Exploring the relationships between dietary intake of early childhood education (ECE) teachers and nutrition best practices in ECE centers

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Abstract

Exploring relationships between dietary intake of early childhood education (ECE) teachers and nutrition best practices in ECE centers

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Background: Early childhood education (ECE) teachers have integral roles in communities as caretakers and educators of young children. Food served in the ECE setting can account for over two-thirds of the diet of children in full-time care, and evidence-based best practices related to nutrition are recommended to establish healthy eating behaviors in children. For these reasons, the nutrition culture in ECE is of increasing interest for public health research and intervention. There is less evidence, however, regarding whether and how teachers' dietary intake may influence their nutrition- and food-related interactions with children. We hypothesized that healthier teacher dietary intake may be positively associated with increased adherence to best feeding practices in the centers at which they work.

Methods: In this cross-sectional study, 366 ECE teachers from 49 ECE centers located in Seattle, WA, South King County, WA and Austin, TX were surveyed. Teachers completed the National Cancer Institute's Dietary Screener Questionnaire to measure dietary intake and the six-item short form of the United States Department of Agriculture (USDA) Food Security Survey Module to assess food security. Center directors filled out a questionnaire gathering basic information about their center, as well as the Nutrition and Physical Activity Self-Assessment for Child Care (NAPSACC), which measures the degree to which centers follow best practices in regards to food and nutrition. Spearman rank correlation and Kruskal-Wallis with post-hoc Dunn tests were performed to examine associations between teacher dietary intake and nutrition-related practices in their employing ECE centers.

Results: Thirty-nine percent of teachers self-reported being food insecure. Food insecurity was associated with several differences in teachers' dietary intake: lower fruit and vegetable intake (-0.14 cup and -0.19 cup respectively), higher added sugar intake (+1.0 tsp. per day), and only slightly lower meat intake (-0.03 time per day). Teacher intake of fruits, vegetables, and whole grains were lower than

national recommendations, and added sugar intake above national recommendations. However, teacher dietary intake of most food groups was comparable to national averages. There was considerable heterogeneity in the NAPSACC scores and sub-scores of centers. NAPSACC scores and sub-scores were high (74% to 89% of maximum possible scores), indicating center practices were close to recommended best practices. Spearman rank correlation tests revealed five weak associations between: fruit intake and the NAPSACC feeding environment sub-score (ρ=0.1209, p=0.0308); combined fruit and vegetable intake and the feeding environment sub-score (ρ=0.1356, p= 0.0154); fruit intake and the feeding practices sub-score (ρ=0.1330, p=0.0249); added sugar intake from SSBs and the professional development sub-score (ρ=0.1408, p=0.0132); and, red and processed meat intake and the menu sub-score (ρ=0.1556, p=0.0055). Kruskal-Wallis tests of differences in NAPSACC scores by quintile of teacher intake of individual food groups with a post-hoc Dunn test found that two of these associations remained significant: fruit intake and the feeding environment (Z=2.90 p=0.0018), and meat intake and the menu sub-score (Z=2.27, p=0.005).

Conclusion: Our findings showed limited weak associations between ECE teacher dietary intake and ECE center best practices. However, the fact that teacher intake of most food groups was not associated with any difference in NAPSACC total score or sub-scores suggests our limited findings may be spurious and not indicative of a true association between teachers' dietary quality and ECE best practices In our findings, the high rate of food insecurity and low dietary quality of teachers is in stark contrast to the high frequencies of best practices regarding food served to children. This strongly suggests that quality of care related to nutrition in ECE is determined by center-level and external policies and not teacher intake. It also suggests that policies which more directly promote teacher nutrition may be beneficial, and future interventional research should attempt to identify supportive policies or practices, such as providing free or low-cost meals, which may benefit teachers. Further research should also investigate if teacher food insecurity is related to quality of care indicators not measured here, and if children's actual dietary intake (versus the quality of food served to children) is associated with teacher intake or food security status.

Introduction

Early childhood education (ECE) teachers have integral roles in communities as caretakers and educators of young children. The most recent childcare census estimates that almost one-third of US children under five years old were cared for by a non-relative, and over 70% of those were in an organized care facility (versus family home programs).[1] This has a particular bearing on childhood nutrition, as food served in the ECE setting can account for over two-thirds of the diet of children in full-time care.[2] The early childhood period establishes taste preferences that often carry into adulthood[3] and can influence risk of both childhood obesity [4,5] and chronic disease later in life.[6] For these reasons, the nutrition culture in ECE is of increasing interest for public health research and intervention. Obesity prevention trials using the ECE setting for intervention delivery have had some successful impacts on anthropometrics and nutrition outcomes in children.[7–9]

Nutrition culture in ECE is formed from a constellation of factors. Logistical and environmental concerns, such as the availability and cost of healthy food, have been identified as factors affecting a center's ability to meet dietary standards.[10,11] However, the food a center provides is only part of the overall nutrition culture: how teachers interact with children around food is equally important. Best practices for feeding children include role modeling[12,13], responsive feeding practices[14–16], serving meals family-style[17], and not using food as a reward.[13] The American Academy of Pediatrics recommends that teachers use best practices when caring for children in the ECE setting in order to best support healthy outcomes in children.[18,19] Centers' use of written internal policies (and associated staff training) mandating compliance with nutrition best practices has been found to be associated with increased use of some best practices.[20,21] The same is true for external policies, such as participation in the Child and Adult Care Food Program (CACFP)[22] or city- or state-level policy changes to ECE nutrition standards.[23]

There has been less research, however, into how teachers' own dietary intake may influence their interactions with children. A cross-sectional survey of 118 ECE teachers by Dev, *et al.* found that teachers who were trying to lose weight, or who considered their own nutrition to be of high importance were more likely to use restrictive feeding practices with children.[24] Teachers also report that their own childhood experiences with food, including food insecurity, shape their current practices.[25]

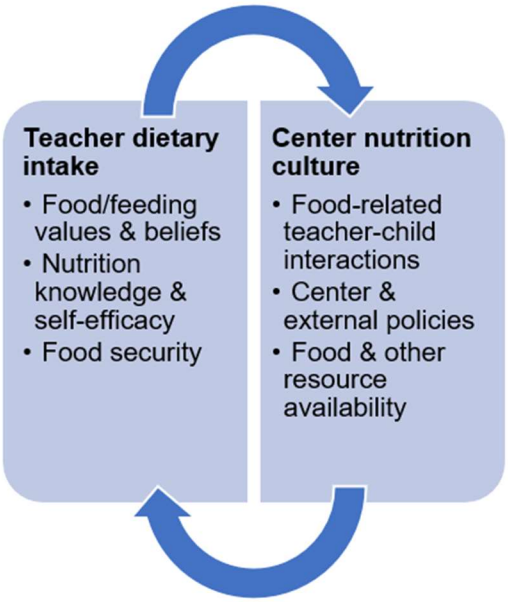
Nutrition knowledge is a potential influence to consider for both teacher intake and teacher-child interactions. A recent systematic review found that nutrition knowledge can have a significant positive relationship with dietary quality of adults, thought the authors point out that adults of lower socio-economic status are underrepresented in the body of research.[26] Interestingly, however, qualitative interviews with teachers have suggested that self-efficacy related to their own nutrition may determine how well teachers role-model healthy eating for children under their care.[27] Teacher self-efficacy and knowledge about nutrition were found to have a significant positive effect on both the food environment and feeding practices in a longitudinal study.[28] Lastly, in a systematic review by Seward *et al.,* both qualitative and quantitative evidence identifying teachers' lack of nutrition knowledge was found to be a barrier to implementation of dietary guidelines in ECE.[29]

The ECE workplace could, in turn, be an influence on teachers' dietary intake. An overwhelmingly female population[30], ECE teachers are a largely low-wage workforce, with recent research estimating that 42% live below the poverty level.[31] In the Seattle area, the Bureau of Labor Statistics estimates that childcare providers earn an average hourly wage of $13.98, with a mean annual salary of approximately $29,000. In the area of Austin-Round Rock, Texas the average wage is $11.35, with an average annual salary of approximately $24,000. In contrast, the mean per capita income is $51,872 in Seattle and $37,888 in Austin, TX.[32] An estimated living wage* for a single adult is $15.92/hour in King County (which contains Seattle) and $12.56 in Austin-Round Rock. For a family of four with two working adults, the living wage increases to $19.17 in King County and $15.64 in Austin-Round Rock.[33] One recent study by Swindle, *et al.* estimates that approximately one-third of teachers are food-insecure, with teachers working in private ECE centers at higher risk than Head Start or state-funded programs.[25] Given the well-established association between food insecurity and poorer diet quality[34,35], low wages may impact ECE teachers' diets.[36] Conversely, teachers working at centers with a more robust nutrition culture may be better informed or motivated in regard to their own diets. Aggarwal *et. al* found that a positive attitude towards healthy eating predicted better dietary quality, independent of socio-economic status (SES).[37] Similarly,

* "Living wage" refers to the wage required to meet basic needs, such as food, transportation, housing, healthcare and childcare, adjusted for the cost of living specific to a geographic location.[33]

the findings of Deroover *et al*. suggest that practical nutrition knowledge can mediate the relationship between SES and dietary quality.[38] Specific to ECE, ECE interventions have had success in improving teacher knowledge about nutrition.[9,39] There is some evidence to support the phenomenon in which trainings to improve the health behaviors of others improves the health of trainees[40], although we are not aware of any ECE-specific evidence for this relationship. Figure 1, below, outlines how some of the ways in which teachers' dietary habits and the ECE workplace may influence one another. In light of these possible dynamics, we hypothesize that healthier teacher dietary intake may be positively associated with increased adherence to best feeding practices in the centers at which they work.

Figure 1: Conceptual model of nutrition culture dynamics in ECE



Methods

Study design

This cross-sectional secondary analysis used baseline data collected from a prospective cohort of early childhood education teachers[†] as part of a larger study titled Exploring Effects of Wage on the Culture of Health in Early childhood Education Centers. The aim of this study is to examine the potential effects of a minimum wage increase in Seattle and South King County, Washington, on the health of ECE teachers and health-related practices in ECE care centers as compared with a control group in Austin, TX.

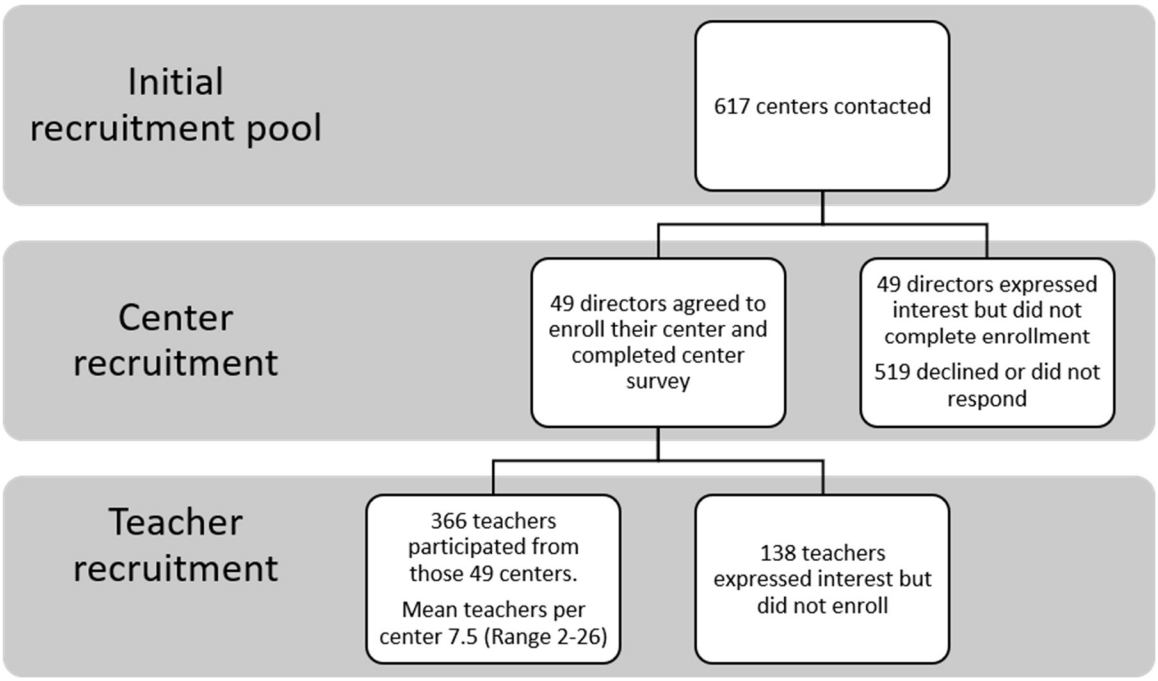
Recruitment

A list of childcare center names and contact information for centers in these locations was obtained via Childcare Aware of America. Centers participating in the Head Start program were excluded because of the difficulty comparing those centers to others, given the program's specific requirements for educational, health, and social support in childcare, including teacher training and child-teacher ratios.[41] In-home centers were also excluded both because Seattle and Washington State minimum wage policies are less likely to apply to businesses with so few employees and to limit sample heterogeneity, as care practices, child nutrition policy, and child demographics can be markedly different between home and center-based childcare, making comparison across the sample difficult.[42–45]

Figure 2 shows the recruitment of centers into the study. Initial contact to 617 eligible centers describing the study was made via an email to the center director. At any time, if a director was interested in enrolling the center, he or she was contacted by phone by the study research coordinator. After follow-up was complete, 49 ECE centers were recruited. An equal number of centers was purposively recruited from each of the study arms (Seattle and South King County, WA and Austin, TX) for purposes of the parent study.

[†] Regarding the term "teachers": See Table 4 for job titles of participants. While not all are employed as teachers, we will use this term going forward for all ECE workers enrolled in the study, as they all work directly with children and participate in their development and education.

Figure 2: Recruitment



At a subsequent in-person visit to the center, directors were given a center-level survey that included questions about the characteristics of the center and the NAPSACC survey (see study measures, below) to be returned by mail. At the same visit, study staff met with center staff to describe the study and recruit teachers to participate. Teachers indicated willingness to participate on postcards which asked for contact information so that additional study materials could be sent by mail or email. Inclusion criteria were that participants work directly with children and have sufficient English proficiency to fill out the questionnaire and study consent form. Directors who also worked directly with children were eligible to participate. Postcards were collected directly by study staff so that center directors did not know which teachers opted to participate. From the 49 centers enrolled, 504 teachers indicated interest in learning more about the study and were sent a survey and consent form. Once the consent form was signed, the teacher was enrolled in the study. After multiple follow-up attempts, 138 (27%) of interested teachers did not enroll.

Study Measures

Center survey

The 46-item center survey was sent to directors to capture data related to the number and types of employees and their wages as well as general characteristics of the center, including the number and age groups of children enrolled, how many children receive state or federal subsidies, and the state and federal child care programs in which the center participates. In addition, basic financial data such as wages and benefits paid to staff, tuition rates by child age, and net and gross income were gathered.

Information about nutrition-related best practices was collected via the NAPSACC (Nutrition and Physical Activity Self-Assessment for Child Care) survey developed by University of North Carolina. NAPSACC, a self-assessment tool, is designed to measure adherence to evidence-based best practices in ECE.[46] In a 2007 publication, the tool was evaluated for test-retest and inter-rater reliability, as well as validation, which concluded NAPSACC is a stable tool for ECE evaluation.[47] The survey consists of seven modules, four of which were used for our larger parent study: child nutrition, breastfeeding and infant feeding, infant and child physical activity, and outdoor play and learning. This analysis will include only the nutrition module, for which each of the 45 questions are scored 1-4, with 4 corresponding to the best practice or highest frequency of a best practice. For example, when asked how often the program provides fruit which is fresh, frozen, or canned in water (not syrup), a response of twice per week or less earns one point, and twice or more per day earns four points. The six sub-sections covered by the survey are nutritional quality of food and beverages served to children, feeding environment, feeding practices, menu, and continuing nutrition education and professional development for staff (examples in Table 1).

Table 1: example questions and scoring for NAPSACC sub-sections

Sub-section	Topics covered	Sample question
Food & beverages provided	How often healthy and unhealthy foods and beverages are served to children	Our program offers fruit that is fresh, frozen or canned in juice (not in syrup): □ 2 times per week or less [1 point]* □ 3-4 times per week [2 points] □ 1 time per day [3 points]

		□ 2 times per day or more [4 points]
Feeding environment	Role modeling, portions, vending machines, educational and promotional materials related to food	Teachers enthusiastically role model eating healthy foods served at meal and snack times: □ Rarely or never [1 point] □ Sometimes [2 points] □ Often [3 points] □ Every meal and snack time [4 points]
Feeding practices	Teacher-child interactions at mealtimes	Teachers require that children sit at the table until they clean their plates □ Every meal and snack time [1 point] □ Often [2 points] □ Sometimes [3 points] □ Rarely or never [4 points]
Menus & variety	How often menus are cycled, variety of healthy foods	Weekly menus include a variety of healthy foods: □ Rarely or never [1 point] □ Sometimes [2 points] □ Often [3 points] □ Always [4 points]
Education & professional development	Nutrition education for children, continuing nutrition education for staff	Teachers and staff receive professional development on child nutrition: □ Never [1 point] □ Less than 1 time per year [2 points] □ 1 time per year [3 points] □ 2 times per year or more [4 points]
Policy	Number of nutrition topics from provided list covered by center's written policy	Our written policy on child nutrition includes the following topics [see NAPSACC survey via reference [46] for full list] □ No written policy or policy does not include these topics [1 point] □ 1-4 topics [2 points] □ 5-8 topics [3 points] □ 9-10 topics [4 points]

*Point value for questions does not appear on survey. Answers also include equivalents for part-time programs, which are not presented here, but can be found in the full NAPSACC survey via reference [46].

Teacher survey

The teacher questionnaire for the main study included a total of 247 questions, which participants could mail in or fill out online. It collected demographic and income data, and also included measures related to physical and mental well-being and occupational health. Teachers' food security was measured using the six-item short form of the USDA Food Security Survey Module.[48] The original eighteen-item version was

developed in 1992 to serve as a national benchmark measure for food security, and was successfully tested for validity using US Census Bureau's Current Population Survey data.[49] The short form minimizes respondent burden and in an evaluation study, correctly identifies the food security status of approximately 98% of households.[50] For each question, respondents indicate how often in the past 12 months they experienced certain difficulties related to food security, such as not being able to purchase the type of food they wanted, worrying about running out of food without being able to buy more, or reducing the size of meals because of not having enough money for food. The responses are then tabulated to classify a respondent as having high or marginal food security, low food security (also called food insecurity without hunger), or very low food security (also called food insecurity with hunger).

Dietary intake was measured using the National Cancer Institute's 26-item Dietary Screener Questionnaire (DSQ). The survey was utilized in the 2009-2010 NHANES (National Health and Nutrition Evaluation Survey) cycle, to develop its scoring algorithms (described below) via comparison to twenty-four hour dietary recalls.[51] The DSQ, a food frequency questionnaire (FFQ) asks about habitual intake of foods selected for their relationship to the dietary factors of interest. For example, to estimate frequency of whole grain intake, the DSQ relies on the frequency of cereal, whole grain bread, popcorn and brown rice consumption. Then, using NHANES-derived portion sizes adjusted for both age and sex, the DSQ estimates the total quantity consumed (in grams, teaspoon, or cup equivalents) of nine dietary factors[52], seven of which are included in this analysis (Table 2). Calcium and fiber intake were both excluded (Table 3), as they have significant overlap in terms of foods included with dairy and whole grains, respectively. In addition, French fries were excluded from vegetable intake, as they are not health promoting[53] and foods with added fat and salt are not included in recommended food group intake per national guidelines.[54]

Table 2: Foods whose intake are measured by DSQ, grouped by dietary factor

Dietary factor	Food items on survey used to estimate total intake of dietary factor
Fruits and vegetables (cup equivalents per day)	Fruit
	Fruit juice
	Salad

	Other [not fried] potatoes
	Dried beans
	Other vegetables
	Tomato sauce
	Salsa
	Pizza
Added sugars (tsp. equivalents per day)	Soda*
	Fruit drinks*
	Cookies, cake, pie
	Doughnuts
	Ice cream
	Sugar/honey in coffee/tea*
	Candy
	Cereal and cereal type
Added sugars from SSBs (tsp. equivalents per day)	Items listed under *added sugars* marked with * above
Dairy (cup equivalents per day)	Milk
	Cheese
	Ice cream
	Pizza
Whole grains (ounce equivalents per day)	Cereal and cereal type
	Whole grain bread
	Popcorn
	Whole grain rice
Red meat (times per day)	Red meat
Processed meat (times per day)	Processed meat

Table 3: DSQ food items not included in analysis

Dietary Factor	Food item	Why factor or item omitted
Fiber (gm)	Nearly all foods	Significant overlap with whole grains, fruits, and vegetables, above.
Calcium (mg)	All or nearly all foods	Significant overlap with dairy, above.
Vegetables	Fried Potatoes	Not a health-promoting food.[53]

Quality Assurance

Teachers were contacted by phone to obtain responses to unanswered survey questions. If a teacher selected two frequencies for a given food, the more frequent choice was used to minimize the number of unknown fields. Seventeen respondents had a missing response to a food security question which was then inferred using the USDA Guide to Measuring Household Food Security.[55] Directors were contacted via email for missing or unclear information, which yielded a 100% response rate.

Data Analysis

Analysis was performed using Stata version 14.2 (StataCorp LLC, College Station, TX). Descriptive summary statistics were calculated for ECE teachers' demographics, dietary intake, and food security and for ECE centers' characteristics, wage information, and NAPSACC nutrition scores. The differences in dietary factor intake between food insecure and food secure teachers was examined using independent sample t-tests. Due to NAPSACC score and sub-scores being ordinal response variables, Spearman rank correlation was used to measure association between teacher dietary quality and NAPSACC scores. Kruskal Wallis with post-hoc Dunn tests were then used to determine potential differences in NAPSACC scores by quintile of teacher intake of individual food groups.

Results

Teacher characteristics & dietary intake

The final sample included 366 ECE teachers from 49 centers. Characteristics of ECE teachers are in Table 4. ECE teachers were predominantly (93%) female. The majority (62%) of our sample identified as white, 11% as African-American, and 6% as Asian. Twenty percent identified as being of Hispanic and/or Latino ethnicity. Participants had a high rate of food insecurity, with almost 40% identified as having low or very low food security, considerably higher than the nationwide rate (approximately 11% in 2018).[56] Despite this, only 23% participated in one or more food assistance programs. In regards to dietary intake, ECE teachers consumed fewer fruits, vegetables and whole grains than is recommended by the USDA (Table 5). We cannot directly compare teachers' dairy intake to recommended intake. This is because USDA guidelines emphasize low-fat dairy including cheese, yogurt and milk[54] while the DSQ measures intake from other dairy sources (see Table 2). While these other sources are potentially nutrient-dense in terms of protein and calcium, some are also high in added fat and sugar, which is inconsistent with recommendations.[54] Teachers had low consumption of red and processed meat, which is consistent with recommendations to limit processed meat, but higher than recommended consumption of added sugar,

both overall and from SSBs alone. Food insecurity was significantly associated with slightly lower intake of fruits, vegetables, and red and processed meats, and a slightly higher intake of added sugar (Table 6).

Center characteristics & NAPSACC scores

Characteristics of ECE center are in Table 7. In terms of profit status, participating centers were split evenly between non-profit and for-profit, aside from three college or university-affiliated centers. The majority were single-site centers, but 16 (33%) had multiple sites. They varied considerably in size, with four centers having less than twenty enrolled students, twenty-three with 20-49 students, seventeen with 50-99 students, and three with 100 or more students. Tuition, similarly, ranged widely, with a range of approximately $500 to $2100 per month for a four-year-old child in full-time care. Most centers (82%) had children enrolled whose care was paid for, at least in part, by a state subsidy program, with fewer (64%) having tuition paid for by city-level or other subsidy programs. Most (92%) had one or more written policies on nutrition-related topics. Adherence to other best practices varied widely across centers but average scores represented 75-89% of maximum possible scores (Table 8). The average total NAPSACC score was 86% of a maximum possible score. Compared to the maximum possible sub-scores, the education and professional development sub-score was the lowest at 76%, with the other sub-scores approximately equal at 88-89%.

Table 4: ECE Teacher demographic & nutrition-related characteristics

Study arm	**N (%)**
Seattle, WA	145 (40%)
South King County, WA	98 (27%)
Austin, TX	123 (34%)
Position	**N (%)**
Center director	29 (8%)
Program coordinator	17 (5%)
Lead teacher or instructor	121 (33%)
Teacher or instructor	95 (26%)
Assistant teacher or instructor	78 (21%)
Aide	3 (1%)
Other*	23 (6%)
Age	**Mean (range)**
	36.4 (18-79)
Gender	**N (%)**
Female	340 (93%)
Male	23 (6%)

Other	3 (1%)	
Education	**N (%)**	
Some high school or less	7 (2%)	
High school graduate	59 (17%)	
Some college in ECE	59 (17%)	
Associate's or Bachelor's degree	202 (57%)	
Master's degree or higher	27 (8%)	
Race	**N (%)**	
White	227 (62%)	
Black or African-American	42 (11%)	
Asian	22 (6%)	
Other	75 (20%)	
Ethnicity	**N (%)**	
Latino	75 (20%)	
Not Latino	291 (80%)	
Type of compensation	**N (%)**	
Hourly	294 (80%)	
Salaried	72 (20%)	
Wage	**Mean (SD)**	**Range**
Hourly	$15.14 (4.49)	$8.71-$70.00
Seattle, WA	$16.77 (2.44)	$13.00-$24.90
South King County, WA	$13.76 (2.87)	$11.00-$30.00
Austin, TX	$14.17 (7.05)	$8.71-$70.00
Salaried (per year)**	$39500 (14269)	$14000-$85000
Seattle, WA	$44500 (11003)	$30000-$70000
South King County, WA	$38900 (16715)	$23900-$69000
Austin, TX	$36900 (15055)	$14000-$85000
Food security	**N (%)**	
High or marginal food security	197 (61%)	
Low food security	61 (19%)	
Very low food security	66 (20%)	
Food Assistance Program Participation	**N (%)**	
None	274 (75%)	
SNAP/EBT	43 (12%)	
Free/reduced price school breakfast/lunch for kids	32 (9%)	
Women, Infants, & Children (WIC)	27 (7%)	
Food bank/pantry	15 (4%)	
Farmers Market Nutrition program for WIC (FMNP)	6 (2%)	
Don't know	6 (2%)	

* "Other" includes administrative support staff, food service, and assistant director.
** 6 extreme values not included due to likely participant error. Means rounded to nearest $100.

Table 5: Estimated ECE teacher daily intake of food groups based on responses to DSQ

Food group	N	Mean (SD)	Min-Max	Recommended intake*
Vegetables (cup equivalents)	342	1.42 (0.38)	0.81-3.16	2½ c-eq/day
Fruit (cup equivalents)	348	0.92 (0.35)	0.45-2.28	2 c-eq/day
Fruit & vegetables (cup equivalents)	339	2.51 (0.61)	1.56-4.97	4½ c-eq/day
Added sugar (tsp.)	328	14.74 (4.28)	9.97-34.22	<10% of total kcal (~12 tsp.)
Added sugar from sugar-sweetened beverages (tsp.)	357	5.85 (2.62)	3.57-19.08	limit
Whole grains (oz. equivalents)	336	0.65 (0.28)	0.34-1.87	≥ 3 oz-eq/day
Red or processed meats (times eaten)	364	0.45 (0.44)	0-3	Limit processed meats
Dairy (cup equivalents)	340	1.4 (0.36)	0.89-3.25**	3 c-eq/day**

* 2015-2020 Dietary Guidelines for Americans (USDA) for a 2000 calorie diet.[54]
**See comments above regarding measurement of dairy intake by DSQ vs. USDA recommendations.

Table 6: Teacher dietary intake by food security status

Daily Intake	Mean (SD); 95% CI		p-value
	High or marginal food security	Low or very low food security	
Fruit (cup equivalents)	0.98 (0.36);0.93-1.03	0.84 (0.31); 0.78-0.90	**0.0006**
Vegetables (cups equivalents, excluding French fries)	1.50 (0.42); 1.44-1.56	1.31 (0.33); 1.25-1.37	**0.0000**
Fruits and vegetables combined (cup equivalents)	2.66 (0.64); 2.57-2.76	2.33 (0.50); 2.24-2.42	**0.0000**
Red or processed meat (times per day)	0.49 (0.45); 0.43-0.56	0.46 (0.43); 0.41-0.50	**0.0434**
Added sugar (tsp.)	14.27 (3.64); 13.73-14.81	15.27 (4.90); 14.37 16.16	**0.0463**
Added sugars from SSBs (tsp.)	5.66 (2.45); 5.32-6.01	5.75 (2.45); 5.32-6.18	0.7662
Whole grains (oz. equivalents)	0.64 (0.27); 0.60-0.68	0.66 (0.30); 0.61-0.72	0.4497
Dairy (cup equivalents)	1.42 (0.37); 1.37-1.47	1.36 (0.31); 1.30-1.41	0.1358

Table 7: Center Characteristics

Study arm	N (%)

Seattle, WA	16 (33%)
South King County, WA	16 (33%)
Austin, TX	17 (35%)
Number of full-time employees	**N (%)**
14 or less	21 (45%)
15-30	22 (47%)
>30	4 (9%)
Average hourly wage of full-time employees	**N (%)**
$7.00–$13.00	16 (35%)
$13.01–$15.00	12 (26%)
$15.01–$21.00	18 (%)
Profit status	**N (%)**
Nonprofit	23 (49%)
For profit	21 (45%)
Affiliated with community college or university	3 (6%)
Number of children enrolled in full-time care	**N (%)**
<20	4 (9%)
20-49	23 (49%)
50-99	17 (36%)
100 or more	3 (6%)
Monthly tuition for a 4-year-old	**N (%)**
<$1,000	20 (44%)
$1000-$1499	18 (40%)
$1500 or more	7 (16%)
Number of sites	**N (%)**
Single-site program	29 (60%)
2-5 sites	13 (27%)
6 or more sites	3 (6%)
Percent of children enrolled whose care is paid for (at least in part) by state subsidies	**N (%)**
Less than 10%	11 (22%)
10-50%	14 (29%)
More than 50%	11 (22%)
Unknown percentage	4 (8%)
Center does not accept state subsidies	6 (12%)
Center accepts states subsidies but has no currently enrolled families utilizing them	3 (6%)
Other subsidy status	**N (%)**
Center has at least 1 child enrolled who is participating in a city-level or other subsidy program	29 (64%)

Table 8: Center NAPSACC total score and nutrition-related sub-scores

Variable	N	Mean (SD); 95% CI	Min-max
Total NAPSACC score 45 questions, possible score range 45-180)	32	155.3 (13.1); 150.6-160.0	119-176

Sub-scores:			
Food & beverages provided [to children] (18 questions, possible score range 18-72)	36	63.8 (5.3); 62.0-65.6	49-71
Menu (2 questions, possible score range 2-8)	48	7.1 (0.2); 6.8-7.4	3-8
Feeding Environment (8 questions, possible score range 8-32)	49	28.1 (3.1); 27.3-29.0	18-32
Feeding Practices (10 questions, possible score range 10-40)	43	35.6 (2.8); 34.7-36.5	27-40
Education & professional development (6 questions, possible score range 6-24)	47	17.9 (4.2); 17.1-18	8-24
	N	**%**	
Number of recommended nutrition topics* included in center's written policies (1 question)	48	100%	-
No written policy or policy does not include these topics	4	8%	-
1-4 topics	13	27%	-
5-8 topics	19	40%	-
9-10 topics	12	25%	-

Relationships between teacher dietary intake & NAPSACC

Spearman rank correlation coefficients showed weak but statistically significant associations between 5 pairs of variables. First, there was a positive association between both ECE teacher fruit intake and combined fruit and vegetable intake and the NAPSACC feeding environment sub-score. There was a significant positive association between ECE teacher fruit intake and the feeding practices sub-score, and between added sugar intake from SSBs and the professional development sub-score. In addition, there was a significant association between red and processed meat intake and the menu sub-score. We found no significant associations between teacher intake of any food group and the total NAPSACC score or food provided sub-score (Table 9).

In a subsequent analysis, we divided teachers into quintiles of intake for each food group, and using Kruskal Wallis, found five significant differences in NAPSACC scores when they were analyzed by quintile of teacher intake (Tables 10-14). First, mean environment sub-score was significantly different across fruit intake quintiles. Second, the food provided sub-score differed significantly across added sugar intake quintiles. Third, the menu sub-score differed significantly across quintiles of meat intake. Fourth and Fifth,

mean total score and mean food provided sub-scores differed between quintiles of whole grain intake. For these significant associations, post-hoc analyses using Dunn's test were then performed to determine if there was a significant difference in NAPSACC scores between the first and fifth intake quintiles (figures 3-7). The only significant findings were between fruit intake and the environment sub-score, in which an approximately one-cup difference in fruit intake was associated with a 1.5-point increase higher sub-score, and between meat intake and the menu sub-score, in which a difference of eating meat one additional time per day was associated with a 0.4 point higher sub-score.

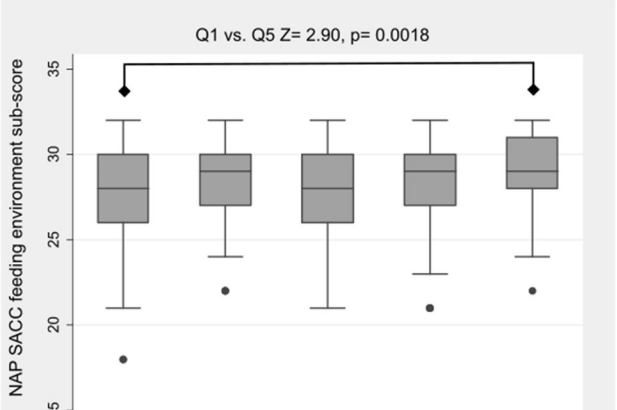
Table 9: Spearman's rank correlation coefficient rho (ρ) between teacher daily intake of food groups & center NAPSACC scores. Significant associations indicated in **bold** font.

	Total NAPSACC score		**Food provided sub-score**		**Menu sub-score**		**Feeding environment sub-score**		**Education & professional development sub-score**		**Feeding practices sub-score**	
Teacher intake food group	ρ	p-value	ρ	p-value	ρ	p-value	ρ	p-value	ρ	p-value	ρ	p-value
Fruit & vegetables (cup equivalents)	-0.0005	0.9942	-0.0074	0.9129	-0.0140	0.8039	**0.1356***	**0.0154**	0.0422	0.4602	0.0553	0.3529
Fruit (cup equivalents)	0.0646	0.362	0.0103	0.8791	-0.0386	0.4938	**0.1209***	**0.0308**	0.0768	0.1783	**0.1330***	**0.0249**
Vegetables (cup equivalents)	-0.0573	0.4188	-0.0125	0.8534	0.0204	0.7179	0.0574	0.307	-0.0293	0.6077	-0.0171	0.7743
Added sugar (tsp.)	-0.0091	0.8977	-0.0068	0.9198	0.0224	0.6913	0.0591	0.2927	0.0741	0.1937	-0.0509	0.3929
Added sugar from SSB (tsp.)	0.0321	0.6512	-0.0587	0.3862	0.0026	0.9630	0.1088	0.0522	**0.1408***	**0.0132**	-0.0036	0.9523
Whole grains (oz. equivalents)	-0.0934	0.1872	-0.0228	0.7367	0.0429	0.4469	-0.0249	0.6578	-0.0492	0.3888	0.0168	0.7776
Meat (times eaten)	-0.0009	0.9904	0.1205	0.0745	**0.1556***	**0.0055**	0.0468	0.405	0.0213	0.7096	-0.012	0.8404
Dairy (cup equivalents)	-0.1148	0.1047	-0.0199	0.7693	-0.0153	0.7866	0.0318	0.5713	-0.0562	0.3244	-0.0903	0.1288

Table 10: Multiple comparison of feeding environment sub-score by teacher fruit intake quintiles using Kruskal Wallis. * indicates significance at alpha level 0.05, ** indicates significance only with ties.

Teacher fruit intake (cups/day)		Feeding environment sub-score				X^2, p-value
Quintile	Mean intake (SD)	N	Mean (SD)	Range	Rank sum	9.54, 0.0489**

Figure 3: Boxplot of fruit intake quintiles with Dunn test to determine difference in feeding environment sub-score between first and fifth quintiles.



1	0.54 (0.05)	71	27.5 (3.15)	18-32	10577.5
2	0.70 (0.04)	69	28.5 (2.36)	22-32	12590
3	0.84 (0.05)	69	28.1 (2.65)	21-32	11439
4	1.00 (0.04)	72	28.4 (2.54)	21-32	12835.5
5	1.51 (0.26)	67	28.9 (2.19)	22-32	13284

Table 11: Multiple comparison of food provided sub-score by teacher added sugar intake quintiles using Kruskal Wallis.

ECE teacher added sugar intake (tsp. day)		Food provided sub-score				X^2, p-value
Quintile	Mean intake (SD)	N	Mean (SD)	Range	Rank sum	
1	10.75 (0.38)	66	64.22 (3.74)	51-71	4853	9.49, 0.0499*
2	12.04 (0.37)	66	66.31 (3.95)	57-71	5550.5	
3	13.61 (0.47)	65	65.55 (4.24)	57-71	5125	
4	15.60 (0.86)	66	65.20 (4.35)	51-71	5493.5	
5	21.81 (3.97)	65	64.24 (4.47)	49-71	5084	

Figure 4: Boxplot of sugar intake quintiles with Dunn test to determine difference in food provided sub-score between first and fifth quintiles

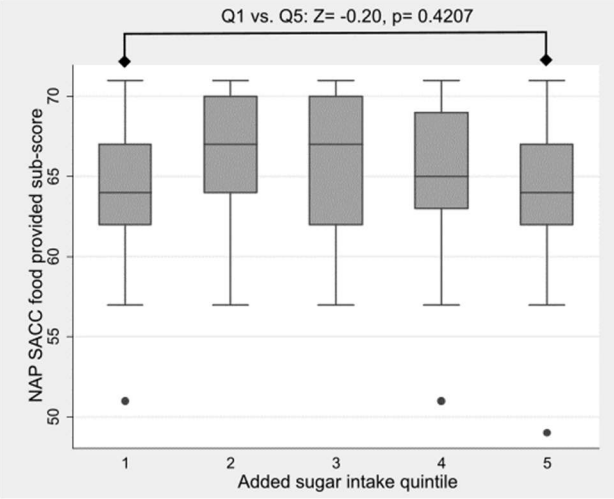
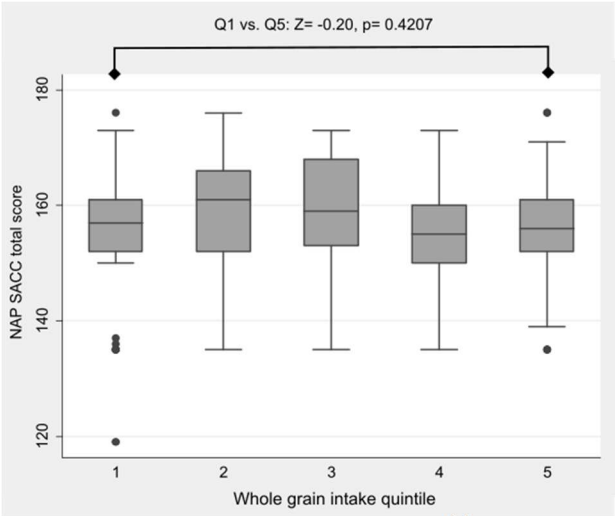


Table 12: Multiple comparison of total NAP SACC score by teacher whole grain intake quintiles using Kruskal Wallis.

ECE teacher whole grain intake (oz. day)		Total NAPSACC score				X^2, p-value
Quintile	Mean intake (SD)	N	Mean (SD)	Range	Rank sum	
1	0.40 (0.03)	45	154.67 (12.63)	119-176	4580	9.893, 0.0423*
2	0.47 (0.02)	42	159.76 (9.63)	135-176	5271.5	
3	0.55 (0.03)	43	159.30 (10.34)	135-176	5266	
4	0.71 (0.06)	40	155.28 (8.40)	135-173	3667	

Figure 5: Boxplot of whole grain intake quintiles with Dunn test to determine difference in NAP SACC total score between first and fifth quintiles



5	1.10 (0.27)	45	155.93 (9.79)	135-176	4435.5	

Table 13: Multiple comparison of food provided sub-score by teacher whole grain intake quintiles using Kruskal Wallis.

ECE teacher whole grain intake (oz. day)		Food provided sub-score				X^2, p-value
Quintile	Mean intake (SD)	N	Mean (SD)	Range	Rank sum	
1	0.40 (0.03)	45	63.35 (5.31)	49-71	4815.5	14.803, 0.0051*
2	0.47 (0.02)	46	66.09 (3.63)	57-71	6075.5	
3	0.55 (0.03)	47	64.57 (3.98)	51-71	6550.5	
4	0.71 (0.06)	48	64.52 (3.92)	57-71	5093.5	
5	1.10 (0.27)	50	64.24 (4.47)	49-71	5195	

Figure 6: Boxplot of whole grain intake quintiles with Dunn test to determine difference in food provided sub-score between first and fifth quintiles

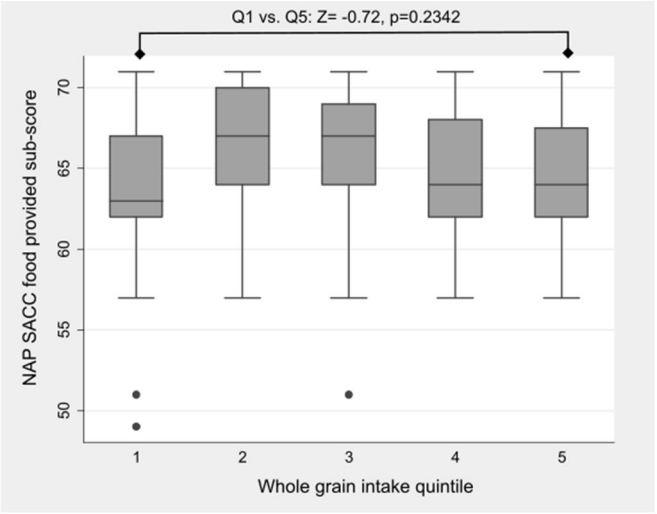
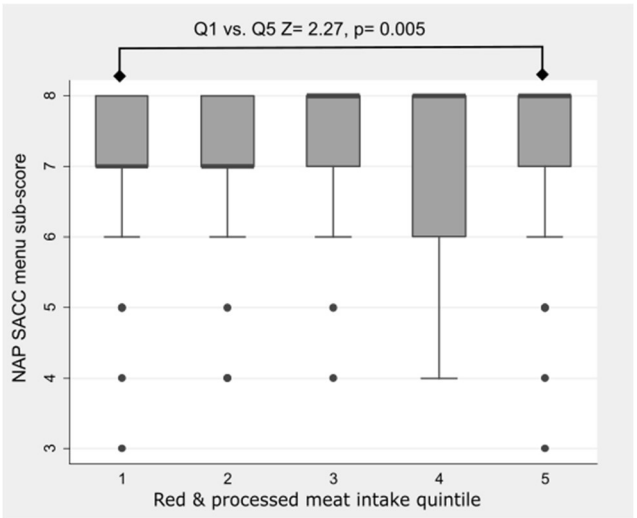


Table 14: Multiple comparison of menu sub-score by teacher red & processed meat intake quintiles using Kruskal Wallis.

ECE teacher meat intake (times/day)		Menu sub-score				X^2, p-value
Quintile	Mean intake (SD)	N	Mean (SD)	Range	Rank sum	
1	0.05 (0.04)	83	6.93 (0.92)	3-8	12333	11.785, 0.0190*
2	0.21 (0.05)	80	7.25 (0.92)	4-8	15103.5	
3	0.39 (0.04)	57	7.28 (0.90)	4-8	10942	
4	0.63 (0.10)	89	7.18 (0.98)	4-8	16324	
5	1.25 (0.54)	52	7.33 (1.06)	3-8	10638.5	

Figure 7: Boxplot of meat intake quintiles with Dunn test to determine difference in menu sub-score first and fifth quintiles. Note: thickened lines used to indicate median overlap with quartiles.



Discussion

The purpose of this exploratory analysis was to describe the dietary intake of ECE teachers and the nutrition practices at their employing centers, and to explore relationships between the two. We found that teachers' intake was below national recommendations for healthy food groups (fruit, vegetables and

whole grains) and above recommendations for added sugar. Centers, in contrast, reported high levels and frequencies of nutrition best-practices. Although initial exploration of the data using Spearman rank correlations showed various associations between teacher dietary intake and best practices as measured by NAPSACC, post-hoc analysis revealed only two weak but statistically significant associations; one between teacher fruit intake and the feeding environment sub-score, the other between teacher meat intake and the menu sub-score.

Teacher Dietary Intake and Food Security

Self-reported dietary intake of teachers in this analysis was comparable to those found in previous studies of ECE teachers by Sharma *et al.*[57], Linnan *et al.*[31] and Swindle *et al.*[25], all of which found that the majority of teachers do not meet recommendations for fruit or vegetable intake. Linnan *et al.* reported a similar finding to ours in regards to the frequency of sugar-sweetened beverages (a frequency of 1.7 times per day compared to our frequency of approximately one time per day, which could be due to geographic differences in our respective samples).[31] It is notable, however, that the dietary intake of fruit and vegetables, added sugar, and dairy reported by teachers are comparable to national averages for adult women. Table 15 compares our findings to national averages as well as recommended intake.

Table 15: Teacher dietary intake compared to USDA recommendations and US average intake

Food group	**Recommended intake per U.S. Dietary Guidelines for Americans[1]**	**Self-reported diet intake of ECE teachers in our sample (n=366)**	**U.S. average dietary intakes***
Vegetables (cup equivalents)	2½ c-eq/day	1.42 (0.38)	1.7
Fruit (cup equivalents)	2 c-eq/day	0.92 (0.35)	1.1
Fruit & vegetables (cup equivalents)	4½ c-eq/day	2.51 (0.61)	2.8
Added sugar (tsp.)	<10% of total kcal (~12 tsp.)	14.74 (4.28)	14.2
Added sugar from sugar-sweetened beverages (tsp.)	limit	5.85 (2.62)	~7**
Whole grains (oz. equivalents)	≥ 3 oz-eq/day	0.65 (0.28)	1
Red meat	No UDSA recommendation specific to red meat; limit high-fat meats	0.28 times per day	0.2 serving
Processed meats	Limit processed meats	0.17 (0.22) times per day	0.4 serving

Dairy (cup equivalents)	3 c-eq/day*	1.4 (0.36)	1.5

*Averages for all foods except added sugars from SSB: 2011-2012 NHANES (Rehm, *et al.* 2016)[60]
** Added sugars from SSB: 2011-2014 NHANES (Rosinger *et al.* 2017)[59]. Approximated based on caloric intake.

In addition, the proportion of teachers in our sample with low or very low food security is comparable to Swindle *et al.*'s findings in which 35% of providers were classified as food insecure.[25] Food insecurity was associated with poorer diet quality, which is consistent with the established body of research. Food insecurity is a major public health concern in large part because the associated decrease in dietary quality[61] confers an elevated risk of chronic disease such as type two diabetes and cardiovascular disease.[62] However, our data show only small differences in intake of fruits and vegetables, which may not be clinically significant. Recent meta-analyses that have suggested a dose-response relationship between fruit and vegetable intake and chronic disease risk generally use differences of approximately one cup or more.[63,64]

Center-level nutrition best practices

Our data showed considerable variation in adherence to nutrition-related best practices, with a large difference between the minimum and maximum NAPSACC scores. While no centers reported perfect levels of best practices across all domains, the data reflects an overall trend towards more desirable practices, with average sub-scores from 74% to 89% of the maximum possible score. Our findings are generally consistent with available research. For example, a 2013 survey of 692 ECE centers in Washington state found that the percent of centers reporting ideal use of best practices varied widely (12-88%) depending on the specific practice in question. This was true of both practices related to food served and those related to teacher behavior. However, as with our data, the majority of respondents indicated the most or second-most desirable response for most best practices addressed on the survey.[65] Other studies have reported similar results; that while ECE centers demonstrate efforts to create a healthy environment by utilizing some best practices, there is a spectrum on how fully individual practices are implemented, and complete adherence is rarely reported.[66–69]

Relationship between teacher diets & Center-level nutrition best practices

Post-hoc analyses showed two significant associations between teacher diets and center best practices. The fact that any significant association between teachers and centers was limited to those two examples makes it challenging to speculate on the underlying explanatory mechanisms. In the case of teacher fruit intake and center feeding environment sub-score, a one-cup increase in fruit intake, which would be a substantial increase given the average intake in our sample, was associated with only a modest (1.5-point) increase in the feeding environment sub-score, which is likely of little practical significance. In considering how the nutrition environment in ECE may be influenced by teachers and vice versa, it is not clear why intake of other healthy food groups, such as vegetables and whole grains, were not significantly associated with difference in any NAPSACC scores while fruit was. The lack of a consistent pattern across food groups between dietary quality and NAPSACC points to this being a spurious association due to the number of tests run but future research may be able to explore more nuanced relationships between intake and ECE practices.

Our exploratory findings suggest that practices within centers may be dictated by factors at the center or state policy level to a much greater degree than by individual teachers' beliefs or habits. Teachers choose to work with children because of a commitment to healthy child development[70] and this may be a much stronger determinant of ECE practices than teachers own diet. A 2017 qualitative study by Swindle *et al.* found that for the children they work with, teachers reported efforts to create a healthier food environment than what they experienced themselves as children.[70] However, these findings also indicate a nutrition knowledge or self-efficacy deficit in ECE teachers in terms of their own intake, which could potentially manifest in teacher-level interactions not captured in this study. For example, a recent study by the Washington State Department of Health found that 92% of teachers who responded believed it was important to educate families about healthy mealtime practices, but less (86% of the same sample) felt confident in doing so, and even fewer (65%) stated they had provided said information. The same sample showed a greater disparity in regards to providing actual food and beverage recommendations: 88% of respondents believed it was important to be a resource, 80% felt confident being a resource, and 62% had provided education to families.[71] Along with our findings, this suggests an opportunity for nutrition professionals and agencies with specialized knowledge in child nutrition, such as local health

departments or state extension programs (which often provide Supplemental Nutrition Assistance education) to educate, inform, and empower ECE teachers to share information that aligns with their training, and to be a resource for more complex nutrition topics outside the scope of teachers' own training.

Strengths and Limitations

There are several limitations to this analysis. First, our analysis was limited to non-parametric tests due to the nature of our variables of interest, limiting our ability to account for multiple influences simultaneously. Second, the DSQ, while well-validated for use in the general population, may not capture intake as accurately as more intensive methods such a 24-hour recall. Food frequency questionnaires are a low-cost and less burdensome method of measuring dietary intake, but are subject to inaccuracies related to bias or poor recall.[72–75] Existing research suggests that female respondents may be particularly susceptible to desirability bias in FFQs, and have been found in some studies to underreport consumption of unhealthy foods, and overreport healthy foods.[73,74,76] However, the marked similarity to the US average intake of fruits, vegetables, and dairy suggests this commonly-utilized tool accurately captures the general diet of this population. Furthermore, our findings related to food security are also consistent with recently published data on childcare teachers, suggesting our sample is a reasonable representation of the ECE teacher population. There is also evidence to suggest that direct observation often reveals significantly different levels of adherence to policies and best practices than indicated in self-assessment surveys.[25] Similarly, both Washington and Texas state guidelines require adherence to certain dietary standards addressed by NAPSACC[77,78], which could have influenced self-reported NAPSACC responses related to fears of being found in noncompliance. On a related note, our study did not capture actual dietary intake of the children in the center, only director-reported best practices related to food groups offered. However, given the similarities between our data and published studies on both teachers and centers, it is reasonable to assume our data accurately represents the practices in the ECE centers we surveyed. However, future studies should seek teachers' input on food environment and feeding practice in centers, as they may offer information on how consistently center policies are followed daily practice. In addition, capturing children's actual intake would be an important component to add to future studies.

This may yield additional data on a potential associations between teacher dietary intake and workplace policies and practices.

Conclusion

While teachers' dietary intake is not unique when compared to the US general population, their occupation makes them uniquely placed to benefit from the overall healthy environment created for children. However, the high rate of food insecurity and low dietary quality of teachers is in stark contrast to the high frequencies of best practices regarding food served to children, strongly suggesting that mere exposure to a robust nutrition environment in the workplace is not sufficient to improve intake in this population. In terms of policy implications, these findings suggest an opportunity for intervention. A 2018 qualitative study found that centers' providing teachers with free meals was positively associated with evidence-based feeding practices[25], and our findings support the potential for a similar program to benefit the teachers as well. Making teachers' meals reimbursable by CACFP would be another potential change that could benefit this population, and would facilitate teachers' ability to role model healthy eating for children and participate in family-style meals, both of which are best practices. Given that the legally allowed child-to-staff ratios vary by state from eight-to-one to fifteen-to-one (for three year-old children as an example)[79], the inclusion of teacher meals would be a relatively small share. In addition, in areas such as Seattle, recent minimum wage increases narrow the pay gap between ECE and minimum wage jobs, which some directors worry may create difficulty in recruiting employees.[80] Offering free meals or a nutrition-focused employee wellness program may be a relatively low-cost benefit of interest to both teachers and centers. On that note, Ward, et al. are currently conducting a randomized control trial to improve health behaviors in ECE teachers via the ECE workplace, and their findings may illuminate the practicality of such interventions. .[81] Meals may be particularly feasible for centers, considering the small share food takes in a center's overall budget (our previously published findings found a median share of 2% for food, compared to the 71% median share for wages).[80] A recent qualitative analysis by Beck *et al.* found that most low-wage workers cite time constraints as a major barrier to desired intake patterns[82], so center-provided meals may have a perceived value beyond the food itself. Ultimately, ECE centers have

shown an ability to be providers of overall high-quality nutrition for children, and finding ways to extend this benefit to teachers is an important area to explore.

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