VARIABILITY IN DIETARY QUALITY OF ELEMENTARY SCHOOL LUNCH MENUS WITH CHANGES IN NATIONAL SCHOOL LUNCH PROGRAM NUTRITION STANDARDS

By

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Abstract:

Objective: There have been numerous changes to the National School Lunch Program (NSLP) nutrition standards over the past 10 years. The Healthy Hunger-Free Kids Act (HHFKA, 2010) presumably improved dietary quality (DQ) of reimbursable school meals from previous standards, while Child Nutrition Program Flexibilities (CNP Flexibilities, 2017) appear to decrease DQ. However, this variability in DQ has not been quantified. Thus, the purpose of this study was to determine differences in nutrient content and DQ between elementary school lunch menus meeting recent NSLP nutrition standards, School Meal Initiatives (SMI, 1995), HHFKA (2012), and CNP Flexibilities (2017), as well as with evidence-based school lunch best practices implemented (BP).
Methods: A base menu, deemed typical by expert opinion, was portioned per three versions of NSLP nutrition standards (SMI, HHFKA, CNP Flexibilities) and BP for elementary schoolchildren, and analyzed for nutrient content and DQ using ESHA Food Processor and The Healthy Eating Index (HEI) 2015. Statistical analyses included one-way ANOVA, Kruskal-Wallis, and Dunnett's test. The level of significance was set at $p<0.0083$.
Results: The BP menu had significantly higher whole fruit (317%) and whole grain (669%) HEI scores than the SMI menu. The BP and HHFKA menus had higher refined grain (156%) and added sugar (2%) HEI scores than the SMI menu. The SMI menu had lower total vegetable (49-50%) and saturated fat (43-51%) HEI scores compared to all other menus. Results were significant ($ps<0.0083$).
Conclusions: This study provides important information for guiding future policy towards further improving NSLP nutrition standards in their mission to provide healthy food to children, combatting malnutrition and obesity. Continuing to improve NSLP policy has the potential to impact the health, academic performance, and future of US children through higher DQ school lunches.
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CHAPTER I

INTRODUCTION

The United States (US) has a growing problem – childhood obesity. In 2016, 18.5% of US children were overweight or obese. This is an increase from the previous year, which was 17.2% (State of Obesity, 2018). These children are more likely to become obese adults and are at a higher risk for developing numerous chronic diseases, such as heart disease and type 2 diabetes, later in life than children with a healthy diet (Biro & Wren, 2010).

Childhood obesity has multiple etiologies, but diet is a major contributor (Centers for Disease Control and Prevention, 2018). The current dietary quality (DQ) score of the diets of US children is 53 out of 100 (United States Department of Agriculture, 2015). According to the United States Department of Agriculture (USDA) Center for Nutrition Policy and Promotion (CNPP), scores that fall below 51 are classified as "poor," between 51-80 "need improvement," and above 80 are "good" (Bowman, Lino, Gerrior, & Basiotis, 1998). Thus, the diets of US children need improvement. Poor diets in childhood may contribute to weight issues and chronic

diseases later in life (Biro & Wren, 2010). Considering that adult and childhood obesity rates have continued to rise for years unimpeded, a big impact solution is needed. With diet being a major contributor to obesity, focusing on nutrition is logical (The State of Obesity, 2018).

The National School Lunch Program (NSLP) provides an opportunity for such a solution. In 2016, 30.4 million US children participated in the NSLP (USDA, 2017b). With 53.9 million US children between the ages of four and 18 during that time (Kids Count Data Center, 2018), this means that the NSLP served over half of the US child population. If a child eats school lunch five days per week, that is 25% of their weekly meals from the school cafeteria. Due to the fact that the NSLP is able to reach a large number of children, and possibly provide a large proportion of their nutrition, school cafeterias are an ideal place to intervene nutritionally.

The NSLP has evolved since its start in 1946. The goal has always been to provide US school children with balanced and nutritious meals (USDA, 2018b). In order to meet this goal, the NSLP has set nutrition standards, which have also evolved over time. Looking at more recent changes to the NSLP nutrition standards, in 1994, the School Meal Initiative (SMI) was established with the goal of meeting one-third of the Dietary Reference Intake (DRI) and complying with the Dietary Guidelines for Americans (DGA) (Institute of Medicine, 2008). The SMI was followed recently in 2010, by the Healthy Hunger-Free Kids Act (HHFKA) that added stipulations that schools provided more whole grains, fruits, vegetables, lean protein, and low-fat dairy, while serving less fat, sugar, and sodium (USDA, 2017a). Most recently in November 2017 and December 2018, the Child Nutrition Program (CNP) Flexibilities allow schools to decrease whole grain provision by half, to include higher levels of sodium, and to serve higher fat flavored

milk options (USDA, 2018a) (USDA, 2018c). This evolution brings to question how changes to NSLP nutrition standards have impacted the DQ of resulting school lunches.

Although, there are multiple etiologies that contribute to childhood overweight and obesity, diet is a major factor that is relatively controllable. Dietary quality of US children is in need of improvement and, when lower, is associated with higher risk of overweight, obesity, and numerous chronic diseases (Dahm et al., 2016) (Marshall, Burrows, & Collins, 2014). Due to the fact that the NSLP serves over half of the US child population and potentially provides a large proportion of their nutrition, school lunches are a great place to intervene, in an attempt to improve child DQ and health status. NSLP nutrition standards are an area in which policy can potentially greatly impact DQ of US child diets. Based on the evolution in the NSLP nutrition standards that has occurred, one begins to wonder how that has impacted DQ of school lunches meeting those standards. Thus, the purpose of this study is to determine the differences in nutrient content and DQ between high school lunch menus meeting the NSLP nutrition standards for the School Meal Initiatives (SMI, 1995), Healthy Hunger-Free Kids Act (HHFKA, 2012), and Child Nutrition Program Flexibilities (CNP Flexibilities, 2017), as well as with evidence-based school lunch best practices implemented (BP).

Research Question

1. What are the differences in nutrient content and DQ between elementary school lunch menus meeting NSLP nutrition standards for the School Meal Initiative (SMI, 1995), Healthy Hunger-Free Kids Act (HHFKA, 2012), and Child Nutrition

Program Flexibilities (CNP Flexibilities (CNP Flexibilities, 2017), as well as with evidence-based school lunch best practices implemented (BP).

Hypotheses:

1. Nutrient content and DQ will be more favorable for the HHFKA as compared to the SMI.
2. Nutrient content and DQ will be more favorable for the HHFKA as compared to the CNP Flexibilities.
3. Nutrient content and DQ will be more favorable for the CNP Flexibilities as compared to the SMI.
4. Nutrient content and DQ will be more favorable for the BP as compared to the SMI, HHFKA, and CNP Flexibilities.

CHAPTER II

LITERATURE REVIEW

What is Dietary Quality?

Dietary quality (DQ) is an assessment to determine how well eating patterns align with a set of dietary guidelines (Wirt & Collins, 2009). For example, the Healthy Eating Index (HEI) is a scoring system that determines how well a person's diet aligns with the Dietary Guidelines for Americans (DGA) (Wirt & Collins, 2009). Measuring DQ is a more true-to-life approach to assess healthfulness of a diet and nutrition provided because it takes into consideration the whole diet as compared to focusing on individual nutrients. It is less practical to look at individual nutrients because people do not, for the most part, consume nutrients individually.

Measuring Dietary Quality

There are many different tools that can be used to measure DQ. These tools evaluate the DQ of food groups, individual nutrients, or both (Wirt & Collins, 2009). The HEI mentioned previously, is one such scoring system of DQ that compares food intake to the DGA. Scores

range from 0 to 100. A higher HEI score indicates higher DQ. Scoring components of the HEI include fruits, vegetables, whole grains, greens and beans, dairy, total protein, refined grains, sodium, added sugars, and saturated fats. The HEI also evaluates diets for balance, variety, adequacy, and moderation, along with food groups (USDA, 2015). Other tools include, the Healthy Diet Indicator, Healthy Food Index, Recommended Food Score, Diet Quality Index, and Diet Quality Score (Wirt & Collins, 2009). The HEI is one of the most commonly used measures of DQ, as it is appropriate for anyone to whom the DGA apply in the US of two years and older. The HEI 2010 is also commonly used, as it is a valid and reliable measure of DQ (Guenther et al., 2014).

Importance of Dietary Quality in Childhood

Dietary quality in childhood is important to focus on as it is associated with overweight, obesity, mortality, and chronic disease risk in childhood and on into adulthood. According to a review study by Marshall, Burrows, and Collins, food choices and the food environment can influence the DQ of a child's diet, which can also influence disease risk (2014). A systematic review study by Wirt and Collins, found that throughout the different measures of DQ, a lower DQ score was related to health conditions, such as higher cholesterol levels, and also showed an increased risk of mortality, cardiovascular disease, and cancer (2014). Finally, according to a secondary analysis of a cross-sectional study by Perry et al., using the DQS to evaluate DQ, normal weight children had a higher DQ score than obese children (2015). With childhood obesity rates increasing, the connection between obesity and chronic disease, and the connection between DQ and obesity and chronic disease, improving DQ of children could result in a decreased risk of overweight, obesity, and chronic disease.

DQ in childhood may have an affect on the overall health of children across their lifespan. Therefore, a higher DQ is important to establish during childhood. A longitudinal study

by Dahm et al. (2015) investigated DQ of women when they were in high school and its association with developing a chronic disease. This study found that higher DQ during adolescence lowered the risk of developing a chronic disease (Dahm et al., 2015). If children develop healthier eating habits during childhood, it benefits their health during adulthood as well (Perry et al., 2015). This shows the connection between child DQ and adult chronic disease risk, and thus the importance of child DQ in childhood and on into adulthood.

There is not only a connection between child DQ and health, but also with academic performance. An intervention study by Belot and James (2011) looked at various educational outcomes with the Feed Me Campaign to improve DQ in schools, in the UK. This study showed a 14% lowered absenteeism rate and higher scoring on school subjects following the Campaign's improved nutrition standards for school meals (Belot & James, 2011).

A child's DQ can also have an effect on their cognitive function. A cross-sectional study by Haapala et al. (2015) used the Baltic Sea Diet (BSD) and the Dietary Approaches to Stop Hypertension (DASH) scores to evaluate children's diets for DQ and to investigate the DQ scores' relationships with cognitive function. This study found that low BSD and DASH scores were associated with worse cognitive function (Haapala et al., 2015). Dietary quality is a factor that contributes to not only potentially chronic diseases, but also academic performance. The DQ of a child's diet might be overlooked, but DQ can affect a child in multiple ways throughout their lifespan.

Dietary Quality of Average US Child's Diet

According to the USDA Center for Nutrition Policy and Promotion (CNPP), the average HEI score for the diet of US children is 53 out of 100 (USDA, 2015). The CNPP indicates that a HEI score over 80 is considered "good," between 51 and 80 is classified as "needs improvement," and less than 51 is considered "poor" (Bowman, Lino, Gerrior, & Basiotis, 1998). Thus, the

average score of a US child's diet is considered to "need improvement" and is close to being considered "poor."

What is the National School Lunch Program?

The National School Lunch Program (NSLP) is a federal meal program that provides balanced school meals to children at a low cost or for free (USDA, 2018b). The NSLP is administered under the USDA's Food and Nutrition Services. Schools receive reimbursement for qualifying meals. To receive reimbursement the schools that participate are required to meet nutrition standards that provide about one-third of the Dietary Reference Intake (DRI) for certain macronutrients, and vitamins and that comply with the DGA (Feeding America, 2018).

The NSLP as Ideal for Dietary Quality Intervention

In the year 2016, the NSLP served 30.4 million children (USDA, 2017b). With 53.7 million US children between the ages of four and 18, during that time (Kids Count Data Center, 2018), this means that the NSLP served 57% of the US child population. Children that consume a school lunch five days per week are receiving 25% of their weekly meals from the school cafeteria. Because the NSLP serves over half of the US child population and possibly a large proportion of the weekly nutrition, school cafeterias are an opportunistic place to intervene to improve child DQ for a large-scale impact.

NSLP Nutrition Standards and Their Evolution

The School Meal Initiative for Healthy Children (SMI) was implemented in the 1999 school year. The purpose of the SMI was to increase the nutrition content of school meals. When this was first introduced, schools were allowed to choose from one of four menu-planning options (USDA, 2000), which included nutrient or food based. More specifically, the options were Nutrient Standard Menu Planning (NSMP), Assisted Nutrient Standard Menu Planning

(ANSMP), Enhanced Food-Based Menu Planning, and Traditional Food-Based Menu Planning. The schools were able to pick from one of these options in order to meet the nutritional standards that are set by the NSLP, based on the Dietary Guidelines for Americans (USDA, 2000).

Following the SMI, the Healthy Hunger-Free Kids Act (HHFKA) was passed in 2010 and went into effect in 2012 (USDA, 2017a). The new school meal standards established by the HHFKA were modeled from expert recommendations to provide children even more nutritious school meals through increasing whole grains, fruits, vegetables, lean protein, and low-fat dairy, while serving less fat, sugar, and sodium (USDA, 2017a). In addition to combatting hunger, a new goal from the HHFKA was to also reduce childhood obesity rates (USDA, 2017a).

The Child Nutrition Program (CNP) Flexibilities are the most recent changes to the NSLP nutrition standard, which were introduced in November 2017 with the Interim Final Rule, that went into effect July 2018 and then with the Final Rule in December 2018 that will go into effect fall 2019 (USDA, 2018a). Under the CNP Flexibilities, schools are allowed "flexibilities" for meals through the types of foods provided to children. The areas that are provided flexibility include milk, whole grains, and sodium. The milk choices that can now be offered include non-fat or low-fat flavored milk instead of only non-fat flavored milk (USDA 2018a) (USDA, 2018c). Regarding grains, the Interim Final Rule and Final Rule differ slightly. For the Interim Final Rule, schools may apply for an exemption from using whole grain rich-grains, and then switch to refined grains instead for grain items that are difficult for them to obtain in whole grain-rich form (USDA 2018a). Under the Final Rule, schools are allowed to serve half of grains as whole grain-rich products (USDA, 2018c). This means that schools will be required to serve lunches that contain 50% less whole grain-rich products than required by the HHFKA. Thus, further lowering DQ of school lunches. For this study, the Final Rule will be the focus of investigation, as it will supersede the Interim Final Rule and to eliminate confusion. For sodium, the level will remain at Target 1 and will not be advanced further and lowered to Targets 2 or 3. To illustrate this sodium

flexibility, 12th graders were supposed to receive less than 740 milligrams by Target 3 however, the limit is 1,420 milligrams for Target 1 and will now remain there (USDA, 2018a) (USDA, 2018c).

Evidence-based school lunch best practices (BP) were created to optimize the DQ of school lunches. These BP are meant to be applied in addition to the NSLP nutrition standards and extend the DQ of school meals beyond that of meeting baseline/minimum standards. For example, the BP encourage the inclusion of low-fat, unflavored dairy, and of increased fruit, non-starchy vegetables, nuts, seeds, whole grains, lean meat/poultry, eggs, and fish, while minimizing red, processed meat, total fat, saturated fat, sodium, refined grains, and pre-fried and fried foods. Increasing and decreasing these specific areas will help improve the DQ score of school lunch menus even further than meeting minimum NSLP standards. BP also include different strategies for implementing higher DQ meals, which encourage healthy food selection and consumption (Joyce, Logan, Cull, Rosenkranz, & Rosenkranz, 2018).

Summary

Dietary quality is a true-to-life assessment of how well eating patterns align with a set of dietary guidelines (Wirt & Collins, 2009). The HEI scoring system helps to evauate how well these two factors align (Bowman, Lino, Gerrior, & Basiotis, 1998). With an average HEI score of 53/100 for the diet of US children, it can be determined that the diets of this population "need improvement" (Bowman, Lino, Gerrior, & Basiotis, 1998). DQ is important to focus on during childhood, as it is related to childhood overweight and obesity and may contribute to the risk chronic health diseases later in life (Wirt & Collins, 2014). Furthermore, DQ also affects a child's academic performance (Belot & James, 2011). Being as child DQ is associated with many aspects of health and academic performance, it is an opportune target for further investigation and intervention.

The NSLP serves over half of the US child population, with low-cost or free meals, making school cafeterias opportunistic environments to help improve DQ of the US child's diet. The NSLP nutrition standards, which schools must meet to receive reimbursement for the meals they serve, have evolved over time (i.e., SMI, HHKFA, and CNP Flexibilities) with significant changes. It is unknown how these changes have impacted the DQ of meals being served in schools. This leads to the purpose of this study, which is to examine how the evolution of the NSLP standards has affected the DQ and nutrient content of school lunch menus.

CHAPTER III

METHODS

Study Design and Sampling Method

This study will use a cross-sectional content analysis to determine differences among four experimental menus created with the application of the four different NSLP nutrition standards presented earlier – SMI, HHFKA, CNP Flexibilities, and Best Practices. A base menu was collected using a convenience sample, to which to apply the four different standards, in order to create four different experimental menus. The base menu was retrieved by conducting a search of local Oklahoma schools' menus for a menu that was deemed typical, based on expert opinion of the faculty advisor for this project. This menu will be the base menu to which all NSLP standards are applied to create experimental menus.

The sample size will be 30 days (6 weeks) of each experimental menu type based on a similar study by Joyce, Rosenkranz, & Rosenkranz (2018). Power calculations were conducted to ensure that this sample size provides adequate power to detect significant differences between

the experimental menus (http://powerandsamplesize.com/Calculators/Compare-2-Means/2-Sample-Equality). Power was set at 0.80, and the level of significance was at 0.05, for a two-tailed, two-sample t-test. Power analysis suggested the need for a sample size of two. A sample size of 30 days was chosen to exceed that suggestion and cover all possible and likely full cycle menu lengths.

NSLP Nutrition Standards

To create the four experimental menus, the four selected NSLP nutrition standards will be applied to the base menu. The different NSLP nutrition standards were introduced in the literature review. A summary of the different nutrition standards can be found in Table 1. A comparison of the four different NSLP standards, showing the evolution across the past three standard systems, can be found in Table 2. These two tables will provide a guide for how the experimental menus will be created and differ.

Table 1. NSLP Nutrition Standards and Best Practices Used to Create the Four Experimental Menus

Component	SMI Traditional (Grades K–3)[F,N]	HHFKA (Grades K–5)	CNP Flexibilities (Grades K–5)	Best Practices (Grades K–5)*
Fruit	½ c combined per day[F] • No subgroup specifications for vegetables	½ c per day (2½ c per week)	No change	-Increase provision -Options with less added sugar
Vegetables		¾ c per day (3¾ c per week) • Dark green ½ c • Red/orange ¾ c • Beans/peas ½ c (legumes) • Starchy ½ c • Other ½ c	No change	-Increase provision -Choose options with less added sodium -Do not add salt -No pre-fried -Limit added fat and only use fats high

				in MUFA and PUFA
Meat/Meat Alternative (M/MA)	1½ oz eq. min. per day[F]	1 oz. eq. min. per day (8-10oz. weekly)	No change	-Limit use of processed meats -No pre-fried -Do not add salt -Use leaner animal proteins (poultry, fish, eggs, low fat dairy) -Limit red meats -Increase use of plant based proteins -Limit added fat and only use fats high in MUFA and PUFA
Grains	1 serving per day[F] (8 per week min.) • Whole grains encouraged	1 oz. eq. min. per day (8-9oz. weekly) • All grains must be whole grain rich	1 oz. eq. min. per day (8-9oz. weekly) • Half of grains must be whole grain rich	-Use 100% whole grains -Limit refined grains -Use low sodium chips/crackers -Limit added fat and only use fats high in MUFA and PUFA -No pre-fried -Do not include grain based desserts
Milk	1 c[F] (variety of fat contents allowed; flavor not restricted)	1 c (fat-free or 1% low fat plain, fat-free flavored)	1 cup fat free or low-fat plain or flavored	Use only unflavored low fat or fat free dairy
Calories	633[N]	550-650	No change	No standard provided
Sodium	No standard provided	Target 1: ≤1230 mg Target 2: ≤935 mg Final Target: ≤640 mg	-Stopped at Target 1: ≤1230mg -No further	Decrease

			reductions	
Total Fat	21 g_N	No standard provided	No change	Decrease
Saturated Fat	7 g_N	<10 % of calories	No change	Decrease
Trans Fat	No standard provided	No trans fat permitted	No change	No standard provided
Vitamin A	200 RE_N	No standard provided	No change	No standard provided
Vitamin C	15 mg_N	No standard provided	No change	No standard provided
Iron	3.3 mg_N	No standard provided	No change	No standard provided
Calcium	267 mg_N	No standard provided	No change	No standard provided

$_F$ Food Based Menu Planning Approach for SMI

$_N$ Nutrient Based Menu Planning Approach for SMI

* In addition to HHFKA Standards

Table 2. Changes in NSLP Nutrition Standards Across Versions

	SMI	**HHFKA (*Reference)**	**CNP Flexibilities**	**Best Practice**
Date	1995	**2012**	2017	Established 2019
Fruits	-3¾ c less per week -Does not have to offer fruit and vegetables separately -No vegetable subgroups	**½ c per day (2½ c per week)**	Remains the same	-Increase provision -Options with less added sugar
Vegetables		**¾ c per day (3¾ c per week)** • **Dark green ½ c** • **Red/orange ¾ c** • **Beans/peas ½ c (legumes)** • **Starchy ½ c** • **Other ½ c**	Remains the same	-Increase provision -Choose options with less added sodium -Do not add salt -No pre-fried -Limit added fat and only use fats high in MUFA and PUFA
Meat/Meat Alternative	-½ oz less minimum per week -Added weekly maximum	**1 oz. eq. min. per day (8-10oz. weekly)**	Remains the same	-Limit use of processed meats -No pre-fried -Do not add salt -Use leaner animal proteins (poultry, fish, eggs, low fat

				dairy) -Limit red meats -Increase use of plant based proteins -Limit added fat and only use fats high in MUFA and PUFA
Grains	-Remained the same -Added weekly maximum -Only encouraged whole grains	**1 oz. eq. min. per day (8-9oz. weekly)** • **All grains must be whole grain rich**	Decrease whole grain provision by half	-Use 100% whole grains -Limit refined grains -Use low sodium chips/crackers -Limit added fat and only use fats high in MUFA and PUFA -No pre-fried -Do not include grain based desserts
Milk	-No change in amount -Flavor and fat not restricted	**1 c (fat-free or 1% low fat plain, fat-free flavored)**	Allowed low fat and flavored	Use only unflavored low fat or fat free dairy
Calories	-No range -Within the HHFKA range	**550-650**	Remains the same	No standard provided
Sodium	No standard	**Target 1: ≤1230 mg** **Target 2: ≤935 mg** **Final Target: ≤640 mg**	Increased by 590mg	Decrease
Total Fat	Provided standard that was eliminated	**No standard provided**	Remains the same	Decrease
Saturated Fat	-9g = 9.8% of calories -Below the HHFKA limit	**<10 % of calories**	Remains the same	Decrease
Trans Fat	No standard	**No standard provided**	Remains the same	No standard provided
Vitamin A	Standard covered in HHFKA	**No standard provided**	Remains the same	No standard provided

	vegetable variety			
Vitamin C	Standard covered in HHFKA vegetable variety	**No standard provided**	Remains the same	No standard provided
Iron	Standard met by food group requirements for all NSLP versions	**No standard provided**	Remains the same	No standard provided
Calcium	Standard met by food group requirements for all NSLP versions	**No standard provided**	Remains the same	No standard provided

*HHFKA was used as the reference for qualitative comparison of standard specifications.

Dietary Quality

Once the NSLP standards have been applied to the experimental menus, the portioned experimental menus will be entered into ESHA Food Processor Nutrient Analysis Software (Version 10.11.0, 2017, Salem, OR) to determine nutrient content. Then, DQ will be determined using the HEI 2015 by the USDA Center for Nutrition Policy and Promotion (USDA CNPP) (USDA, 2015). The HEI scoring method is commonly used, appropriate for this population, and considered a valid and reliable measure of DQ based on 2005 and 2010 versions (Guenther et al., 2014).

Statistical Analysis

Descriptive statistics will be used including mean, standard deviation, and 95% confidence intervals. To determine the differences in nutrient content and DQ between the four different NSLP standards, a one-way ANOVA will be used, with Bonferroni correction for multiple comparisons. Assumptions will be checked using a Kolmogorov-Smirnov test for normality and a Brown-Forsythe test for equality of variance.

CHAPTER IV & V

MANUSCRIPT

Abstract

National School Lunch Program (NSLP) standards recently changed significantly. Healthy Hunger-Free Kids Act (HHFKA) presumably improved dietary quality (DQ) of meals, while Child Nutrition Program (CNP) Flexibilities appear to decrease DQ. This variability has not been quantified. Objective: To determine differences in DQ between elementary school lunch menus meeting NSLP standards – School Meal Initiative (SMI), HHFKA, CNP Flexibilities, evidence-based best practices (BP). A base menu was portioned per NSLP standards and analyzed for nutrient content and DQ. Statistical analyses included one-way ANOVA, Kruskal-Wallis, and Dunnett's test. BP menu had higher whole fruit and whole grain Healthy Eating Index scores than SMI. BP and HHFKA menus had higher refined grain and added sugar scores than SMI. SMI menu had lower total vegetable and saturated fat scores than all menus. Results were significant ($ps<0.0083$). This study informs policy towards improving standards, positively impacting child health and academic performance through higher DQ lunches.

Key Words:

National School Lunch Program

Nutrition policy

Dietary quality

Child nutrition

Adolescent nutrition

Healthy, Hunger-Free Kids Act

Child Nutrition Program

Child Nutrition Program Flexibilities

Introduction

The National School Lunch Program (NSLP) was established in 1946 with the goal of providing United States (US) school children with balanced and nutritious meals in order to combat malnutrition. The goal has since been modified to also include combatting obesity.[1] In 2016, 30.4 million US children participated in the NSLP, over half of the US child population.[2,3] The NSLP has evolved since its start in 1946, with some of the most recent nutrition standards including the School Meal Initiative (SMI, 1995; 7 CFR Part 210, 7 CFR Part 220), the Healthy Hunger-Free Kids Act (HHKFA, 2012; 7 CFR Part 210), and the Child Nutrition Program Flexibilities (CNP Flexibilities, 2017; 7 CFR Part 210, 7 CFR Part 215, 7 CFR Part 220, 7 CFR Part 226).

The introduction of the HHFKA, in 2012, resulted in substantial changes to the SMI and other previous NSLP standards. These changes required schools to provide more whole grains, fruits, vegetables, lean protein, and low-fat dairy, while serving less fat, sugar, and sodium.[4] These changes appear to improve the healthfulness of school meals. With the HHFKA in place, the DQ score, using the Healthy Eating Index (HEI) 2010, of a school lunch was reported to be between a 77 and 82 out of 100, which was a 41% increase from previous standards.[5,6] Considering over half of US children participate in the NSLP and that the average US child's diet has a HEI score of 53 out of 100, which needs improvement according to the USDA Center for Nutrition Policy and Promotion (CNPP),[7] the 41% increase in DQ of school lunches could be greatly benefitting a large proportion of US children.

The Child Nutrition Program Flexibilities, introduced in 2017, are the most recent changes to the NSLP nutrition standards. These flexibilities allow schools to decrease whole grain provision, to provide higher sodium content, and to serve low-fat flavored milk options rather than fat free, as outlined in the HHFKA.[8,9] Research shows that increased dietary sodium intake among children, is not necessary, and leads to major health consequences.[10-13] These changes could affect three major HEI scoring components

through the offering of less whole grains, more saturated fat, and more sodium, lowering the overall DQ of school lunches.

Considering the average US child's DQ score is poor, further improvements in school meal DQ would greatly benefit children's overall DQ.[7] Additionally, improving DQ is important to focus on during childhood, as a higher DQ has been associated with healthier weight status, lower risk of chronic disease, and improved academic performance.[14-17] Recent changes to the nutrition standards via flexibilities appears to reverse some of the HHFKA increase in school lunch DQ; however, this reversal is yet to be verified. Thus, the purpose of this study was to determine the differences in nutrient content and DQ of elementary school lunch menus meeting NSLP nutrition standards including the SMI, HHFKA, and CNP Flexibilities, as well as with evidence-based school lunch best practices (BP) implemented.

Methods

Study Design and Sampling Method

This study used a cross-sectional content analysis to determine differences among four experimental menus created with the application of the three different NSLP nutrition standards and best practices presented earlier – SMI, HHFKA, CNP Flexibilities, and BP. To establish a base menu, researchers conducted a search in September, October, and November of 2018 of school lunch menus in a southwestern state for one deemed typical, based on expert opinion of one of the authors (JJ). Researchers applied each of the three NSLP standards to the same base menu to create three of the four experimental menus. The fourth menu was created by applying BP, which were based on Dietary Guidelines for Americans (DGA) Healthy Meal Pattern Recommendations,[18] Child and Adult Care Food Program Best Practices,[19] and an unpublished review conducted by researchers affiliated with this study.

The sample size included 30 school days (six weeks) for each experimental menu type based on a similar study by Joyce, Rosenkranz, and Rosenkranz.[6] Power calculations were conducted to ensure that this sample size provided adequate power to detect significant differences between the experimental menus (Power and Sample Size Calculator, HyLown Consulting LLC, Atlanta, GA, Version 2018). Power was set at 0.80, and the level of significance was at 0.05, for a two-tailed, two-sample *t*-test. Power analysis, based on the Joyce, Rosenkranz, and Rosenkranz study,[5] suggested the need for a sample size of two days. A sample size of 30 days was chosen to exceed that suggestion and cover most full cycle menu lengths.

NSLP Nutrition Standards

To create the four experimental menus, the three selected NSLP nutrition standards and BP were applied to the base menu. Table 1 provides a summary of the different nutrition standards. Table 2 compares the four different NSLP standards, which shows the evolution across the past three standard systems. The information provided a guide to the researchers in creating the experimental menus and demonstrated how the menus differ.

Dietary Quality

Once the standards were applied to the experimental menus, the portioned experimental menus were entered into ESHA Food Processor Nutrient Analysis Software (Version 10.11.0, 2017, Salem, OR) to determine nutrient content. Dietary quality was then determined using the HEI 2015 (USDA Center for Nutrition Policy and Promotion).[7] The HEI scoring method is commonly used to assess DQ in the US, appropriate for this population, and considered a valid and reliable measure of DQ based on 2005 and 2010 versions.[20] The total score ranges from 0 to 100 points. A higher HEI score indicates higher DQ. Scoring subcomponents of the HEI include fruits, vegetables, whole grains, greens and beans, dairy, total protein, refined grains, sodium, added sugars, and saturated fats. Scores for subcomponents range from 5

to 10 points. The HEI also evaluates diets for balance, variety, adequacy, and moderation, along with food groups.[7]

Statistical Analysis

Descriptive statistics used included mean and standard deviation. A one-way ANOVA was used to determine if differences existed in nutrient content and DQ between the four different experimental menus. Dunnett's test was performed for pairwise comparisons. With correction for multiple comparisons, the level of significance was set at $p<0.0083$. Assumptions were checked using a Kolmogorov-Smirnov test for normality and Brown-Forsythe and Levene's tests for equality of variance. Variables found to be non-normal were transformed using log and inverse transformations. If variables continued to be non-normal, a Kruskal-Wallis test was performed to determine significant differences between experimental menus.

Results

Content of Nutrients Required for Monitoring by the NSLP

Table 3 shows descriptive statistics for and significant differences in nutrients required for monitoring by the NSLP. Menus significantly differed in calories (eta squared = 0.121), saturated fat (eta squared = 0.271), trans fat (eta squared = 0.186), and sodium (eta squared = 0.145) content. The BP menu was 16% lower in calories than the HHFKA menu (mean difference = 99 calories, $p<0.0083$) and 15% lower than the CNP Flexibilities menu (mean difference = 96 calories, $p<0.0083$). For saturated fat, the SMI menu was 40% and 46% higher than the HHFKA and BP menus (respectively, mean differences = 2.5g and 4.0g, ps<0.0083). The BP menu was 46% lower in saturated fat than the SMI menu (mean difference = 4.0g, $p<0.0083$) and 35% lower than CNP Flexibilities menu (mean difference = 2.2g, $p<0.0083$). For

trans fat, the BP menu was 75% lower than SMI menu and 67% lower than HHFKA and CNP Flexibilities menus (mean differences = 0.3g, 0.2g, and 0.2g, respectively, *p*s<0.0083). In relation to sodium, the BP menu was 34% lower when compared to the HHFKA menu (mean difference = 385mg, *p*<0.0083) and 32% lower when compared to the CNP Flexibilities menu (mean difference = 353mg, *p*<0.0083).

Content of Other Macro- and Micronutrients of Concern

Table 3 also shows descriptive statistics for and significant differences in additional nutrients monitored indirectly by the NSLP. Menus significantly differed in protein (eta squared = 0.156), total fiber (eta squared = 0.217), sugar (eta squared = 0.327), total fat (eta squared = 0.247), monounsaturated fatty acids (MUFA, eta squared = 0.163), and potassium (eta squared = 0.226). Protein content in the BP menu was 15% higher than the SMI menu (mean difference = 4.5g, *p*<0.0083). For fiber, the SMI menu was 35% lower when compared to the HHFKA menu (mean difference = 2.8g, *p*<0.0083) and 46% lower than the BP menu (mean difference = 4.4g, *p*<0.0083). For sugar content, the SMI menu was 29% lower than the HHFKA menu (mean difference = 11.6g, *p*<0.0083) and 27% lower than CNP Flexibilities menu (mean difference = 10.4g, *p*<0.0083). The BP menu was 31% lower in sugar than HHKFA menu (mean difference = 12.4g, *p*<0.0083) and 29% lower than the CNP Flexibilities menu (mean difference = 11.2g, *p*<0.0083). The total fat content for the BP menu was 46% lower than the SMI menu (mean difference = 10.0g, p<0.0083), 35% lower than the HHFKA menu (mean difference = 6.4g, *p*<0.0083), and 41% lower than the CNP Flexibilities menu (mean difference = 8.1g, *p*<0.0083). Monounsaturated fatty acid (MUFA) content for the BP menu was 45% lower than the SMI menu (mean difference = 2.7g, *p*<0.0083) and 41% lower than the CNP Flexibilities menu (mean difference = 2.3g, *p*<0.0083). For potassium, the SMI menu was 24% lower than the HHFKA menu (mean difference = 286.4mg, *p*<0.0083), 22% lower than the CNP Flexibilities menu (mean difference = 249.4mg, *p*<0.0083), and 21% lower than the BP menu (mean difference = 236.4mg, *p*<0.0083).

Dietary Quality

Table 4 and Figure 1 show the comparison of DQ, as HEI 2015 scores and HEI subcomponents, between the experimental menus. Menus significantly differed in total HEI score (eta squared = 0.582) and subcomponent scores including total fruit (eta squared = 0.121), whole fruit (eta squared = 0.332), total vegetable (eta squared = 0.344), whole grains (eta squared = 0.456), refined grains (eta squared = 0.535), added sugar (eta squared = 0.071), and saturated fat (eta squared = 0.243). The total HEI score for the SMI menu was 30% lower than the HHFKA menu (mean difference = 20.5, $p<0.0083$), 22% lower than the CNP Flexibilities menu (mean difference = 13.9, $p<0.0083$), and 39% lower than the BP menu (mean difference = 31.0, $p<0.0083$). For subcomponent scores, the total fruit score of the BP menu was 6% higher than the HHFKA menu (mean difference = 0.3, $p<0.0083$). Whole fruit in the BP menu was 317% higher than the SMI menu (mean difference = 3.8, $p<0.0083$), 150% higher than the HHFKA menu (mean difference = 3.0, $p<0.0083$), and 66% higher than the CNP Flexibilities menu (mean difference = 2.0, $p<0.0083$). For total vegetable, the SMI menu was 50% lower than the HHFKA menu (mean difference = 2.5, $p<0.0083$), 49% lower than the CNP Flexibilities menu (mean difference = 2.4, $p<0.0083$), and 50% lower than the BP menu (mean difference =2.5, $p<0.0083$). The whole grains score for the BP menu was 669% higher compared to the SMI menu (mean difference = 8.7, $p<0.0083$), 108% higher than the HHFKA menu (mean difference = 5.2, $p<0.0083$), and 335% higher than the CNP Flexibilities menu (mean difference = 7.7, $p<0.0083$). For the refined grains score, the BP menu was 56% higher than the CNP Flexibilities menu (mean difference = 3.6, $p<0.0083$) and 156% higher than the SMI menu (mean difference = 6.1, $p<0.0083$), while no difference existed between the BP and HHKFA menus. For the added sugar subcomponent score, the BP menu was 2% higher than the CNP Flexibilities menu and the SMI menu (mean differences = 0.2, ps<0.0083), while no difference existed between the BP and HHKFA menus. The HHKFA menu was also 2% higher for the added sugars score compared to the SMI menu and the CNP Flexibilities menu (mean differences = 0.2, ps<0.0083). For the final HEI subcomponent score of saturated fat, the SMI menu was 49% lower than the HHFKA menu (mean difference = 3.8, $p<0.0083$),

43% lower than the CNP Flexibilities menu (mean difference = 3.0, $p<0.0083$), and 51% lower in the BP menu (mean difference = 4.2, $p<0.0083$).

Discussion

The purpose of this cross-sectional content analysis was to investigate the differences in DQ of school lunch menus that meet the various recent NSLP nutrition standards. Applying best practices and HHFKA nutrition standards both resulted in higher HEI subcomponent scores for refined grains and added sugars than the SMI. The SMI menu had the lowest HEI score for total vegetable and saturated fats compared to the HHFKA, CNP Flexibilities, and BP menus. Thus, policy changes over time have significantly affected DQ of school lunches, related to refined grain, added sugars, total vegetable, and saturated fat HEI subcomponents.

High DQ, as evidenced by a high HEI score, is important in childhood. The HEI assesses DQ by determining how well a person's diet aligns with the DGA.[19,20] Measuring DQ is a more true-to-life approach to assess healthfulness of a diet and nutrition provided because it takes into consideration the whole diet, as compared to focusing on individual nutrients. It is less practical to look at individual nutrients because people do not, for the most part, consume nutrients individually. The HEI is one of the most commonly used measures of DQ, as it is appropriate for anyone to whom the DGA apply in the US of two years and older.[19] Dietary quality is important to assess during childhood, as a lower HEI score, and thus lower DQ, is associated with higher risk of overweight, obesity, mortality, and chronic disease in childhood and on into adulthood.[16,17,21] A higher HEI score is also associated with improved academic performance.[15] Federal Child Nutrition Programs (CNP), including the NSLP if used by children, could be contributing significantly to their daily nutrition and HEI score. Thus, knowing how the changes in NSLP policy affect school lunch DQ is of great importance.

This is the first study to our knowledge to investigate the impact on school lunch DQ of multiple recent changes in NSLP nutrition policy. According to a study by the USDA Food and Nutrition Services (FNS), HEI scores of school lunches increased significantly between school years 2009 to 2010 and again between 2014 to 2015. The HEI score for NSLP-qualifying school lunches increased from 57.9 to 81.5 out of 100.[6] The current study, adds to the idea that NSLP policy changes moved in a positive direction with implementation of the HHFKA. Another study by Joyce and colleagues (2018) examined differences between a typical school lunch menu, meeting baseline HHFKA NSLP nutrition standards, and a best practice school lunch menu, optimizing nutrition. This study found that applying best practices to a school lunch menu could significantly further improve the HEI score of NSLP-qualifying school lunches.[5] The current study results are consistent with and add to those of the Joyce et al. study[5] in that the HHFKA policy changes improved DQ of school lunches, but there is additional room for further improvement.

Strengths

Strengths of this study include that the NSLP nutrition standards were only applied to one base menu, as opposed to four different base menus. This single base menu ensures that differences in DQ are not due to different menus and the differences inherently in those menus. All experimental menus were created for the same season to eliminate seasonal variations. For example, best practices encourage fresh fruit and vegetable consumption, which could include seasonal items to lower cost and improve food quality. Furthermore, the base menu used for this study was a true-to-life menu, not research created, which helps eliminate bias and improve practicality. Additionally, DQ was determined using the HEI 2015, which has been shown to be valid and reliable.[20] Another strength was that researchers were transparent and used the same portioning and nutrient analysis assumptions for each menu, favoring higher DQ for all menus. Furthermore, only two researchers entered experimental menus for analysis, and one additional researcher reviewed all analyses to help ensure consistency and reduce intra-rater variability. Lastly, power calculations ensured the sample size was adequate to detect significant differences.

Limitations

A limitation of this study includes the cross-sectional design, which is considered a weaker observational study design, however this design best met the purpose of this study. Another limitation includes possible misinterpretation of the NSLP nutrition policy standards. However, the interpretation by researchers was made transparently and consistently throughout the methodology. A limitation within the nutrient analysis of experimental menus include the use of ESHA Food Processor, which does not have Child Nutrition Program (CNP) labeled and approved versions of food items. However, where possible, USDA standard references were used to represent food items on the menu and were consistently used across all experimental menus to represent the same food items. Additionally, consistent food codes were used for similar food items, and all researchers applied consistent assumptions. Furthermore, this study used a theoretical design and theoretical menus, which were not perfectly true-to-life. However, the use of four different actual menus would have resulted in the comparison of different base menus, and thus differences seen between standards may have been due to the base menus and not the standards themselves.

Importance of Findings

The results of the current study can be used to inform NSLP policy. In 2012, the HHFKA led to significant and larger improvements in DQ of school lunches from the SMI, especially in regards to total fruit and vegetable. More recently, in 2017, the CNP Flexibilities did not significantly decrease DQ, but do appear to be trending towards decreased DQ from that of the HHFKA, as the flexibilities resulted in fewer improvements over previous versions than the HHFKA. Despite HHFKA improvements, further significant improvement in DQ of NSLP-qualifying school lunches could be made, as evidenced by the BP menu having the highest DQ. Thus, future NSLP policy should seek to continue to improve nutrition standards and resulting DQ of school lunches.

Conclusions

The results of the current study showed that great improvements were made in DQ of school lunches from HHFKA changes in NSLP policy, but there are possibly more meaningful improvements yet to be made. This study provides important information for guiding future policy towards further improving NSLP nutrition standards in their mission to provide healthy food to children, combatting malnutrition and obesity. Continuing to improve NSLP policy has the potential to impact the health, academic performance, and future of US children through higher DQ school lunches.

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KP, DH, LA, and JJ designed the study. KP, KS, and JJ conducted the research study. KP, KS, and JJ analyzed data and performed statistical analysis. KP and JJ wrote the paper. KP, KS, DH, LA, and JJ were responsible for the final content of the manuscript. All authors have read and approve the final manuscript.

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Tables

Table 1. NSLP Nutrition Standards and Best Practices Used to Create the Four Experimental Menus

Component	SMI Traditional (Grades K–6, 4–12)F,N	HHFKA (Grades K–5)	CNP Flexibilities (Grades K–5)	Best Practices (Grades K–5)*
Fruit	½ cup combined per dayF, no subgroup specifications for vegetables	½ cup per day (2½ cup per week)	No change	Increase provision, options with less added sugar
Vegetables		¾ cup per day (3¾ cup per week); must have the following varieties throughout the week: dark green ½ cup, red/orange ¾ cup, beans/peas ½ cup (legumes), starchy ½ cup, other ½ cup	No change	Increase provision, choose options with less added sodium, do not add salt, no pre-fried, limit added fat and only use fats high in MUFA and PUFA
Meat/Meat Alternative (M/MA)	2 oz eq. min. per dayF	1 oz eq. min. per day (8-10 oz per week)	No change	Limit use of processed meats, no pre-fried, do not add salt, use leaner animal proteins (poultry, fish, eggs, low fat dairy), limit

				red meats, increase use of plant based proteins, limit added fat and only use fats high in MUFA and PUFA
Grains	1 serving per day[F] (8 per week min.), whole grains encouraged	1 oz eq. min. per day (8-9 oz per week), all grains must be whole grain rich	1 oz eq. min. per day (8-9oz weekly), half of grains must be whole grain rich	Use 100% whole grains, limit refined grains, use low sodium chips/crackers, limit added fat and only use fats high in MUFA and PUFA, no pre-fried, do not include grain based desserts
Milk	1 cup[F] (variety of fat contents allowed, flavor not restricted)	1 cup (fat-free or 1% low fat plain, fat-free flavored)	1 cup fat free or low-fat plain or flavored	Use only unflavored low fat or fat free dairy
Calories	664[N]	550-650	No change	No standard provided
Sodium	No standard provided	Target 1: ≤1230 mg Target 2: ≤935 mg Final Target: ≤640 mg	Stopped at Target 1: ≤1230mg; no further reductions	Decrease content
Total Fat	22 g[N]	No standard provided	No change	Decrease content

Saturated Fat	7 g_N	<10% of calories	No change	Decrease content
Trans Fat	No standard provided	No trans fat permitted	No change	No standard provided
Vitamin A	224 RE_N	No standard provided	No change	No standard provided
Vitamin C	15 mg_N	No standard provided	No change	No standard provided
Iron	3.5 mg_N	No standard provided	No change	No standard provided
Calcium	286 mg_N	No standard provided	No change	No standard provided

Table 2. Changes in NSLP Nutrition Standards Across Versions

	SMI	**HHFKA (*Reference)**	**CNP Flexibilities**	**Best Practice**
Date	1995	**2012**	2017	DGA 2015, CACFP best practices 2016, unpublished review 2017
Fruits	3¾ cup less per week, does not have to offer fruit and vegetables separately, no vegetable subgroups	**½ cup per day (2½ cup per week)**	Remains the same	Increase provision, options with less added sugar
Vegetables		**¾ cup per day (3¾ cup per week), must have varieties**	Remains the same	Increase provision, choose options with less added

		throughout the week: dark green ½ cup, red/orange ¾ cup, beans/peas ½ cup (legumes), starchy ½ cup, other ½ c		sodium, do not add salt, no pre-fried, limit added fat and only use fats high in MUFA and PUFA
Meat/Meat Alternative	Added weekly maximum	**1 oz eq. min. per day (8-10 oz per week)**	Remains the same	Limit use of processed meats, no pre-fried, do not add salt, use leaner animal proteins (poultry, fish, eggs, low fat dairy), limit red meats, increase use of plant based proteins, limit added fat and only use fats high in MUFA and PUFA
Grains	Minimum amount remained the same, added weekly maximum, only encouraged whole grains	**1 oz eq. min. per day (8-9 oz per week), all grains must be whole grain rich**	Decrease whole grain provision by half	Use 100% whole grains, limit refined grains, use low sodium chips/crackers, limit added fat and only use fats high in MUFA and PUFA, no pre-fried, do not

				include grain based desserts
Milk	No change in amount, flavor and fat not restricted	**1 cup (fat-free or 1% low fat plain, fat-free flavored)**	Allowed low fat and flavored	Use only unflavored low fat or fat free dairy
Calories	No range, 14 calories above the HHFKA upper range	**550-650**	Remains the same	No standard provided
Sodium	No standard	**Target 1: ≤1230 mg** **Target 2:** **≤935 mg** **Final Target: ≤640 mg**	Target timeline extended, Final Target eliminated	Decrease
Total Fat	Provided standard that was eliminated	**No standard provided**	Remains the same	Decrease
Saturated Fat	9g = 9.8% of calories, slightly below the HHFKA limit	**<10% of calories**	Remains the same	Decrease
Trans Fat	No standard	**No standard provided**	Remains the same	No standard provided
Vitamin A	Standard covered in HHFKA vegetable variety	**No standard provided**	Remains the same	No standard provided

Vitamin C	Standard covered in HHFKA vegetable variety	**No standard provided**	Remains the same	No standard provided
Iron	Standard met by food group requirements for all NSLP versions	**No standard provided**	Remains the same	No standard provided
Calcium	Standard met by food group requirements for all NSLP versions	**No standard provided**	Remains the same	No standard provided

Table 3. Comparison of nutrient content between experimental menus

Nutrient	**SMI (Mean±SD)**	**HHFKA (Mean±SD)**	**CNPFlex (Mean±SD)**	**BP (Mean±SD)**
Calories*	601 ± 134$_{a,b}$	628 ± 111$_{b}$	625 ± 110$_{b}$	529 ± 72$_{a}$
Protein (g)	30.2 ± 12.4$_{a}$	30.7 ± 4.7$_{a,b}$	30.6 ± 4.4$_{a,b}$	34.7 ± 5.0$_{b}$
Carbohydrate (g)	71.3 ± 19.5	87.3 ± 20.0	82.9 ± 17.5	73.9 ± 11.3
Total Fiber (g)	5.2 ± 2.4$_{a}$	8.0 ± 3.2$_{b}$	7.6 ± 3.1$_{a,b}$	9.6 ± 3.5$_{b}$
Sugar (g)	28.3 ± 9.9$_{a}$	39.9 ± 8.3$_{b}$	38.7 ± 8.4$_{b}$	27.5 ± 4.2$_{a}$
Added Sugar (g)	5.3 ± 6.3	5.2 ± 6.0	5.7 ± 6.6	0.4 ± 1.0
Total Fat (g)	21.9 ± 7.5$_{a}$	18.3 ± 6.8$_{a}$	20.0 ± 7.4$_{a}$	11.9 ± 4.7$_{b}$
Saturated Fat (g)*	8.7 ± 2.7$_{a}$	6.2 ± 2.2$_{b,c}$	6.9 ± 2.5$_{a,b}$	4.7 ± 2.2$_{c}$

Mono. Fat (g)	6.0 ± 2.9[a]	5.0 ± 2.4[a,b]	5.6 ± 2.5[a]	3.3 ± 1.5[b]
Poly. Fat (g)	3.0 ± 2.6	3.2 ± 2.6	3.4 ± 2.8	2.1 ± 1.2
Trans Fat (g)*	0.4 ± 0.3[a]	0.3 ± 0.2 [a]	0.3 ± 0.2 [a]	0.1 ± 0.4[b]
Cholesterol (mg)	76.4 ± 68.9	55.6 ± 15.7	60.5 ± 15.1	57.2 ± 16.5
Vitamin A (IU)	1016 ± 1163	3167 ± 4445	3197 ± 4524	3442 ± 5403
Vitamin B6 (IU)	0.49 ± 0.32	0.56 ± 0.25	0.75 ± 0.34	0.60 ± 0.31
Vitamin B12 (mcg)	2.01 ± 0.70	1.92 ± 0.69	1.87 ± 0.75	1.87 ± 0.57
Vitamin C (mg)	8.94 ± 10.93	19.06 ± 16.01	18.64 ± 16.39	19.95 ± 18.87
Vitamin D (IU)	59.9 ± 63.5	54.1 ± 57.9	55.9 ± 59.9	45.1 ± 56.3
Vitamin E (mg)	1.46 ± 1.12	1.74 ± 1.24	1.71 ± 1.24	1.6 ± 1.0
Folate (mcg)	73.0 ± 44.0	76.3 ± 42.5	80.1 ± 42.4	109.8 ± 57.3
Vitamin K (mcg)	16.3 ± 20.9	26.9 ± 26.9	27.3 ± 27.7	27.6 ± 27.9
Calcium (mg)	477 ± 156	525 ± 135	524 ± 147	536 ± 166
Iron (mg)	3.48 ± 1.17	3.78 ± 1.15	3.75 ± 1.67	3.32 ± 1.13
Magnesium (mg)	82.9 ± 26.3	104.7 ± 26.5	98.4 ± 28.3	119.2 ± 31.5
Phosphorous (mg)	525 ± 152	567 ± 118	553 ± 127	614 ± 117
Potassium (mg)*	893 ± 191[a]	1179 ± 246[b]	1142 ± 235[b]	1133 ± 176[b]
Sodium (mg)*	943 ± 370[a,b]	1135 ± 415[b]	1103 ± 388[b]	750 ± 332[a]
Zinc (mg)	3.83 ± 1.83	4.31 ± 2.09	4.27 ± 2.04	3.77 ± 1.22

* Nutrients monitored by the NSLP

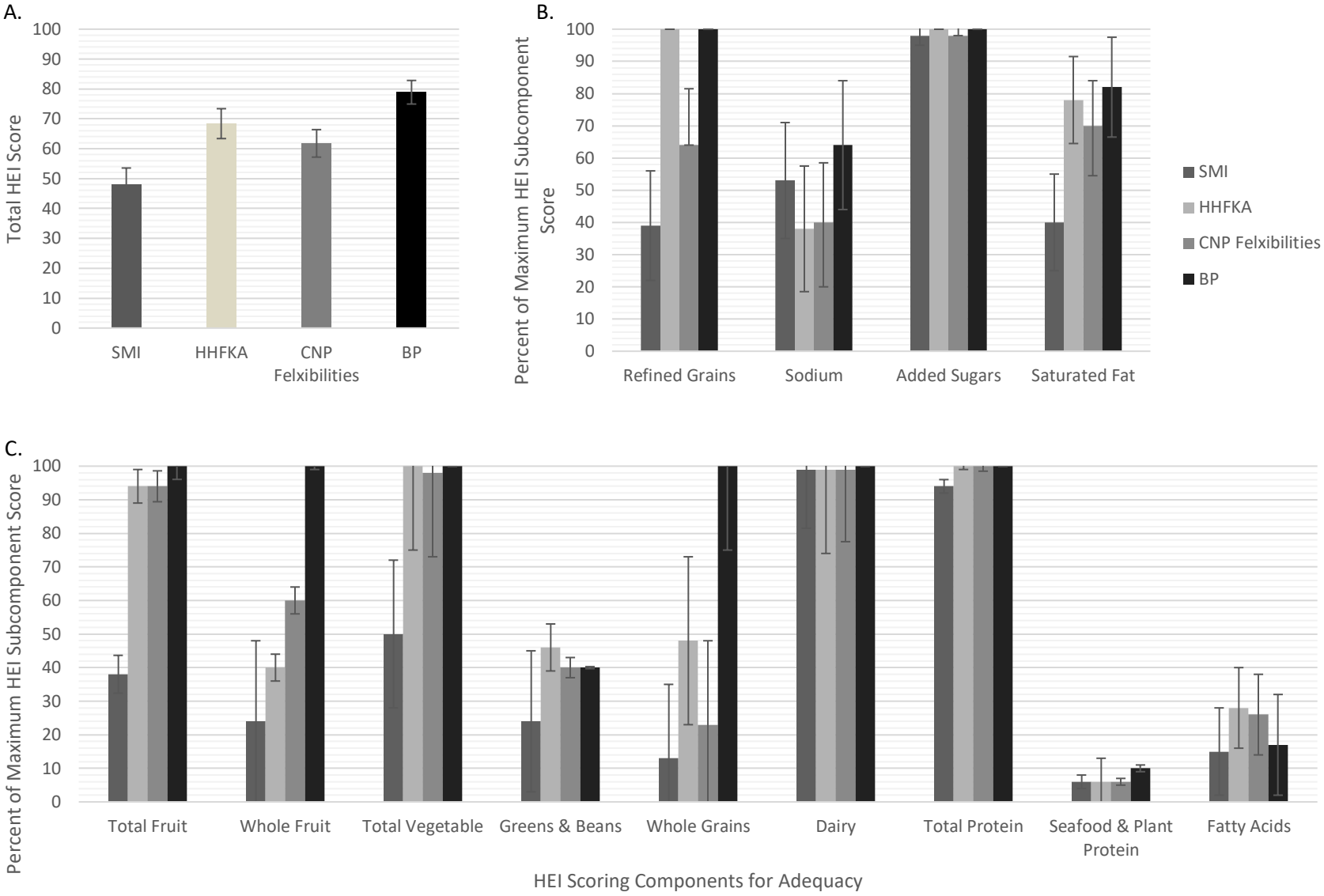
**Significant differences indicated by unlike superscripts.

Table 4. Comparison of dietary quality between experimental menus as HEI 2015 and HEI subcomponents

HEI Component Scores	SMI (Mean±SD)	HHFKA (Mean±SD)	CNPFlex (Mean±SD)	BP (Mean±SD)
Total HEI Score	47.9 ± 11.3$_{a}$	68.4 ± 10.0$_{b}$	61.8 ± 9.2$_{b}$	78.9 ± 7.9$_{c}$
Total Fruit	1.9 ± 2.4$_{a,b}$	4.7 ± 0.4$_{a}$	4.7 ± 0.4$_{a,b}$	5.0 ± 0.1$_{b}$
Whole Fruit	1.2 ± 2.2$_{a}$	2.0 ± 2.5$_{a}$	3.0 ± 2.5$_{a}$	5.0 ± 0.0$_{b}$
Total Vegetable	2.5 ± 2.1$_{a}$	5.0 ± 0.7$_{b}$	4.9 ± 0.3$_{b}$	5.0 ± 0.03$_{b}$
Dark Greens/ Legumes	1.2 ± 2.2	2.3 ± 2.5	2.0 ± 2.5	2.0 ± 2.5
Whole Grains	1.3 ± 3.5$_{a}$	4.8 ± 5.0$_{a}$	2.3 ± 4.3$_{a}$	10.0 ± 0.0$_{b}$
Dairy	9.9 ± 0.4	9.9 ± 0.2	9.9 ± 0.3	10.0 ± 0.0
Total Protein	4.7 ± 0.2	5.0 ± 0.7	5.0 ± 0.1	5.0 ± 0.1
Seafood/ Plant Protein	0.3 ± 1.3	0.3 ± 1.2	0.3 ± 1.2	0.5 ± 1.5
Fatty Acid Ratio	1.5 ± 2.8	2.8 ± 4.0	2.6 ± 3.7	1.7 ± 2.5
Refined Grains	3.9 ± 3.4$_{a}$	10.0 ± 0.0$_{b}$	6.4 ± 3.5$_{a}$	10.0 ± 0.0$_{b}$
Sodium	5.3 ± 3.6	3.8 ± 3.9	4.0 ± 3.7	6.4 ± 4.0
Added Sugar	9.8 ± 0.6 $_{a}$	10.0 ± 0.0$_{b}$	9.8 ± 0.6$_{a}$	10.0 ± 0.0$_{b}$
Saturated Fat	4.0 ± 3.0$_{a}$	7.8 ± 2.7$_{b}$	7.0 ± 2.8$_{b}$	8.2 ± 3.1$_{b}$

*Significant differences indicated by unlike superscripts.

Figure 1. Comparison of Total and HEI Subcomponent Scores across Experimental Menu Types



Supplementary Table 1. Six Weeks of Portioned Lunch Menu for Grades K-5 Applying SMI Nutrition Standards

Week #: 1

Component	**Mon (9/24/18)**	**Tues (9/25/18)**	**Wed (9/26/18)**	**Thurs (9/27/18)**	**Fri (9/28/19)**
Fruit &/or Veg (1/2c)	1/2c French fries	1/2c ranchero beans	1 med. baked potato	1/2c banana slices	1c romaine lettuce, 1T LF Italian dressing
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef, 2T cheese sauce	14oz protein between chili and cheese (1/2 c. chili ¾ oz. cheese)	14oz protein from nuggets	14oz protein from cheese pizza
Grain (2oz per day)	1 hamburger bun	2oz WG nacho chips	2oz chocolate chip cookie	2oz 1 roll, 1t butter	30g CHO from pizza
Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Week #: 2

Component	**Mon (10/1/18)**	**Tues (10/2/18)**	**Wed (10/3/18)**	**Thurs (10/4/18)**	**Fri (10/5/18)**
Fruit &/or Veg (1/2c)	1/2c apple slices	1/2c fresh celery 1 T LF ranch	1c tomato soup	1/2c banana slices	1c romaine lettuce, 1T LF Caesar dressing
Meat (2oz or 14oz protein)	2oz ground beef	14g protein between chili and cheddar cheese (0.75 c. chili & 0.25 oz. cheese)	2oz American cheese	14g protein chicken tender	14oz protein from Pepperoni pizza
Grain (2oz per day)	1 hamburger bun	2oz Fritos chips WG	2oz bread	2oz waffles and 1T syrup	30g from pizza
Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Week #: 3

Component	**Mon (10/8/18)**	**Tues (10/8/18)**	**Wed (9/19/18)**	**Thurs (10/11/18)**	**Fri (10/11/18)**

Fruit &/or Veg (1/2c)	1/2c potato wedges	1/2c refried beans	1/2c marinara sauce 1/2c canned pineapple	1/2c banana slices	1c iceberg lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef (with 1/8 tsp taco seasoning)	2oz ground beef	14g protein chicken tenders	2oz moz cheese, 2T pizza sauce
Grain (2oz per day)	1 hamburger bun	2oz tortillas	1c spaghetti	2oz garlic toast	2oz flatbread
Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Week #: 4

Component	**Mon (10/15/18)**	**Tues (10/16/18)**	**Wed (11/7/18)**	**Thurs (11/8/18)**	**Fri (11/9/18)**
Fruit &/or Veg (1/2c)	1/2c French fries	1/2c canned peaches	1/2c broccoli 1T LF ranch	1/2c berries (1/4c. strawberries 1/4c blueberries) mixed frozen	1/2c. sweet potato fries
Meat (2oz or 14oz protein)	14g protein BBQ pork rib	1.5oz chicken 2 oz. black beans	14g protein tangerine chicken	4oz vanilla yogurt, 1oz mozzarella cheese stick	14g protein between refried beans and cheese
Grain (2oz per day)	2oz hoagie bun	2oz tortilla and 1/4c white rice	1c cooked rice	1/2c. Granola WG	2oz tortilla and 1/4c white rice
Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Week #: 5

Component	**Mon (11/12/18)**	**Tues (11/13/18)**	**Wed (11/14/18)**	**Thurs (11/15/18)**	**Fri (11/16/18)**
Fruit &/or Veg (1/2c)	1/2c apple slices	1/2c canned peaches	1c lettuce, 1T LF ranch	1/2c bananas	1/2c tropical fruit
Meat (2oz or 14oz protein)	14g protein breaded chicken	14g protein from cheese pizza	2oz ground beef, 1/8c sloppy joe sauce	2oz Swedish meatballs	14oz protein from cheese
Grain (2oz per day)	2oz hamburger bun	30g CHO from pizza	2oz hamburger bun	1c cooked rice	30g CHO macaroni pasta

Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Week #: 6

Component	**Mon (10/8/19)**	**Tues (10/9/18)**	**Wed (10/10/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit &/or Veg (1/2c)	1/2c potato wedges	1/2c refried beans	1/2c broccoli, 1T cheese sauce	1/2c marinara sauce	1/2c tropical fruit mix
Meat (2oz or 14oz protein)	2oz grilled chicken	1oz shredded chicken, 1oz cheddar cheese	14oz protein grilled chicken leg	2oz mozzarella cheese	1.5oz shredded chicken, 0.5oz cheddar cheese, 2T BBQ sauce
Grain (2oz per day)	2oz hamburger bun	2oz tortillas	1c cooked rice	1c ziti pasta 1 piece garlic toast	2oz nacho chips WG
Milk (1c)	1c milk 2%	1c chocolate milk 2%	1c milk 2%	1c chocolate milk 2%	1c milk 2%

Portioning Notes:

Fruits:

- 1T low-fat ranch with vegetables
- 1/2t butter with cooked vegetables
- Choices were based on which compliments entrée the best

Grains:

- Did not use whole grains on menu because whole grains are encouraged but not required under SMI nutrition standards.
    - Unavailable for schools, easier to do non whole grain products, perceptions that children will not like healthier options
- 1oz grain equivalent:
    - 1oz bread/bun
    - 1/2c cooked pasta, rice, cereal
    - 1oz dry cereal

Milk:

- Variety of fat contents allowed
- No flavor specifications

ESHA Notes:

- Ranchero beans = used baked beans

HEI Notes:

- Canned fruit/ tropical fruit does not count as whole fruit

Supplementary Table 2. Six Weeks of Portioned Lunch Menu for Grades K-5 Applying HHFKA Nutrition Standards

Week #: 1

Component	**Mon (9/24/18)**	**Tues (9/25/18)**	**Wed (9/26/18)**	**Thurs (9/27/18)**	**Fri (9/28/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c ranchero beans	1 med. baked potato, 1/2c cucumber, 1T ranch	3/4c fresh carrots, 2T ranch	1c romaine lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef, 2T cheese sauce	14oz protein between chili and cheese	14oz protein from nuggets	14oz protein from cheese pizza
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz nacho chips (WG)	1oz chocolate chip cookie	30g carbs between nuggets and roll, 1t butter	30g carbs from cheese pizza
Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c): 1/2c RO (3/4c): 3/4c Legumes(1/2c): 3/4c Starchy(1/2c): 1.5c Other(1/2c): 1/2c

Week #: 2

Component	**Mon (10/1/18)**	**Tues (10/2/18)**	**Wed (10/3/18)**	**Thurs (10/4/18)**	**Fri (10/5/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4 c baked beans	3/4c fresh celery 2T LF ranch	1c tomato soup	3/4c cheesy potatoes	1c romaine lettuce, 1T Caesar dressing
Meat (2oz or 14oz protein)	2oz ground beef	14g protein between chili and cheddar cheese	2oz American cheese	14g protein chicken tender	14oz protein from Pepperoni pizza
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz Fritos chips (WG)	2oz bread (WG)	30g CHO between chicken and waffles and 1T syrup	30g CHO from cheese pizza

Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c): 3/4c RO (3/4c): 3/4c Legumes(1/2c): 3/4c Starchy(1/2c): 3/4c Other(1/2c): 3/4c

Week #: 3

Component	**Mon (10/8/18)**	**Tues (10/9/18)**	**Wed (9/19/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c potato wedges	3/4c refried beans	Caesar salad 1 c romaine, 1T Caesar dressing 1/2c marinara sauce	3/4c fresh carrots, 2T ranch	1c iceberg lettuce, 1T Italian dressing 2T pizza sauce
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef (with 1/8 tsp taco seasoning)	2oz ground beef	14g protein chicken tender	14g protein from moz cheese
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz tortillas (WG)	1c spaghetti	15g CHO between chicken and garlic toast (as needed)	2oz flatbread
Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c): 1/2c RO (3/4c): 1 &1/8c Legumes(1/2c): 3/4c Starchy(1/2c): 3/4c Other(1/2c): 1/2c

Week #: 4

Component	**Mon (10/15/18)**	**Tues (10/16/18)**	**Wed (11/7/18)**	**Thurs (11/8/18)**	**Fri (11/9/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c berries	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c ranchero beans	3/4c broccoli, 2T ranch	3/4c green beans, 1tsp butter	3/4c sweet potato fries
Meat (2oz or 14oz protein)	14g protein BBQ pork rib	1.5oz chicken 3-4g prot protein black beans	14g prot tangerine chicken	4oz vanilla yogurt, 1oz mozzarella cheese stick	14oz protein between refried beans and cheese
Grain (2oz on 4 days,	2oz hoagie bun	1.5oz tortilla WG, and	Carbs from chicken +	1/4c Granola WG	1.5oz tortilla WG, 1/4 c

1oz on 1 day)		1/4c brown rice	minimum 1/4c cooked rice		brown rice
Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)__3/4___ Legumes(1/2c)___3/4__ Starchy(1/2c)__3/4___ Other(1/2c)__3/4___

Week #: 5

Component	**Mon (11/12/18)**	**Tues (11/13/18)**	**Wed (11/14/18)**	**Thurs (11/15/18)**	**Fri (11/16/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c cowboy beans	3/4c corn, 1tsp butter	1c lettuce, 1T LF ranch	3/4c carrots, 2T LF ranch	1c romaine, 1T Caesar dressing
Meat (2oz or 14oz protein)	14g prot bread chicken	14g protein from cheese pizza	2oz ground beef, 1/8c sloppy Joe sauce	2oz Swedish meatballs	14oz protein from cheese
Grain (2oz on 4 days, 1oz on 1 day)	2oz WG hamburger bun	30g CHO from pizza	2oz WG hamburger bun	1/2c cooked rice	30g carbs macaroni pasta
Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)___3/4__ Legumes(1/2c)__3/4___ Starchy(1/2c)__3/4___ Other(1/2c)__3/4___

Week #: 6

Component	**Mon (10/8/18)**	**Tues (10/9/18)**	**Wed (10/10/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c refried beans	3/4c steamed broccoli, 2 T cheese sauce	1/4c carrots 1T LF ranch, 1/2c marinara	1c lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz grilled chicken	1oz shredded chicken, 1oz cheddar cheese	14g prot grilled chicken leg	2oz mozzarella cheese	1.5oz shredded chicken, .5oz cheddar, 2T BBQ sauce
Grain (2oz on 4 days,	2oz WG hamburger	2oz WG tortilla	1/2c cooked rice	1c ziti	2oz nacho chips (WG)

1oz on 1 day)	bun				
Milk (1c)	1c low fat	1c chocolate milk non fat	1c low fat	1c chocolate milk non fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)__3/4___ Legumes(1/2c)__3/4___ Starchy(1/2c)___3/4__ Other(1/2c)__3/4___

Portioning Notes:

- Week 3: Wednesday was substituted to match pattern

Fruits:

- Added a fruit pattern that was the same for each week (because the original menu did not have a fruit menu).
    - Picked variety of typical pattern of canned and fresh fruit.

Grains:

- Followed weekly pattern:
    - Two days of whole grain for one week
    - Three days of whole grain for following week
    - Alternate
- 1oz grain equivalent
    - 1oz bread/bun
    - 1/2c cooked pasta, rice, cereal
    - 1oz dry cereal
    - 1/4c granola
- If combination food (ex: pizza) there should be minimum of 30grams of carbohydrate to equal 2oz of grain.
- Plain roll served with 1tsp butter

Milk:

- Schoolchildren will typically pick chocolate milk
    - Served two out of five days per week to be conservative

Meats:

- Burger
    - Must be 80% lean/20% fat
- Cheese
    - Must be real cheese
    - Ex: cheese sauce does not count
- Hotdogs
    - Must be 80% muscle meat
- Lunch meats
    - Must be muscle meat
- If combination food: there should be 14grams of protein to equal 2oz of meat.

Vegetables:

- Depends on which standards need to be met.
    - Chose options that complement the entrée.
    - Sweet potato count as a starchy vegetable or Red-Orange food group
    - Legumes can be starchy or legume

- If fresh vegetables or salad:
    - Will be served with dressing:
        - 1Tbsp of appropriate dressing or dip 2Tbsp low-fat ranch
- Steamed or plain vegetables:
    - Add 1tsp of butter

Specific Food Items:

- Baked potato with toppings
    - 3/4c baked potato, 14oz protein between chili and cheese
- Burger will be most plain version
- Chicken burrito
    - 1.5oz chicken, 3-4g protein black beans, 1/8c rice, and 1.5oz tortilla
- Cowboy beans are equivalent to baked beans
- Nachos grande
    - 2oz ground beef, 2T cheese sauce, and 2oz nacho chips
- Pizza will be most plain version
- Ranchero beans are equivalent to baked beans
- Tacos will be most plain version
    - Beef and cheese
- Sloppy Joe
    - 2oz ground beef and 1/8c sloppy Joe sauce
- Spaghetti
    - 1/4c spaghetti served with 1/2c sauce
- Yogurt box
    - 4oz yogurt, 1oz string cheese, and 1/2c granola (2oz grain)

Other notes:

- Week 6 would have been the 3rd week in the cycle
    - Reusing week 3 with cycle option to mimic option

Supplementary Table 3. Six Weeks of Portioned Lunch Menu for Grades K-5 Applying CNP Flexibilities Nutrition Standards

Week #: 1

Component	**Mon (9/24/18)**	**Tues (9/25/18)**	**Wed (9/26/18)**	**Thurs (9/27/18)**	**Fri (9/28/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c ranchero beans	1 med. baked potato, 1/2c cucumber, 1T ranch	3/4c fresh carrots, 2T ranch	1c romaine lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef, 2T cheese sauce	14oz protein between chili and cheese	14oz protein from nuggets	14oz protein from cheese pizza
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun	2oz nacho chips (WG)	1oz chocolate chip cookie	30g carbs between nuggets and roll, 1t butter	30g carbs from cheese pizza
Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c): 1/2c RO (3/4c): 3/4c Legumes(1/2c): 3/4c Starchy(1/2c): 1.5c Other(1/2c): 1/2c

Week #: 2

Component	**Mon (10/1/18)**	**Tues (10/2/18)**	**Wed (10/3/18)**	**Thurs (10/4/18)**	**Fri (10/5/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4 c baked beans	3/4c fresh celery 2 T LF ranch	1c tomato soup	3/4c cheesy potatoes	1c romaine lettuce, 1T Caesar dressing
Meat (2oz or 14oz protein)	2oz ground beef	14g protein between chili and cheddar cheese	2oz American cheese	14g protein chicken tender	14oz protein from Pepperoni pizza
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun	2oz Fritos chips (WG)	2oz bread (WG) 1t butter	30g CHO between chicken and waffles and 1T syrup	30g CHO from cheese pizza

Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c): 3/4c RO (3/4c): 3/4c Legumes(1/2c): 3/4c Starchy(1/2c): 3/4c Other(1/2c): 3/4c

Week #: 3

Component	**Mon (10/8/18)**	**Tues (10/9/18)**	**Wed (9/19/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c potato wedges	3/4c refried beans	Caesar salad 1 c romaine, 1T Caesar dressing 1/2c marinara sauce	3/4c fresh carrots, 2T ranch	1c iceberg lettuce, 1T Italian dressing 2T pizza sauce
Meat (2oz or 14oz protein)	2oz ground beef	2oz ground beef (with 1/8 tsp taco seasoning)	2oz ground beef	14g protein chicken tender	14g protein from moz cheese
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun	2oz tortillas (WG)	1c spaghetti	15g CHO between chicken and garlic toast (as needed)	2oz flatbread
Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c): 1/2c RO (3/4c): 1 &1/8c Legumes(1/2c): 3/4c Starchy(1/2c): 3/4c Other(1/2c): 1/2c

Week #: 4

Component	**Mon (10/15/18)**	**Tues (10/16/18)**	**Wed (11/7/18)**	**Thurs (11/8/18)**	**Fri (11/9/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c berries	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c ranchero beans	3/4c broccoli, 2T ranch	3/4c green beans, 1tsp butter	3/4c sweet potato fries
Meat (2oz or 14oz protein)	14g protein BBQ pork rib	1.5oz chicken 3-4g prot protein black beans	14g prot tangerine chicken	4oz vanilla yogurt, 1oz mozzarella cheese stick	14oz protein between refried beans and cheese
Grain (2oz on 4 days,	2oz hoagie bun	1.5oz tortilla WG, and	Carbs from chicken +	1/4c Granola	1.5oz tortilla WG,

1oz on 1 day)		1/4c brown rice	minim1um 1/4c cooked rice		1/4 c brown rice
Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)__3/4___ Legumes(1/2c)___3/4__ Starchy(1/2c)__3/4___ Other(1/2c)__3/4___

Week #: 5

Component	**Mon (11/12/18)**	**Tues (11/13/18)**	**Wed (11/14/18)**	**Thurs (11/15/18)**	**Fri (11/16/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c cowboy beans	3/4c corn, 1tsp butter	1c lettuce, 1T LF ranch	3/4c carrots, 2T LF ranch	1c romaine, 1T Caesar dressing
Meat (2oz or 14oz protein)	14g prot bread chicken	14g protein from cheese pizza	2oz ground beef, 1/8c sloppy Joe sauce	2oz Swedish meatballs	14oz protein from cheese
Grain (2oz on 4 days, 1oz on 1 day)	2oz hamburger bun	30g CHO from pizza	2oz WG hamburger bun	1/2c cooked rice	30g carbs macaroni pasta
Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)___3/4__ Legumes(1/2c)__3/4___ Starchy(1/2c)__3/4___ Other(1/2c)__3/4___

Week #: 6

Component	**Mon (10/8/18)**	**Tues (10/9/18)**	**Wed (10/10/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit (1/2c)	1/2c apple slices	1/2c canned peaches	1/2c canned pineapple	1/2c banana slices	1/2c tropical fruit mix
Veg (3/4c)	3/4c French fries	3/4c refried beans	3/4c steamed broccoli, 2 T cheese sauce	1/4c carrots 1T LF ranch, 1/2c marinara	1c lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz grilled chicken	1oz shredded chicken, 1oz cheddar cheese	14g prot grilled chicken leg	2oz mozzarella cheese	1.5oz shredded chicken, .5oz cheddar, 2T BBQ sauce
Grain (2oz on 4 days,	2oz hamburger	2oz WG tortilla	1/2c cooked rice	1c ziti	2oz nacho chips (WG)

1oz on 1 day)	bun				
Milk (1c)	1c low fat	1c chocolate milk low fat	1c low fat	1c chocolate milk low fat	1c low fat

DG (1/2c)__3/4___ RO (3/4c)__3/4___ Legumes(1/2c)__3/4___ Starchy(1/2c)___3/4__ Other(1/2c)__3/4___

Portioning Notes:

- Week 3: Wednesday was substituted to match pattern

Fruits:

- Added a fruit pattern that was the same for each week (because the original menu did not have a fruit menu).
    - Picked variety of typical pattern of canned and fresh fruit.

Grains:

- Followed weekly pattern:
    - Two days of whole grain for one week
    - Three days of whole grain for following week
    - Alternate
- 1oz grain equivalent
    - 1oz bread/bun
    - 1/2c cooked pasta, rice, cereal
    - 1oz dry cereal
    - 1/4c granola
- If combination food (ex: pizza) there should be minimum of 30grams of carbohydrate to equal 2oz of grain.
- Plain roll served with 1tsp butter

Milk:

- Schoolchildren will typically pick chocolate milk
    - Served two out of five days per week to be conservative

Meats:

- Burger
    - Must be 80% lean/20% fat
- Cheese
    - Must be real cheese
    - Ex: cheese sauce does not count
- Hotdogs
    - Must be 80% muscle meat
- Lunch meats
    - Must be muscle meat
- If combination food: there should be 14grams of protein to equal 2oz of meat.

Vegetables:

- Depends on which standards need to be met.
    - Chose options that complement the entrée.
    - Sweet potato count as a starchy vegetable or Red-Orange food group
    - Legumes can be starchy or legume

- If fresh vegetables or salad:
    - Will be served with dressing:
        - 1Tbsp of appropriate dressing or dip 2Tbsp low-fat ranch
- Steamed or plain vegetables:
    - Add 1tsp of butter

Specific Food Items:

- Baked potato with toppings
    - 3/4c baked potato, 14oz protein between chili and cheese
- Burger will be most plain version
- Chicken burrito
    - 1.5oz chicken, 3-4g protein black beans, 1/8c rice, and 1.5oz tortilla
- Cowboy beans are equivalent to baked beans
- Nachos grande
    - 2oz ground beef, 2T cheese sauce, and 2oz nacho chips
- Pizza will be most plain version
- Ranchero beans are equivalent to baked beans
- Tacos will be most plain version
    - Beef and cheese
- Sloppy Joe
    - 2oz ground beef and 1/8c sloppy Joe sauce
- Spaghetti
    - 1/4c spaghetti served with 1/2c sauce
- Yogurt box
    - 4oz yogurt, 1oz string cheese, and 1/2c granola (2oz grain)

Other notes:

- Week 6 would have been the 3rd week in the cycle
    - Reusing week 3 with cycle option to mimic option

Supplementary Table 4. Six Weeks of Portioned Lunch Menu for Grades K-5 Applying BP Nutrition Standards

Week #: 1

Component	**Mon (9/24/18)**	**Tues (9/25/18)**	**Wed (9/26/18)**	**Thurs (9/27/18)**	**Fri (9/28/18)**
Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear
Veg (3/4c)	3/4c homemade baked French fries	1/4c lettuce, 1/4c tomato, 1/4c salsa	1 med. baked potato, 1/2c cucumber, 1T Greek yogurt ranch	3/4c fresh carrots, 2T Greek yogurt ranch	1c romaine lettuce, 1T Italian dressing , 1/8c pizza sauce
Meat (2oz or 14oz protein)	2oz ground beef (93% lean)	1oz LF cheddar cheese, 7g protein black beans	14oz protein between turkey chili and LF cheddar cheese (1/2c chili + 1/2oz cheese)	14oz protein from homemade WG nuggets	2oz LF mozzarella cheese
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz baked unsalted Tostitos chips (WG)	1oz cornbread (WG)	30g carbs between nuggets and roll (WG)	30g carbs WG from pizza crust
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Week #: 2

Component	**Mon (10/1/18)**	**Tues (10/2/18)**	**Wed (10/3/18)**	**Thurs (10/4/18)**	**Fri (10/5/18)**
Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear
Veg (3/4c)	3/4 c dried reconstituted black beans	3/4c fresh celery 2T LF Greek yogurt ranch	1c low sodium tomato soup	3/4c oven roasted potatoes	1c romaine lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz ground beef (93% lean)	14g protein between turkey chili and LF cheddar	2oz LF cheddar, mozzarella, & Swiss cheese	14g protein homemade chicken tender	2oz LF mozzarella cheese

		cheese (1/2c chili + ½ oz cheese)			
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz baked unsalted Tostitos chips (WG)	2oz bread (WG)	30g CHO between chicken and waffles (WG) and 1T light syrup	30g CHO from cheese pizza (WG)
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Week #: 3

Component	**Mon (10/8/18)**	**Tues (10/8/18)**	**Wed (9/19/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**
Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear
Veg (3/4c)	3/4c homemade baked potato wedges	3/4c homemade refried beans	1 c romaine, 1T Italian dressing 1/2c low sodium marinara sauce	3/4c fresh carrots, 2T LF Greek yogurt ranch	1c iceberg lettuce, 1T Italian dressing 2T low sodium pizza sauce
Meat (2oz or 14oz protein)	2oz ground beef (93% lean)	2oz shredded chicken (with 1/8 tsp taco seasoning)	2oz ground turkey	14g protein homemade chicken tender	14g protein from mozzarella cheese
Grain (2oz on 4 days, 1oz on 1 day)	1 hamburger bun (WG)	2oz tortillas (WG)	1c spaghetti (WG)	15g CHO between chicken and WG roll (as needed)	2oz flatbread (WG)
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Week #: 4

Component	**Mon (10/15/18)**	**Tues (10/16/18)**	**Wed (11/7/18)**	**Thurs (11/8/18)**	**Fri (11/9/18)**
Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear

Veg (3/4c)	3/4c homemade baked French fries	3/4c dried reconstituted pinto beans	3/4c fresh broccoli, 2T Greek yogurt ranch	3/4c frozen green beans	3/4c homemade baked sweet potato fries
Meat (2oz or 14oz protein)	2oz protein BBQ chicken, 1T low sodium BBQ sauce	1.5oz chicken, 3-4g protein reconstituted black beans (1oz.)	14g protein teriyaki grilled chicken, 1/2T low sodium teriyaki sauce	4oz vanilla yogurt, 1oz LF mozzarella cheese stick	14oz protein between dried reconstituted black beans and LF cheddar cheese
Grain (2oz on 4 days, 1oz on 1 day)	2oz hoagie bun (WG)	1.5oz tortilla WG, and 1/4c brown rice	1c cooked brown rice	1/4c Granola WG	1.5oz tortilla WG, 1/4c cooked brown rice
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Week #: 5

Component	**Mon (11/12/18)**	**Tues (11/13/18)**	**Wed (11/14/18)**	**Thurs (11/15/18)**	**Fri (11/16/18)**
Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear
Veg (3/4c)	3/4c homemade cowboy beans (salad)	3/4c frozen corn 2T low sodium pizza sauce	1c lettuce, 1T LF Greek yogurt ranch	3/4c carrots, 2T LF Greek yogurt ranch	1c romaine, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz grilled chicken	14g protein from LF mozzarella cheese	2oz ground turkey, 1/8c sloppy joe sauce	2oz Swedish meatball (93% lean)	14oz protein from LF cheddar cheese
Grain (2oz on 4 days, 1oz on 1 day)	2oz hamburger bun (WG)	30g CHO from cheese pizza (WG)	1 hamburger bun (WG)	1/2c cooked brown rice	1/2c WG macaroni pasta
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Week #: 6

Component	**Mon (10/8/18)**	**Tues (10/9/18)**	**Wed (10/10/18)**	**Thurs (10/11/18)**	**Fri (10/12/18)**

Fruit (1/2c)	1/2c fresh apple	1/2c fresh grapes	1/2c banana	1/2c fresh pineapple	1/2c fresh pear
Veg (3/4c)	3/4c homemade baked French fries	3/4c homemade refried beans	3/4c frozen, steamed broccoli	1/4c carrots 1T LF ranch, 1/2c low sodium marinara sauce	1c lettuce, 1T Italian dressing
Meat (2oz or 14oz protein)	2oz grilled chicken	1oz shredded chicken, 1oz LF cheddar cheese	14g protein grilled chicken leg	2oz LF mozzarella cheese	1.5oz shredded chicken, 0.5oz LF cheddar cheese, 2T low Na BBQ sauce
Grain (2oz on 4 days, 1oz on 1 day)	2oz hamburger bun (WG)	2oz WG tortilla	1/2c cooked brown rice	1c WG ziti	2oz nacho chips (WG)
Milk (1c)	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain	1c 1% plain

DG (1/2c)_____ RO (3/4c)_____ Legumes(1/2c)_____ Starchy(1/2c)_____ Other(1/2c)_____

Portioning Notes:

- Week 3: Wednesday was substituted to match pattern

Fruits:

- Added a fruit pattern that was the same for each week (because the original menu did not have a fruit menu).
    - Picked variety of commonly used fresh fruit in school

Grains:

- Each item was whole grain
- 1oz grain equivalent
    - 1oz bread/bun
    - 1/2c cooked pasta, rice, cereal
    - 1oz dry cereal
    - 1/4c granola
- If combination food (ex: pizza) there should be minimum of 30grams of carbohydrate to equal 2oz of grain.

Meat:

- Lean options and cooking methods (>80% lean/20% fat beef)
- Substituted beef for leaner options if, more than once per week with appropriate item to match meal (increased variety of proteins used).

- Low-fat cheeses
- If combination food: there should be 14grams of protein to equal 2oz of meat.

Milk:

- No flavored milk
- All low-fat content

Vegetables:

- Depends on which standards need to be met.
    - Chose options that complement the entrée.
    - Sweet potato count as a starchy vegetable or Red-Orange food group
    - Legumes can be starchy or legume
- If fresh vegetables or salad:
    - Will be served with dressing:
        - 1Tbsp of clear appropriate dressing or dip 2Tbsp non-fat Greek yogurt ranch
- Steamed or plain vegetables:
    - Add 1tsp of butter

ESHA Notes

- Homemade baked French fries or oven roasted potatoes
    - 1 baked potato and 1/8 tsp. oil
- Greek yogurt ranch
    - Nonfat plain Greek yogurt, ranch herb recipe would be added, but provides no nutritional value, so only yogurt was added
- Whole grain chicken nuggets or tenders
    - 2oz grilled chicken, 1Tbsp egg beaters, 1Tbsp whole wheat bread crumbs
- Used healthy recipe for Swedish sauce and mac and cheese

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