practices	*Comprehensive Feeding Practices Questionnaire (CFPQ)*	Parent feeding practices: strategies	"How often do you model healthy eating for your child by eating healthy foods yourself?"
			Parent feeding practices: pressure to eat	"When he/she says he/she is finished eating, how often do you try to get your child to eat one more (2 more, etc.) bites?"
			Parent feeding practices: positive involvement in child eating	"How often do you limit or keep track of the high-fat foods that your child eats?"
			Parent feeding practices: use of food to control behavior	"How often do you offer your child his/her favorite foods in exchange for good behavior?"
Nansel et al, 2013[172]	Relationships Among Parent and Youth Healthful Eating Attitudes and Youth Dietary Intake in a Cross-Sectional Study of Youth with Type 1 Diabetes	*Healthful Eating Attitudes Scale*	Parent self-efficacy	"I am sure I can...make healthy meals that my family will enjoy"
			Parent self-efficacy: barriers	"I have very little time to prepare healthy meals"
O'Connor et al, 2010[173]	Parenting Practices are Associated with Fruit and Vegetable Consumption in Pre-school Children	*Caregivers Feeding Style Questionnaire (CFSQ)*	Parent feeding practices: strategies	"[Please mark how often you do the following.] Ask my child to help me prepare meals."
Rich et al, 2005[174]	Perceptions of Health Status and Play Activities in Parents of Overweight Hispanic Toddlers and Preschoolers	Personal Interviews	Parent nutrition knowledge	"Are there short-term risks of child obesity? If yes, list at least 2."

Survey Constructs Adapted from Existing Studies				
Authors	**Title**	**Tool**	**Constructs Used**	**Sample Questions**
Storfer-Isser et al, 2013[175]	Measuring Parent Time Scarcity and Fatigue as Barriers to Meal Planning and Preparation: Quantitative Scale Development	Online Survey	Parent self-efficacy: barriers	"At the end of the day, I (or another family member) have enough energy or time to cook."
				"I (or another family member) usually plan meals for the week."
Tschann et al, 2013[176]	Parental Feeding Practices in Mexican American Families: Initial Test of an Expanded Measure	*Parent Feeding Practices (PFP) Questionnaire*	Parent feeding practices: positive involvement in child eating	"How often do you ask your child what he/she ate during the day?"
			Parent feeding practices: pressure to eat	"How often do you tell your child to eat everything on the plate?"
			Parent feeding practices: restriction of amount of food	"How often do you encourage your child to eat less?"
			Parent feeding practices: use of food to control behavior	"How often do you tell your child if he/she finishes the meal, he/she can have a sweet or soda?"

Parent survey questions arranged by construct[2]

Construct	Items Included
Parent perception of self- and child-weight	• Self-height and weight • Self-weight status (underweight, normal, overweight, obese) • Child height and weight • Child weight status (underweight, normal, overweight, obese)
Home food environment	**Accessibility** • In the last 12 months, were you hungry but didn't eat because there wasn't enough money for food? • In the last 12 months, I/we couldn't afford to eat balanced meals. • **Do you use any of the following resources? (WIC, SNAP, TANF, food bank or food pantry, reduced or free school meals)** • How often does someone in your household go grocery shopping? • Please indicate the foods that are stored at your home that your child can reach. (Ice cream, carrots, bananas, chips, bread, juice, cheese, candy, milk, etc.) **Mealtime structure** • **How often are home-cooked foods served to the members of your household for dinner?** • How often are ready prepared foods served to the members of your household for dinner? • **How often are fast foods served to the members of your household for dinner?** • **How often is sit down restaurant food served to the members of your household for dinner?** • How often do you eat sitting at a dining table? • How often do you eat sitting around a television? • How often do you eat sitting at another location? • How often do family members eat separately at different times?
Parent nutrition knowledge	• Are there short-term risks of child obesity? If yes, list at least 2. • Are there long-term risks of child obesity? If yes, list up to 4. • Do you know what factors can lead to childhood overweight/obesity? Check all that apply. (Eating fruits and vegetables, Eating salty snacks, Watching TV, etc.) • **What is the most amount of time your child should spend watching TV in one day?** • Recommended time child should be active per day • What is the minimum number of fruit servings your child should eat each day? • What is the minimum number of vegetable servings your child should eat each day?

Parent feeding practices	**Strategies**
	• How often do you:
	  o Tell your child that eating fruits and vegetables will make him/her strong and healthy?
	  o Ask your child to help prepare meals?
	  o Tell your child what will happen to him/her if he/she eats too many bad foods?
	  o Praise your child when she/he eats fruits or vegetables?
	  o Mix fruits and vegetables with other foods that your child likes?
	  o Keep junk foods out of the house or out of reach of child?
	  o **Model healthy eating for your child by eating healthy foods yourself?**
	  o **Eat together as a family?**
	Pressure to eat
	• **If your child says, I'm not hungry, how often do you try to get him/her to eat**

[2] The individual parent survey questions used as variables in this analysis are emphasized in bold.

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anyway?

- When he/she says he/she is finished eating, how often do you try to get your child to eat one more (2 more, etc.) bites?
- If your child eats only a small amount, how often do you try to get him/her to eat more?
- How often do you tell your child he/she has to finish eating before he/she can go play or do something else?
- How often do you tell your child to eat everything on the plate?
- How often do you tell your child if he/she doesn't eat, he/she can't watch TV?

Use of food to control behavior

- How often do you:
  - **Offer your child his/her favorite foods in exchange for good behavior?**
  - Offer sweets to your child as a reward for good behavior?
  - Tell your child if he/she finishes the meal, he/she can have a sweet or a soda?

Restriction of amount of food

- **How often do you:**
  - **Encourage your child to eat less?**
  - Tell your child he/she has eaten enough?
  - Let your child decide what or when he/she will eat?
  - Allow your child to have seconds?
  - Limit how much your child can eat of his/her favorite foods?
- If your child asks for a snack how often do you give it to her/him?
- How often does your child get his/her own snack without asking first?

Positive involvement in child eating

- How often do you:
  - Ask your child what he/she ate during the day?
  - Add small servings of new foods to your child's plate?
  - Limit or keep track of the sweets that your child eats?
  - Limit or keep track of the snack food that your child eats?
  - Limit or keep track of the high-fat foods that your child eats?
  - Limit or keep track of the sugary drinks your child drinks?

Plans

- How often your family plans to eat out for dinner.
- **How often your family plans to have vegetables at dinner.**
- How often your family plans to have fruits at dinner.

Knowledge of child intake

- I know what my child eats when at home.
- I know what is served to my child while in childcare/school.
- I know how much my child eats when in childcare/school.

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Parent self-efficacy

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Barriers

- To what extent do you agree or disagree with the following statements?
  - The cost of healthy foods prevents me from buying them.
  - Eating fruits and vegetables will keep my child healthy.
  - My child eats enough fruits and vegetables to keep him/her healthy.
  - At the end of the day, I (or another family member) have enough energy or time to cook.
  - I (or another family member) usually plan meals for the week.
  - Preparing and cooking vegetables would be time consuming.
  - Healthy foods cost too much.
  - We don't like the taste of some healthy foods.
  - We waste (throw away) too much healthy food.
  - Healthy foods are too hard to prepare/ cook.

Self-efficacy

- I am sure I can:
  - Make healthy meals that my family will enjoy.

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	○ **Find time to prepare healthy meals.** ○ Make healthy choices when we eat out. ○ **Plan meals ahead of time to make sure they include foods like vegetables, fruits, beans, and whole grains.** ○ Eat as healthy as I want my family to eat. ○ Make healthier versions of our favorite foods. ○ Limit the amount of junk food at home. ○ Select healthy foods at the grocery store.

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