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Differences in preschool-age children's dietary intake between meals consumed at childcare and at home

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ABSTRACT

Preschool children need optimal nutrition, including a variety of nutrient-dense foods, for growth and development. The purpose of this study was to determine differences in foods and nutrients consumed at childcare and home environments. Children ages 3-to-5 years ($n = 90$, 3.8 ± 0.7 years; 56% female) from 16 childcare centers participated in this cross-sectional study from 2011 to 2014. Lunches at childcare were observed for two days; three days of dinners at home were reported by caregivers. Nutrient-dense and energy-dense foods were counted and nutrient content of meals was determined using FoodWorks®. More servings of fruit (0.92 ± 0.82 vs. 0.15 ± 0.26; $p \leq 0.0001$), vegetables (1.47 ± 1.43 vs. 0.62 ± 0.60; $p \leq 0.0001$), and low-fat dairy (0.83 ± 0.32 vs. 0.07 ± 0.19; $p \leq 0.0001$) were consumed at childcare than at home. More servings of high-fat, high-sugar *foods* (0.08 ± 0.18 vs. 0.43 ± 0.39, $p \leq 0.0001$) and sugary drinks (0.22 ± 0.41 vs. 0.39 ± 0.35. $p \leq 0.001$) were consumed at home than at childcare. There were no differences between environments in whole-grains, high-fat meats, or high-fat high-sugar *condiments* consumed. On average, children consumed 333.0 ± 180.3 kcal at childcare and 454.7 ± 175.3 at home ($p \leq 0.0001$). There were no differences in macronutrient profiles or in iron, zinc, folate, or vitamin B6 intake. More calcium (86.2 ± 44.6 vs. 44.6 ± 22.2 mg/kcal, $p \leq 0.0001$) and vitamin A/kcal (56.1 ± 36.9 vs. 26.5 ± 24.2 RAE/kcal, $p \leq 0.0001$) were consumed at childcare than at home. Preschool children are consuming more nutrient-dense foods and a more servings of fruit and vegetables at childcare during lunch than at home during dinner. Childcare and parents should work together to provide early and consistent exposure to nutrient-rich foods to ensure optimal nutrition for developing children.

1. Introduction

Dietary habits developed in early childhood serve as a foundation for future preferences and intake (Savage et al., 2007), and are difficult to modify as children age (Birch, 1999). Familiar eating environments, such as the home and childcare, influence the formation of children's dietary habits (Ziegler et al., 2006). The home food environment and feeding practices affect dietary quality and, ultimately, the child's health (Couch et al., 2014; Skouteris et al., 2011; Jones et al., 2014). While parents undeniably have great impact on children's eating habits, 11 million young children attend childcare daily (Child Care in America, 2014) and are influenced by the childcare food environment (Kharofa et al., 2015). In the U.S., childcare centers are required to meet dietary quality standards (United States Department of Agriculture, 2015; Oklahoma Department of Human Services, 2016), while meals served at home are not subject to regulation. Dietary quality standards vary based on participation in the Child and Adult Care Food Program (CACFP) and state licensure requirements, if a center does not participate in the CACFP. Researchers report that children in childcare overconsume foods high in fats and sugar (Benjamin Neelon et al., 2012), while under-consuming fruit, vegetables, grains, and fiber (Briley et al., 1999; Gubbels et al., 2014).

Studies contrasting dietary intake of young children at home and childcare are limited (Ziegler et al., 2006; Briley et al., 1999; Gubbels et al., 2014; Bernardi et al., 2010; Bruening et al., 1999; Sepp et al., 2001; Worobey et al., 2005). Half were conducted outside the U.S. (Gubbels et al., 2014; Bernardi et al., 2010; Sepp et al., 2001), and those in the U.S. were published at least 10 years ago (Ziegler et al., 2006; Briley et al., 1999; Bruening et al., 1999; Worobey et al., 2005). Additionally, of those studies conducted in the U.S., only one indicated whether or not childcare centers participated in the CACFP (Bruening et al., 1999) and another included Head Start Centers which necessitates participation in CACFP since they serve a low-income population (Worobey et al., 2005). Discrepancies among the dietary intake findings in infant, toddler, and preschool-age children could be attributed to the

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global reach of the locations and the outdated time frame. However, findings are inconsistent. Higher fats and sweets were generally consumed at home (Briley et al., 1999; Bruening et al., 1999; Sepp et al., 2001), although one study reported more sweet snacks consumed at childcare (Gubbels et al., 2014). Two studies found that more vegetables were consumed at home (Briley et al., 1999; Gubbels et al., 2014), while another observed that more vegetables were consumed at childcare (Bruening et al., 1999). Energy intake was equivalent between environments (Ziegler et al., 2006; Gubbels et al., 2014; Bernardi et al., 2010), or higher at home (Sepp et al., 2001; Worobey et al., 2005). Researchers reported that either macronutrient profiles (percent carbohydrate, fat, protein) were the same in both environments (Ziegler et al., 2006; Worobey et al., 2005), more fat and protein was consumed at home (Gubbels et al., 2014; Bernardi et al., 2010), or more fat was consumed at childcare (Sepp et al., 2001). Some reported that more micronutrients were consumed at childcare than at home (Ziegler et al., 2006; Bruening et al., 1999), while others noted equivalent micronutrient consumption in both environments (Briley et al., 1999; Sepp et al., 2001). Regarding those findings that could discern between CACFP-participating centers and homes, the centers provided lower fat (Bruening et al., 1999), more vegetables (Bruening et al., 1999), lower energy (Worobey et al., 2005), and more micronutrients (Bruening et al., 1999) compared to homes. Of the study conducted in the U.S. that reported higher vegetable intake at home, CACFP participation was not indicated (Briley et al., 1999). Given the inconsistency across studies and need for a current understanding of dietary patterns among young children in the U.S., the purpose of the present study was to determine differences in foods and nutrient intake between meals consumed by preschool-age children at childcare and at home. We hypothesized that more nutrient-dense meals would be consumed at childcare than at home.

2. Methods

2.1. Study design

This cross-sectional study involved 3-to-5-year-old children and their parents from 16 childcare centers across Oklahoma. Data collection occurred from 2011 through 2014. All study procedures were approved by the University Institutional Review Board.

2.2. Recruitment

Licensed childcare centers that provided full-time care and a lunch meal to preschool children were eligible. Participation in CACFP was not a requirement and was not recorded as part of data collection. Oklahoma state licensure requirements for childcare state that centers must provide meals consistent with the CACFP (Oklahoma Department of Human Services, 2016). Centers were contacted via phone to determine interest and eligibility. Thirty-three centers were contacted; 13 were not eligible, eight had scheduling conflicts, and 16 participated. Three-to-five-year-old children enrolled at participating centers were eligible. Caregivers completed a consent form and reported demographics, including the child's age, sex, and race. Socio-economic status of the families was not reported. Although, in Oklahoma, 23% of families with children < 5 years are living below the poverty threshold (United States Census Bureau, 2016). Approximately 1/3 of residents live in rural areas, and 18% are uninsured (United States Census Bureau, 2016). Of 508 eligible children, 252 consented to observation at childcare, and 90 agreed to participate in phone interviews.

2.3. Dietary intake at childcare

Plate waste was observed using the Dietary Observation for Child Care (DOCC) (Ball et al., 2007) tool to assess all foods and beverages consumed during lunch at childcare. Trained researchers received plate waste proficiency via training and passed a plate waste practical exam. There was high reliability between observers across foods (ICC = 0.968, $p < 0.001$) before observations in the field. Each researcher observed foods served, traded, spilled, and additional servings, and subtracted food remaining, for up to three children during one lunch meal (Ball et al., 2007). Food and recipe details were obtained. Researchers aimed to conduct two observations for each child which would be averaged for analyses; however, 21 children had a single observation. Using a dependent *t*-test, there was not a significant difference for intake during day one and day two; therefore, day one values were imputed for day two for those 21 children. Day one and day two values were then averaged for data analyses.

2.4. Dietary intake at home

Information about dinner at home was collected from caregivers during a telephone interview using the 3-Dinner Dietary Recall (3DDR) form that was developed for this study. Researchers were trained on standard recall interview techniques and procedures (Thompson and Byers, 1994) and engaged in ample practice before participating in data collection with caregivers. Trained researchers asked caregivers to recall foods the child consumed during the previous three dinner meals. Parents were prompted to recall easily forgotten foods, such as condiments, and probed for food preparation methods and brands. Interviewers used a guide to help caregivers visualize volumes of foods using common household goods (i.e., ping-pong ball equals two tablespoons). Researchers aimed to obtain three days of dinner recall for each child which would be averaged for analyses; however, 11 children had only two days. For those children with three dinner recalls, using a repeated measures Analysis of Variance, there was not a statistically significant difference across days. Similarly, there was no significant difference for dietary intake between weekdays and weekend days using a dependent *t*-test. Therefore, for those 11 children with two recalls, an average of day one and day two was imputed for day three. Day one, two, and three values were then averaged for analyses.

2.5. Dietary intake data processing

Foods consumed (fruit, vegetables, low-fat dairy, whole-grains, high-fat meats, high-fat high-sugar foods, high-fat high-sugar condiments, and sugary drinks) were counted. The criterion for each category is in Table 1. Each food was counted as one serving rather than using actual volumetric serving size. This approach errs in favor of the caregiver who provides a variety of fruits and vegetables, although each independently may not constitute a complete serving. For example, if a mixed vegetable recipe was served, each vegetable included was counted separately as one serving. Energy (kilocalories), macronutrients (carbohydrate, protein, fat), and micronutrients (calcium, iron, zinc, vitamin A, folate, vitamin B6) were determined using FoodWorks® (The Nutrition Co., Long Valley N.J.) and the United States Department of Agriculture food database. Macro- and micronutrients were examined relative to energy consumed, so that differences in the energy content of the meal were attenuated.

2.6. Analysis

Descriptive characteristics (mean ± *SD* and frequency) were calculated. Dependent *t*-tests were conducted to determine the differences in foods and nutrients consumed during meals at childcare and at home. There were 19 dependent variables examined; thus, the alpha was adjusted, using the Bonferroni method for significance ($p < 0.003$). Data were analyzed using SPSS Statistical Analysis Software (IBM Corporation, Somors, NY).

Table 1
Criteria for foods and food categories.

Food group	Criterion
Fruit	Included: fresh, frozen or canned varieties (i.e. applesauce, fruit medleys). Excluded fruited yogurt and any fruit juice.
Vegetable	Included fresh, frozen or canned varieties; corn and beans as a starchy vegetable (i.e., corn on the cob, baked beans, hummus, or lentil soup); and avocados as a fatty vegetable. Excluded any fried preparation (i.e., French fries or fried green beans); small amounts of processed tomato products (i.e., spaghetti or pizza sauce); pickles, and deli salads (i.e., potato salad).
Low-fat dairy	Included fat-free or 1% unflavored milk, fat-free or 1% cheese, fat-free or 1% yogurt, skim chocolate milk, fat-free or 1% cottage cheese, smoothie made with fat-free or 1% dairy products, etc.
Whole-grains	Included oatmeal, brown rice, bread, unsalted-unbuttered popcorn, corn tortillas, etc. Excluded bread, pasta, flour (refined) tortillas, or buns made with refined (white) flour; any foods that can be included in high-fat high-sugar category.
High-fat meat	Included bologna, ham if not deli slices sausage, bacon, 80/20 ground beef, and pot roast.
High-fat high-sugar *foods*	Included foods with 9 g or more per serving of added sugar, which includes: cookies, cakes, donuts, muffins, sweet bread, cereal bar, breakfast fruit bars, any sweetened cereal, meals prepared with cream-based soup.
High-fat high-sugar *condiments*	Included condiments that contain >9 g of sugar or >5 g of fat per serving.
Sugary drinks	Included juice that is not 100% fruit, drinks that contain added sugar, flavored milk.

3. Results

Ninety 3-to-5-year-old children and their caregivers participated. Children were 3.8 ± 0.7 years old, 55.6% female, 44.4% white, 33.3% American Indian or Alaska Native, 8.9% black, 11.1% Hispanic, and 2.2% Asian.

Lunches were observed throughout the week: 10% of lunches were observed on Monday, 15% on Tuesday, 14% on Wednesday, 29% on Thursday, 20% on Friday, and 12% were imputed. Dinners were recalled throughout the week: 20% of recalls represent meals consumed on Monday, 17% on Tuesday, 13% on Wednesday, 10% on Thursday, 7% on Friday, 11% on Saturday, 18% on Sunday, and 4% were imputed.

A list of the variety of fruits and vegetables consumed at childcare and home are presented in Table 2. Thirty-four different fruits and vegetables were consumed by children at childcare while forty-four were consumed by individual children at home. Mean foods and nutrients consumed at both environments and the differences between the environments are reported in Table 3. During lunch at childcare, children consumed significantly more fruit, vegetables, combined total fruit and vegetables, and low-fat dairy than during dinner at home. During lunch at childcare, children consumed significantly fewer high-fat high-sugar *foods* and sugary drinks than during dinner at home. Although not statistically significant after correction for multiple analyses, children consumed more high-fat high-sugar *condiments* during lunch at childcare than during dinner at home. There was no difference between whole-grains and high-fat meats consumed between environments.

Children consumed significantly fewer kilocalories during lunch at childcare than during dinner at home. Although not statistically significant after correction for multiple analyses, more carbohydrates and less fat were consumed during lunch at childcare than dinner at home. No difference was observed in protein consumption between environments. More food was consumed during dinner at home than lunch at childcare; therefore, micronutrients were calculated relative to energy. Children consumed significantly more calcium/kcal and vitamin A/kcal during lunch at childcare than during dinner at home. Although not significantly different after adjustment for multiple analyses, children consumed more iron/kcal and folate/kcal during dinner at home than lunch at childcare. There was no difference for zinc/kcal or vitamin B6/kcal consumed at either environment.

Table 2
List of fruits and vegetables consumed by preschool-age children (3 to 5 years; $n = 90$) at childcare and home environments in Oklahoma 2011–2014.

Childcare	Home
Apple	Apple
Applesauce	Applesauce
	Artichoke
Asparagus	Asparagus
	Avocado
Banana	Banana
Beans	Beans
	Bell peppers
	Black beans
Black-eyed peas	
	Blueberries
Broccoli	Broccoli
Brussel sprouts	
Cabbage	Cabbage
	Cantaloupe
Carrots	Carrots
Cauliflower	Cauliflower
Celery	Celery
Cherries	Cherries
	Chickpeas
Corn	Corn
Cucumber	Cucumber
	Edamame
	Field greens
	Fruit cocktail
Grapes	Grapes
Green beans	Green beans
	Lentils
Lettuce	Lettuce
Lima beans	
	Mushrooms
	Olives
	Onion
Oranges	Oranges
Peaches	
Pears	Pears
Peas	Peas
Pineapple	Pineapple
Pinto beans	Pinto beans
Plums	
Potatoes	Potatoes
Salad	Salad
	Seaweed
Spinach	Spinach
Strawberries	Strawberries
Sweet potato	Sweet potato
Tangerine	
Tomatoes	Tomatoes
Watermelon	Watermelon
	Zucchini

4. Discussion

Primary findings generally supported our hypothesis and revealed that preschool-age children consumed more servings of fruit (Gubbels et al., 2014), vegetables (Bruening et al., 1999), and low-fat dairy products (Bruening et al., 1999) during lunch at childcare than during dinner at home. While the listed variety of fruits and vegetables consumed by children at home has a wider variety than that consumed at childcare, this is likely due to a few children rather than the majority of children as evidenced by data showing more fruits and vegetable consumption at childcare. Furthermore, more servings of high-fat, high-sugar *foods* and sugary drinks were consumed during dinner at home (Briley et al., 1999; Bruening et al., 1999; Sepp et al., 2001), making dinner a potential source of excess energy and fat consumption. While we reported

Table 3
Servings of food groups and nutrients consumed by preschool-age children (3 to 5 years; $n = 90$) at childcare and home environments in Oklahoma 2011–2014.

Foods/nutrients	Childcare	Home	*p*-Value
	(Mean ± *SD*)	(Mean ± *SD*)	
Fruit	0.92 ± 0.82	0.15 ± 0.26	≤0.0001[a]
Vegetable	1.47 ± 1.43	0.62 ± 0.60	≤0.0001[a]
Total fruit and vegetable	2.39 ± 1.80	0.75 ± 0.62	≤0.0001[a]
Low-fat dairy products	0.83 ± 0.32	0.07 ± 0.19	≤0.0001[a]
Whole-grains	0.18 ± 0.33	0.11 ± 0.20	0.067
High-fat meat	0.37 ± 0.40	0.37 ± 0.35	0.915
High-fat/high-sugar *foods*	0.08 ± 0.18	0.43 ± 0.39	≤0.0001[a]
High-fat/high-sugar *condiments*	0.31 ± 0.54	0.13 ± 0.22	0.003
Sugary drinks	0.22 ± 0.41	0.39 ± 0.35	≤0.001[a]
Kilocalories	333.00 ± 180.33	454.67 ± 175.28	≤0.0001[a]
Protein (%)	20.53 ± 6.57	19.29 ± 6.69	0.166
Carbohydrates (%)	48.76 ± 13.26	44.69 ± 9.69	0.027
Fat (%)	32.54 ± 11.79	36.75 ± 8.29	0.007
Calcium (mg/kcal)	86.23 ± 42.6	44.61 ± 22.17	≤0.0001[a]
Iron (mg/kcal)	0.61 ± 0.18	0.70 ± 0.27	0.020
Zinc (mg/kcal)	0.69 ± 0.27	0.68 ± 0.62	0.913
Vitamin A (RAE/kcal)	56.11 ± 36.92	26.49 ± 24.18	≤0.0001[a]
Folate (mcg/kcal)	14.8 ± 5.80	17.44 ± 9.62	0.024
Vitamin B6 (mg/kcal)	0.08 ± 0.04	0.09 ± 0.04	0.778

Statistical difference, using a dependent *t*-test, is determined by a *p*-value of $p < 0.003$, adjusted for 19 dependent variables using Bonferroni's adjustment.
[a] Indicates statistically significant difference.

higher vegetable consumption at childcare, two studies (Briley et al., 1999; Gubbels et al., 2014) reported higher vegetable consumption at home. (Briley et al., 1999; Gubbels et al., 2014)Differences may be explained by cultural food habits, as Gubbels et al. (Gubbels et al., 2014) was conducted in the Netherlands, or changes in vegetables served at either home or childcare since 1999 (Briley et al., 1999). Furthermore, Briley et al. (Briley et al., 1999) did not indicate if centers participated in the CACFP, while Oklahoma state regulations require all centers to adhere to CACFP guidelines (Oklahoma Department of Human Services, 2016). Another recent study (Robson et al., 2015) demonstrated that children are consuming inadequate fruit, vegetables, and low-fat dairy products away from childcare. In the present study, the servings of fruit, vegetables, and low-fat dairy products consumed at childcare were at least twice that consumed at home.

While more energy was consumed at home than at childcare (Sepp et al., 2001; Worobey et al., 2005), there were no significant differences in macronutrient profiles (Ziegler et al., 2006; Worobey et al., 2005). Two previous studies (Sepp et al., 2001; Worobey et al., 2005) reported that energy intake was higher at home; however, three studies (Ziegler et al., 2006; Gubbels et al., 2014; Bernardi et al., 2010) reported that energy intake was equivalent between environments. Ziegler et al. (Ziegler et al., 2006) studied toddlers, not preschoolers, and lacked an objective assessment of meals at childcare, since parents reported all foods and CACFP-participation was not indicated. Cultural differences may explain the discrepancy between the other two studies (Gubbels et al., 2014; Bernardi et al., 2010) and ours, as both were conducted outside the U.S. Further demonstrating potential cultural differences, three international studies (Gubbels et al., 2014; Bernardi et al., 2010; Sepp et al., 2001) reported different macronutrient profiles consumed at home versus childcare, while our study and others in the U.S. (Ziegler et al., 2006; Worobey et al., 2005) did not even though CACFP participation was clear in our study as well as Worobey et al. (Worobey et al., 2005).

Consumption of calcium (Bruening et al., 1999) and vitamin A (Sepp et al., 2001) relative to energy consumed was higher at childcare than home, likely due to higher intake of low-fat dairy products. Although there were no differences in iron, zinc, folate, or vitamin B6 intake between environments, some previous studies indicated more micronutrients intake at childcare (Ziegler et al., 2006; Bruening et al., 1999), although others showed no difference (Briley et al., 1999). Of these previous studies Ziegler et al. (Ziegler et al., 2006) and Briley et al. (Briley et al., 1999) did not indicate CACFP participation while centers included in Bruening et al. (Bruening et al., 1999) did participate in the program. Our method of evaluating micronutrients relative to energy was unique. As children consumed more food at home, it could be assumed that a greater volume of food would be associated with a greater volume of micronutrients; thus, we felt it prudent to account for the total energy of the meal when evaluating micronutrients.

Discussion of strengths and limitations is warranted. Strengths include researcher observation of lunch meals to more accurately ascertain volume rather than menu analysis or proxy report. Childcare centers were recruited from across the state, but may not have been representative of all childcares. Participation in CACFP was not recorded, although state licensure requires all centers to adhere to CACFP guidelines (Oklahoma Department of Human Services, 2016). Greater understanding of dietary quality in centers that participate in the CACFP would enhance the application of child nutrition at childcare versus home environments. Fewer caregivers participated in the dinner recall than children who were observed at lunch, which may introduce response bias. Although, no difference between weekend and weekday dinners was observed, dietary intake from dinner included both while childcare only included weekdays. The socioeconomic status of families was not recorded in this project which may impede the ability to generalize findings to similar populations. As a state, Oklahoma has a high prevalence of rural and low-income families. While children or childcare kitchen staff may have altered behavior or foods during observation, this is unlikely since researchers did not interact with children and observation dates were unknown to cooks. While observing dinner meals was not feasible, limitations exist for dietary recall, which may decrease accuracy, as not all details of food preparation may be remembered. Further, social desirability bias may have influenced parental response.

There was risk of underestimation of energy-dense foods due to each food being counted as a serving, which does not consider the volume of the serving. For example, a child could eat ten chicken nuggets, which would only be counted as one energy-dense food. The kilocalories and fat would be reflected in the nutrient analyses (i.e., kilocalories). This method of assessment also risks overestimation of fruits and vegetables, since each single fruit was counted rather than a full volume serving size. While this errs in the favor of caregivers who expose children to multiple small amounts of fruits and vegetables in a given meal, it overestimates the actual volume consumed.

Further investigation comparing the meal consumption of preschool-age children throughout the entire day, including cultural and seasonal differences, and snacking, would provide a complete understanding of intake and areas for improvement. Additionally, it is suggested that examination of dietary intake of children attending centers that participate in CACFP versus those that do not would provide further understanding of those policies and the provision of adequate nutrition to children at childcare. Utilization of emerging technology may assist in accurate meal representation from home when observation is not feasible. Assessing barriers that prevent caregivers from providing maximally nutritious meals would aid in the development of interventions.

This study demonstrated that preschool-age children consumed more nutrient-dense foods and micronutrients at childcare than at home, and children are consuming more energy-dense foods and sugary drinks at home. Implications of this study emphasize the importance of the CACFP (United States Department of Agriculture, 2015) and congruent state regulations (Oklahoma Department of Human Services, 2016). While nutritional inadequacies are reported in childcare (Benjamin Neelon et al., 2012; Briley et al., 1999; Gubbels et al., 2014; Rasbold et al., 2016), federal and state regulation likely enhance the quality of foods prepared for children and appear healthier than foods provided at home. While a wider variety of foods were consumed by individual children in their homes the total fruit and vegetable consumption was lower at home indicating that some children are being served a variety of foods at home. Although this discrepancy also emphasizes the importance of the childcare providers in serving a variety of foods to all

children regardless of home caregiver food provision and home food availability. Preschool-age children are dependent on caregivers for food that supports normal growth and development in both environments. The optimal diet for children includes consistent provision of nutrient-dense foods by both parents and childcare providers.

Conflict of interest

No authors have a conflict of interest to report.

Transparency document

The Transparency document associated with this article can be found, in the online version.

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