Research Article

Integration of Food-based Learning With Science in the Preschool Classroom: Implementation Gaps and Opportunities

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ABSTRACT

Objective: To explore *Head Start* teachers' use and integration of food-based learning (FBL) with science learning in the *Head Start* classroom.

Design: Phenomenological approach using in-depth semistructured telephone interviews.

Setting: North Carolina *Head Start* preschools.

Participants: Thirty-five *Head Start* lead and assistant teachers.

Phenomenon of Interest: All interviews were transcribed verbatim. Authors coded interview data for emergent themes.

Analysis: Eleven primary themes were identified during analysis and inductively organized using the Systems Thinking Iceberg Model.

Results: Teachers described most frequently using FBL during mealtimes. Teachers stated they felt successful when children were engaged and willing to try a new food. However, they struggled to connect food to science concepts. Teachers reported several motivators (eg, improving health) and barriers (eg, food waste) to integrating FBL. Teachers prioritized preparing children for kindergarten, but most teachers did not see how FBL could help them achieve this goal.

Conclusions and Implications: *Head Start* teacher professional development programs could impact all 4 levels of the Systems Thinking Model to improve teachers' perceptions, underlying structures, and mental models regarding integrative FBL. Additional research is warranted to investigate the adoption, implementation, and potential impact of FBL on academic outcomes.

Key Words: food-based learning, preschool, kindergarten readiness, STEAM, integration (*J Nutr Educ Behav.* 2023;55:266−284.)

Accepted January 4, 2023.

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Conflict of Interest Disclosure: The authors have not stated any conflicts of interest.

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https://doi.org/10.1016/j.jneb.2023.01.002

INTRODUCTION

Food-based learning (FBL), using food as a teaching tool in the classroom, can improve children's willingness to try and consume healthy foods.[1–4] Food-based learning can occur both during mealtime by creating a positive mealtime environment,[5] and outside the mealtime through activities such as gardening, reading books, and conducting science experiments in which food is present.[1,2,6–8] The use of healthy foods (eg, fruits and vegetables) during FBL is ideal because prior research estimates that 30% of preschool-aged (3-5 years) children are considered overweight or obese,[9] and < 20% consume daily recommended servings of vegetables.[10] Children from low-income backgrounds are at higher risk for low fruit and vegetable intake than the general population.[11,12] Improving dietary behaviors early in childhood can decrease children's risk for developing obesity, hypertension, type 2 diabetes, cancer, and cardiovascular disease in adulthood.[13–15]

Although some teachers consider mealtime an opportune time to talk about food, many teachers find mealtime environments to be chaotic, making FBL difficult.[16,17] Other research suggests teachers may be tempted to coerce and pressure children to eat healthy foods during meals, which has been associated with negative health outcomes such as obesity.[18,19] Therefore, FBL outside mealtime allows children to be exposed to healthy foods in a low-pressure environment and encourages children's exploration of foods using all 5 senses (sight, sound, smell, touch, taste), which may not be encouraged during mealtime because children's exploration of food may be perceived as poor table manners (eg, playing with food).[20–22] In addition, although methods for improving vegetable consumption in children, such as flavor-flavor learning,[23] flavor-nutrient learning,[23] manipulation of portion size,[24] and rewards[23,24] have been studied, the strategy of repeated exposure is suggested to be the most effective method for impacting both preference and consumption.[7,22] Repeated exposure allows children to experience healthful foods multiple times, in multiple forms, to increase familiarity with a food.[6,7] Specifically, prior research suggests children need 8–15 exposures to increase their liking of new food.[7,25]

Although parents and caregivers can serve as positive healthy-eating role models to their children,[26–29] achieving the necessary number of repeated exposures to healthy foods in the home environment is often difficult because of preschool children's neophobia (continual refusal of food) and concerns about food waste in low-resource families.[30,31] Exposing children to vegetables can be particularly difficult because vegetables have a bitter taste profile, making them less biologically acceptable than fruits.[13] Because preschool children in the US spend > 30 h/wk and consume half or more of their daily dietary intake at preschool,[32] preschool teachers, specifically in *Head Start* programs, are an important partner in increasing children's exposure to healthy foods using FBL.[33,34]

Head Start, the federally funded preschool program, strives to meet the nutritional, social, and academic needs of 1 million preschoolers from low-income families nationwide.[35] To address nutritional needs, *Head Start* participates in the *Child and Adult Care Food Program* (CACFP), which guarantees children access to healthy foods, including fruits and vegetables, at school meals and snacks.[36] Food-based learning in *Head Start* programs is important because it can improve children's preference for and consumption of fruits and vegetables in an environment in which these foods are guaranteed to be available,[1,37] compared with children's home environments, which may have limited access to fruits and vegetables.[38] Although the *Head Start* policy encourages teachers to engage children in activities with healthy foods, *Head Start* teachers have reported barriers to FBL in the classroom, such as limited time,[39] competing kindergarten readiness priorities,[12,39] and limited FBL professional development.[39,40] *Head Start* teachers and administrators have suggested that these limitations could be overcome by integrating FBL into other learning domains related to kindergarten readiness to impact dietary quality and kindergarten readiness outcomes.[39]

Head Start's Early Learning Outcomes Framework organizes the skills, behaviors, and knowledge in which children should be proficient before kindergarten into 5 domains: approaches to learning; social and emotional development; language and literacy; cognition; and perceptual, motor, and physical development.[41] The cognition domain, which includes preschool scientific reasoning, is a key area for FBL integration as science provides a natural foundation for hands-on learning related to living things (eg, humans, animals, and plants, including vegetables), their relationships with one another, and how to care for our bodies and other living things (eg, healthy eating, animal/plant life cycle). The science environment can also improve children's language, literacy, and mathematics skills[42] while serving as a platform to expose children to healthy foods through experimentation and exploration (eg, creating an experiment to see what conditions a spinach plant needs to grow, observing and documenting its changes, then tasting the leaves).[1] In addition, as preschoolers cognitively mature, the skills developed through high-quality science learning will enable them to make positive choices about their health and living things in their environment, making science key for kindergarten readiness.[20,41,42]

To leverage the potential for *Head Start* teachers' integration of FBL into routine learning, our team planned to develop the *More PEAS Please!* program, a multilevel intervention focused on improving children's dietary quality and school readiness through early exposure and access to healthy foods in high-quality science-learning environments. The *More PEAS Please!* intervention was developed on the basis of the Social Cognitive Theory[43] and Interconnected Model of Teacher Professional Growth[44] to improve the quality of children's early language and science-learning experiences by supporting teachers' instructional practices focused on integrating FBL with other learning domains. Our

study informed the development of the *More PEAS Please!* Program by examining the current contextual environment surrounding *Head Start* teachers' FBL practices and integration with science. Although prior studies have examined the general use of food and nutrition education in *Head Start*,[39] additional research is needed to understand how *Head Start* teachers are, or are not, integrating FBL with other learning domains. Therefore, this study aimed to explore the common lived experience of *Head Start* teachers' use and integration of FBL with science in the preschool classroom.

METHODS

Study Design

We used a qualitative, transcendental, phenomenological approach to examine North Carolina (NC) *Head Start* teachers' shared experiences using and integrating FBL with science-learning activities in the preschool classroom.[45] We collected qualitative data via in-depth, semistructured interviews. This study was part of a larger mixed-methods cross-sectional study conducted across NC to assess the specific needs, assets, and resources of partner *Head Start* programs to inform the development of professional development resources for the Preschool Education in Applied Science (PEAS) Institute for Early Childhood Teachers.[46] The study underwent an expedited review by the Institutional Review Board at East Carolina University, which approved all study protocols and materials (UMCIRB no. 18-002749). All participants provided written consent for participation.

Participants and Recruitment

We identified 54 NC-funded Head Start agencies using a list published on Head Start's website in the fall of 2020, excluding 1 agency that primarily served migrant families because it was not open in the winter or spring.[47] We attempted contact with each agency's education managers or program directors via phone. After establishing contact, we provided information about the study and asked permission to communicate via email with *Head Start* teachers at each center within that agency. *Head Start* staff either forwarded our recruitment email to teachers or requested we email teachers directly. By incorporating agencies of varied sizes and locations, we ensured different perspectives. Thirty-five agencies never responded to the initial communication. *Head Starts* in NC often follow their public-school counterparts' academic calendars. Many public schools were closed during this study because of the coronavirus disease 2019 (COVID-19).[48] It is likely *Head Start* agencies were also closed or providing virtual education to children, making it difficult to communicate with program administrators and staff.[49]

Data Collection Procedures

Demographic questionnaire. After obtaining permission from *Head Start* agencies, an email was sent to teachers describing the study and asking them to complete a brief questionnaire online. Items on the questionnaire included *Head Start* center location, size, and demographic data. Teachers self-reported race and ethnicity from a list including White or European American, non-Hispanic; Latino(a), or Spanish; Black or African American, non-Hispanic; Asian or Asian American, non-Hispanic; American Indian or Alaskan Native, non-Hispanic; Middle Eastern or North African; Native Hawaiian or Pacific Islander; Multiethnic; or other (specify). Participants were allowed to select multiple responses to accurately reflect individuals' self-designation. The demographic survey followed the US Office of Management and Budget protocols, which guide the collection of race and ethnicity data in the US.[50,51] Participants open-endedly self-reported their gender. Demographic data were collected solely to describe the sample of participants. The survey concluded by asking teachers if they were interested in scheduling an individual interview to further discuss their experiences with FBL in *Head Start*. We used purposive sampling to determine which of the interested teachers to reach out to on the basis of geographical location and program size. A member of the research team maintained maps charting participants' locations. Our team met weekly to review maps and discuss the distribution of data. We targeted interviews and recruitment accordingly. For example, if we recently interviewed > 10 teachers from 1 geographical region of the state, we would purposefully contact teachers from a different region to diversify the sample. We contacted teachers via email to schedule the phone interview.

Qualitative interviews. Three trained graduate students (2 females and 1 male) with no prior relationship to participants conducted in-depth semistructured one-on-one telephone interviews between October 2020 and March 2021. We chose semistructured interviews to allow teachers to comfortably engage with data collectors to share their personal experiences.[52,53] Interviews lasted 45−60 minutes and were conducted over the phone. The authors designed the interview guide to address primary research questions using an iterative process over multiple rounds.[54] The interview guide consisted of a verbal script, questions, and required and optional probes (Table 1). Although the interviews occurred during the COVID-19 pandemic, we specifically asked teachers about their experiences before COVID-19 (Table 1), reminding them of this with a prompt at the start of each question. At the end of the interview, teachers had opportunities to share their experiences regarding COVID-19.

At the start of the interview, the interviewer informed the participant about the researcher's interest in the topic and read the consent form to obtain verbal consent. Teachers provided a pseudonym to protect their identities. During the interview, data collectors kept notes of participants' responses to each question. At the end of the interview, the interviewer summarized the participant's response to each question and asked them to confirm, modify, or disconfirm their

Table 1. Semistructured Qualitative Interview Guide Questions and Probes Regarding Teachers' Experiences with Food-based Learning in the *Head Start* Classroom (n = 35)

Interview Questions (Pilot-Tested)	Required Probes
Can you describe some lessons or activities you have used in the last year, before COVID-19, to teach children about science using food? Remember, nutrition is a science, too, so be sure to consider all the science topics you teach with food.	a. If the activity described appears to be preplanned, ask: Can you give me an example of a time you used food as a teaching tool that was not preplanned? If the activity appears to be unplanned, ask: Can you give me an example of a time you used food as a teaching tool that was planned? b. What are some things that have influenced your ability to use food experiences as a teaching tool in the classroom? c. How did you know when you were doing a good job of incorporating food experiences? d. How did you know when you were struggling to do a good job incorporating food experiences? e. How did your standard determine if you were doing a good job or struggling compared with what your supervisor expected?
Can you list things that helped or supported you when you incorporated food experiences in your classroom before COVID-19? This can be people, places, or things.	a. I heard you list [say what they listed as supports]. Are there any others you would like to add? b. Which of these supports you've listed do you think helped the most? c. How did having this help or support influence which activities or lessons you did in the classroom? d. Can you give me a detailed example, like a story, about how [list what they said was most helpful], has helped incorporate food experiences in your classroom before COVID-19?
Can you list some challenges you faced when incorporating food experiences in your classroom before COVID-19? This can be people, places, or things.	a. I heard you list [say what they listed as challenges]. Are there any others you would like to add? b. Which of these challenges you've listed do you think is the biggest? c. How did this challenge affect which science activities and lessons you did in the classroom before COVID-19? d. Can you give me a detailed example, like a story, about how [list what they said was most challenging] has been challenging for you while you incorporated food experiences with children before COVID-19?
In your opinion, what are some reasons you should use food experiences to teach science to preschool children?	a. On the contrary, why do you think you should not incorporate food experiences to teach science to preschool children?
In what ways has COVID-19 already impacted your current science classroom?	a. How might COVID-19 impact your use of food experiences? b. How else might COVID-19 impact your classroom as a whole?

COVID-19 indicates coronavirus disease 2019.

response (member checking).[55] Interviewers used the Rev App recorder on university-owned iPads to transcribe the interviews verbatim. Other strategies employed to ensure trustworthiness included: bracketing to identify researchers' biases before the start of data collection; biweekly debriefing sessions between data collectors to discuss codes, emergent themes, and address potential biases; reflective commentary; and triangulation of data with Head Start participants.[56] Triangulation occurred by sending participants an email summary of their interview, asking them to confirm, revise, or disconfirm.[55] All teachers responded to the request.

Data collection for this study continued until saturation was achieved, defined as the collection of new data not yielding novel information about the phenomenon being studied.[56] Prior literature identifies a qualitative

sample size of 10 as adequate, especially if saturation is verified.[57] Researchers verified saturation using a saturation grid with codes on the vertical axis and interviews on the horizontal axis.[58] As interviews progressed, we observed a visual tapering of new codes created. Both primary coders confirmed saturation was achieved when no new codes were developed with the collection of new interview data.[56,58]

Before beginning interview data collection, data collectors completed training in human ethics and qualitative methods using the 5-phase Goodell protocol.[59] As part of the training process, data collectors completed 2 cognitive interviews using the interview guide, first with another data collector and second with a local preschool teacher resembling the participant population. Data analysis did not include cognitive interviews; interviewees were asked for feedback to improve data collectors interviewing techniques. Cognitive interviews also improved the clarity and flow of the guide.[59] For example, we reorganized the interview guide into 2 distinct sections and removed and/or condensed 5 interview questions to reduce redundancy on the basis of feedback we received from cognitive interviews.

Data Analysis

We used SPSS (version 28.0, IBM Corp, 2017) for descriptive statistics. We then used Moustakas' structured method for inductive data analysis in this phenomenological study.[52] The 4 steps of in-depth analysis include: horizontalization, reduction of statements, categorizing or clustering, and final identification and narrative of themes. After training, the first author and a second analyst served as primary coders.[59] Before analysis, coders immersed themselves in the data by reading all transcripts twice. Coders reread transcripts a third time to record preliminary memos and highlight key concepts.[45] Coders then began the first step of the analysis, horizontalization, by independently reading transcripts, giving equal value and importance to each statement, and coding statements with a descriptive label.[45] In step 2, coders eliminated statements that were not a horizon of the study experience and did not represent details necessary for understanding the participants' experiences. Research meetings occurred 3 times weekly among the 2 coders. At each meeting, coders collectively read each transcript, comparing codes to reach 100% verbal consensus.[57] When necessary, a third author served as a tiebreaker. The authors created the codebook, which defined codes to aid in analyses of common perceptions among data to construct clusters of meaning.[57] In addition, throughout the analysis process, coders maintained memos of emergent codes, categories, theoretical connections, themes, and questions which served as additional documentation of the evolution of coding throughout the analysis.[57] Researchers also condensed codes into overall categories or "clusters" and assigned each category a thematic label. The repetition of this process resulted in collapsing all codes into subsequent categories. Finally, coders derived final themes from the data and confirmed themes by rereading transcripts to ensure themes and codes were consistent with teachers' expressed words. The final themes described the what (textural descriptions) and how (structural descriptions) of participants' experiences, which together represent the overall essence of the phenomenon.[45,57]

After inductive coding and identification of final themes, we deductively organized themes using the Systems Thinking Iceberg Model after coding was complete.[60] The Systems Thinking Model allows researchers to rethink how systemic, reoccurring issues occur by examining the interrelationships of individuals and processes in a system.[61,62] The Iceberg Model of Systems Thinking visualizes 4 interacting components of a system: events (What just happened?), patterns/trends (What trends have there been over time?), underlying structures (What has influenced patterns? What are the relationships between the parts?), and mental models (What assumptions, beliefs, and values do people hold about the system? What beliefs keep the system in place?). Prior studies have identified reoccurring barriers and teacher experiences with FBL[1,2,39]; thus, understanding the interrelationships between the parts of the FBL system is critical before enacting or expecting a change in the FBL system in *Head Start*.[63,64]

RESULTS

The final sample included 35 teachers from 16 counties spanning each geographical region of NC (Mountains, Piedmont, and Coastal Plain) (Figure 1). We suspected saturation at interview 31 but conducted 4 additional interviews to ensure saturation was reached. Participants were 94% female and were an average age of 40.80 ± 10.06 years at the time of the interview. Teachers' races were predominantly White (53%) and Black/African American (44%). Teachers' ethnicities were non-Hispanic (97%), followed by Hispanic (3%). Many teachers held either a bachelor's (54%) or an associate's (20%) degree. Most teachers (83%) had experience working in preschool settings outside of *Head Start*.

We identified 11 primary themes related to teachers' experiences using and integrating FBL in the classroom (Table 2). Figure 2 visually represents the identified themes within the theoretical model.

Level 1: FBL Events in the Preschool Classroom

Teachers described 2 main events in which FBL occurs in the classroom: inside and outside mealtime. Many teachers struggled to envision the possibilities of FBL outside the mealtime environment, leading to most FBL events occurring at mealtime. Teachers who did FBL outside the mealtime often did not relate FBL to academic concepts.

Teachers implement FBL mostly during mealtimes. Teachers described the contexts in which they integrated FBL in the classroom, both inside and outside the mealtime environment. However, many teachers reported that mealtime was the primary location for FBL activities. Teachers said they used FBL during

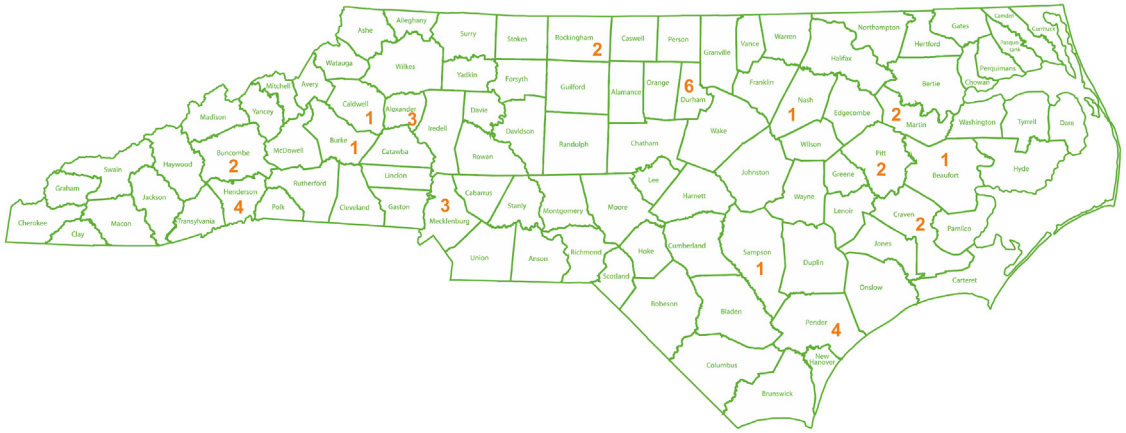

Figure 1. Teachers (n = 35) from North Carolina counties participating in semistructured qualitative interviews regarding their experiences with food-based learning and science in *Head Start* classrooms.

mealtime to teach children about nutrition concepts (eg, food groups). A few teachers stated that FBL occurred exclusively in the mealtime environment: "I would say food conversation and experimentation is limited to lunch in investigative conversation while they're eating" (Tammy). Teachers listed a plethora of strategies they used during mealtime, such as encouraging children to try foods before stating they did not like them (eg, no thank you bite), using positive descriptive words to talk about food (eg, these peas are so green and fresh), providing children with physical and verbal rewards, encouraging children to make a happy plate (eg, trying everything on their plate), and role modeling healthy eating behaviors. Teachers' activities and strategies primarily focused on persuading children to eat food at meals rather than exploring food through integrated learning outside of meals.

Teachers' FBL activities outside of mealtime often had disconnected between the concept of food and science (eg, food used as art). Conversely, some teachers described using food outside of mealtime by integrating FBL with other learning domains, such as science. When considering FBL's role in science, many teachers discussed using healthy food to demonstrate common preschool science concepts (eg, in a unit about vehicles and wheels, having children create model car wheels out of orange slices). However, the food featured in these activities was often disconnected from the science concept being explored. For example, teachers described using food as art or construction material to illustrate a scientific concept rather than using food as the scientific concept being studied. Leah described a unit about the lifecycle of a butterfly:

> *Nutrition is taught alongside with science. . .One example in specific would be, we were discussing the life cycle of the butterfly. . . So we used food, healthy food, such as celery, tomatoes, raisins, and created a butterfly out of those vegetables. . . so that's kind of how we incorporated food with our science lesson.*

Few teachers recognized the weak connection between the FBL activity they described (eg, making a butterfly out of celery) and the science concept (eg, the lifecycle of a butterfly); however, most teachers believed that the FBL activity was beneficial for improving children's science knowledge. Although many teachers recognized that FBL and science could be taught in tandem, teachers struggled to use FBL as a scientific concept (eg, studying celery as an example of a vegetable plant that butterflies pollinate) and rather used food as part of their science units or art (eg, making butterfly out of celery).

Level 2: Patterns and Trends of FBL in the Preschool Classroom

Teachers' detailed descriptions of FBL events revealed overarching patterns that define FBL in the classroom, including teachers' use of unhealthy foods in FBL activities, teachers' uncertainty on how to integrate FBL into science, and teachers' general feelings of helplessness related to doing FBL in the classroom. These patterns hindered teachers' ability to implement FBL and/or made FBL less beneficial for children.

Teachers use unhealthy foods during FBL activities. Teachers frequently described FBL activities that used unhealthy foods (eg, M&Ms, Cool Whip, pudding). Many teachers indicated they enjoyed doing taste tests in their classrooms to expose children to new food. During these activities, children were often encouraged to try various foods and discuss their preferences. Other teachers created their FBL activities on the basis of thematic units using unhealthy foods. For example, during an insect unit, Lily explains,

> *We were making worms in the dirt, because we were talking about insects and so the item included pudding, and gummy*

Table 2. Themes and Related Concepts Regarding *Head Start* Teachers' Use and Integration of Food-based Learning in the Preschool Classroom Aligned with the Systems Thinking Iceberg Model (n = 35)

Theoretical Category	Theme	Main Concepts	Examples	Quote
FBL events in the preschool classroom	Inside mealtime environment	• The primary setting for engaging children in FBL in the classroom	• The teacher discusses food groups during lunch ("peas are a vegetable, peaches are a fruit") • The teacher encourages children to try at least one bite of each food on their plate • Teachers role model healthy eating by eating foods served, regardless of personal preference, while stating, "this is so yummy" • The teacher is concerned that children eat food and occasionally uses coercion ("If you don't try that vegetable, you can't have more milk")	"[At lunch] Let's all see who liked that [vegetable], who doesn't like it." We can make a chart and count. We can actually talk about if it's crunchy, if it's soft, if it's sweet, was it sour. It all goes back to those five senses too. So it kind of builds up off each other." (Blue)
	Outside mealtime environment	• The teacher struggles to connect food activities to academic learning leading to disconnected FBL activities that often use food as models or art • Teacher perceives that disconnected FBL activities can still improve children's knowledge of science	• The teacher invites the outside visitor to come in and teach the children how to make tortillas from masa • The teacher uses apple slices, peanut butter, and marshmallows to help children create a mouth model for a lesson on brushing teeth • The teacher conducts taste tests with multiple varieties of apples and charts children's favorite • The teacher grows strawberries, beans, and herbs in the classroom • The teacher builds electricity conductors out of potatoes	"I guess what we do with food is more honestly artistic. We will make a fire truck out of a Graham Cracker and licorice and carrots. So that would be more food as art. I don't know, as we do food as science necessarily other than growing sunflower seeds, beans, avocado." (Tammy)

(continued)

Table 2. Themes and Related Concepts Regarding *Head Start* Teachers' Use and Integration of Food-based Learning in the Preschool Classroom Aligned with the Systems Thinking Iceberg Model (n = 35) (*Continued*)

Theoretical Category	Theme	Main Concepts	Examples	Quote
Patterns and trends of FBL in the preschool classroom	Teachers' use of unhealthy foods	• The teacher uses unhealthy foods for taste-testing and FBL activities • Teachers may not consider unhealthy foods to be unhealthy	• The teacher engages children in making chocolate pudding to demonstrate state changes (liquid, powder, solid) • The teacher uses pepperoni during an activity discussing building muscle by eating protein • The teacher helps children make model spiders using M&Ms	"What food does to our bodies, how fats and sugars are used for energy and proteins are used for muscles, and they build their muscles, we do push ups and then we eat a piece of pepperoni and then we do more pushups and see if we're stronger. So we do that. Yeah, mostly nutrition and also keeping the food in an edible form." (Tammy)
	Uncertainty on how to integrate FBL into science	• The teacher understands intuitively that FBL could be integrative with science but is unsure how to do that in the classroom	• The teacher uses graham crackers and Teddy Grahams to build a bears den in a unit on winter-hibernating animals • The teacher states food activities are solely related to nutrition rather than science • The teacher relies on engaging with food solely in the mealtime environment	"[I would like] new ideas on how to incorporate food with science. I feel like I have simple, simple ideas, but some that will create higher thinking and higher learning." (Simone)
	Feelings of helplessness	• The teacher feels it is difficult to get children to try new, healthy foods	• Teacher describes trying all year to convince a child to try a food before saying they don't like it, to no available • The teacher concludes she cannot change a child's food preferences on smoothies • The teacher mentioned cooking a recipe with the class, and the children liked making it but would not attempt to taste it	"Just if they don't like it. I mean, but there's not much I can really change about someone's sense of taste." (Mia)

(continued)

Table 2. Themes and Related Concepts Regarding *Head Start* Teachers' Use and Integration of Food-based Learning in the Preschool Classroom Aligned with the Systems Thinking Iceberg Model (n = 35) (*Continued*)

Theoretical Category	Theme	Main Concepts	Examples	Quote
Underlying structures affecting FBL	Food waste	• Teachers recognize that wasting food during FBL is inappropriate • Teachers acknowledge the children they serve come from low-resource backgrounds, so food should be available to eat after activities	• The teacher completes an FBL activity in the classroom but is distressed when there is still some food left over after the activity that may go to waste • Teachers cut open an apple to examine the seeds inside and then distribute slices to the class for tasting • Teachers recognize they used to waste food in older activities (eg, painting with a potato) but that they no longer do that • Teachers avoid using vegetables or foods that they think children will not be willing to eat during FBL activities to avoid food waste	"If you're going to throw it away, then no. Because that child might not have anything to hold it and to eat and I'm playing with the rice or I'm doing something and I'm throwing it away. So, other than that, you should teach him about science not with food, but only if they are allowed to eat it or grow it, but not to throw it away." (Melissa)
	Policy	• Teacher receives contradictory communication regarding food policy in *Head Start* • Teachers' misconceptions about policy in *Head Start* perpetuated among conversation of teachers to other teachers	• The teacher describes the fear of being in noncompliance with *Head Start* policy on food in the classroom • The teacher compares what she was told by other coworkers (eg, food was not allowed in the classroom) compared with her supervisor (eg, healthy food *is* allowed in the classroom)	"I think that the biggest challenge is the limitations that the state has put on us. As far as I know, it's the state. It's been the same no matter where I go. And I know some places are stricter than others. Because the state says you can't have food in it's edible form in the classroom. But where I'm at now, they're a lot stricter even than that, you can't really have it at all. So I have to say that that's the biggest setback. Because if we were allowed to have it in the classroom, then I think teachers would be encouraged to find ways to adapt to where they could use it for the children and make the germ thing work." (Alex)

(continued)

Table 2. Themes and Related Concepts Regarding *Head Start* Teachers' Use and Integration of Food-based Learning in the Preschool Classroom Aligned with the Systems Thinking Iceberg Model (n = 35) (*Continued*)

Theoretical Category	Theme	Main Concepts	Examples	Quote
	COVID-19	• COVID-19 further restricts the ability to do food activities in the classroom	• Teacher compares pre-COVID-19, when they were allowed to have children cook together, to current policies (2020) • The teacher is disappointed she cannot have family members come in and prepare special traditional foods for children to try • The teacher is overwhelmed with safety and sanitation regulations	"I'm going to get by with the one that we're doing on Friday because I'm just going to shut my classroom door I guess. The kids will wear gloves and they each have their own measuring spoon but that's just not something that I guess that we can do all the time. They don't really want us doing a lot of nutrition activity." (Ashley)
Teachers' mental models for FBL	Motivators for FBL	• Teachers motivated to do FBL in the classroom for its social, cultural, and health benefits	• The teacher encourages children to cook together to build relationships and communication skills • The teacher believes children can be "agents of change" in their family by encouraging their other family members to purchase and eat healthier foods after being exposed to them at school • Teacher recognizes that incorporating the cultural foods of diverse children in her classroom builds a deeper appreciation of individuals' differences	"I think that's important because I think the more they know about food as they get older, the more they can make their own choices on food. Like I said, it introduces them to new foods. Who knows? That might start somebody on a journey to healthy eating, if they're familiar with foods from when they're young." (Sean)
	Perceptions of Successful FBL	• The teacher feels successful at FBL when children consume the food	• The teacher feels pressure to ensure children are eating food, both at mealtimes and during FBL activities • The teacher tells the child, "Just put a tiny bit of the green bean on the tip of your tongue to try," and feels discouraged when the child refuses • The teacher feels good when the child remembers a prior FBL activity they did	"When the kids were willing to try something they've never tried before, maybe. If we can convince them along the way that this is something that we should at least try before we say we don't like it, makes us think that we're working our way into a good direction. . . (but) sometimes it's hard just because kids are kids and they like what they think they like and that's it." (Teri)

(continued)

worms, and Oreo cookies, so that we have our model, so that the children can understand that there are layers, and that the worms go in and out of those layers to get where they need to.

Many teachers acknowledged that the *Head Start* policy discouraged the use of unhealthy foods in the classroom and did not consider the foods they chose to feature in the activity to be unhealthy.

Teachers are uncertain how to effectively integrate FBL into science. Teachers indicated uncertainty regarding the integration of FBL and science in the classroom. Teachers more often viewed food solely in the mealtime context and did not see how food could be integrated into other learning domains. One teacher (Nicole) explicitly stated that she knew, in theory, that FBL could be integrated; however, she did not know how to do it:

They're all exposed to food in our classroom, and you can use food to teach so many things, like language, literacy, math, cultural diversity, different foods. [But] aside from just talking about where food comes from and what it does for our bodies, I'm not really sure how to make that into an activity aside from like our fruit salad... I don't really know how to incorporate food into a science lesson.

Teachers repeatedly cited that they would like future training to learn how to integrate FBL with other learning domains to reduce their uncertainty.

Teachers feel helplessness while trying to implement FBL in the classroom. A common trend in teachers' perception of FBL in the classroom was feelings of helplessness. Teachers stated that it was difficult to encourage children to try foods during FBL activities and many teachers stated that there was nothing they could do to change a child's decision not to try a food: "There's still some things that no kid's going to like no matter what" (Teri). Teachers expressed children were stuck in their preferences and

Table 2. Themes and Related Concepts Regarding *Head Start* Teachers' Use and Integration of Food-based Learning in the Preschool Classroom Aligned with the Systems Thinking Iceberg Model (n = 35) (*Continued*)

Theoretical Category	Theme	Main Concepts	Examples	Quote
	Make the connection between FBL and science to promote kindergarten readiness	• Some teachers saw how FBL could be used in the scientific environment • Most teachers did not make the connection between integrating FBL and the science-learning environment to prepare children for kindergarten	• The teacher feels science can be used to enhance language, critical thinking, and fine motor skills • The teacher states she doesn't see how to use food to do anything sciencey	"I think with preschool science and education it would go back to what those developmental milestones are for that age, so of course they're going to be working on their language and they're going to be working on their fine motor skills, they're going to be working on their gross motor skills and all those things can be incorporated." (Lily)

COVID-19 indicates coronavirus disease 2019; FBL, food-based learning.
Note: Teachers provided pseudonyms to protect their identities.

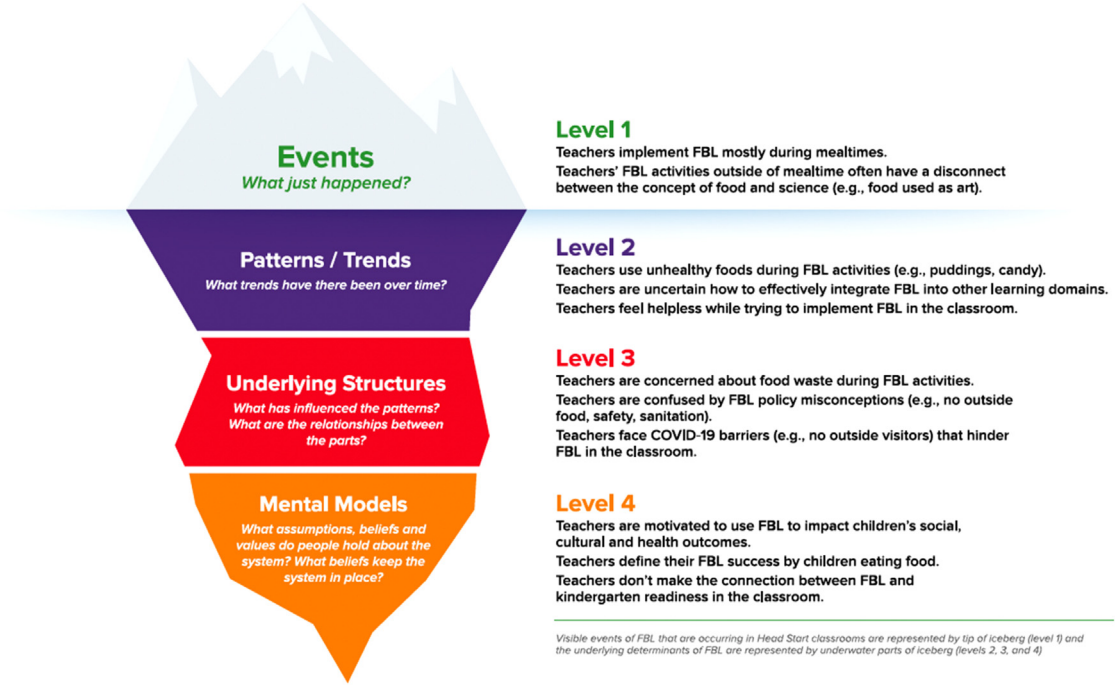

Figure 2. Theoretical model presenting the relationship between *Head Start* teachers' (n = 35) experiences with food-based learning (FBL) at 4 different levels of the Systems Thinking Iceberg Model.

were not likely to change their minds, regardless of how many times teachers included the food in FBL activities: "he's not going to try [the new food]. So, it could affect all over, not just one time, but every time you try to do something in that aspect" (Susie). Other teachers emphasized the importance of honoring children's preferences about food, such that if a child expressed dislike of a certain food, they should not be asked to try it again later. The idea of honoring children's preferences extended into FBL activities in which teachers stated they purposefully chose foods for FBL activities that they knew children would like (eg, fruits), and avoided foods (eg, vegetables) that they knew children would not likely eat.

Level 3: Underlying Structures Affecting FBL

Several underlying structures challenged teachers, influencing their use and integration of FBL in the classroom. These underlying structures often presented themselves as barriers to FBL in the classroom and included food waste, policy, and, more recently, the impact of COVID-19 on FBL.

Teachers are concerned about food waste during FBL activities. Teachers were concerned that FBL activities involving children playing with food were detrimental because teachers misperceived that children could not consume this food. Many teachers emphasized that children in their classroom came from food-insecure homes and that manipulating food such that it could no longer be consumed was inappropriate. Some teachers cited food waste as a primary reason they did not do FBL in their classrooms:

> *No, we're not allowed to use food… if we use food that could have been food that they could have ate. So, we don't actually get to use any chemistry to teach our children science [using food].* (Lucy)

Teachers are confused by FBL policy misconceptions regarding FBL. The Head Start FBL policy environment was also a significant underlying structure affecting FBL. Many teachers interpreted their center's policies as unsupportive of FBL outside of the mealtime environment. Teachers commented that they received contradictory communication from coworkers and administrators about policies regarding FBL:

> *So, the first year [the supervisor] was discouraged from using food and I heard from other co-workers that we weren't supposed to use food in our classroom ever, at all, for any reason. And I had to probe and push and ask, and then, communication came out oh no, their policy does allow it.* (Natasha)

This contradictory communication was further exemplified in interviews in which 2 teachers described the same activity (eg, making a necklace out of cheerios to practice counting), with one teacher stating the activity was a positive example of an FBL activity and the other stating it was a negative example. Both cited *Head Start* policies related to FBL.

Teachers also had concerns about the safety of FBL experiences in their classrooms, citing sanitation and food allergies. Teachers interpreted the *Head Start* sanitation policy to indicate that sharing utensils and children working together was not

allowed. Many teachers also mentioned concerns about children's allergies and hesitation regarding bringing food into the classroom.

Teachers face COVID-19 barriers. Finally, teachers described barriers to FBL, considering COVID-19. Teachers highlighted that COVID-19 had further limited, or removed, their ability to integrate FBL in the classroom. One teacher described FBL during COVID-19 as a taboo subject stating that "after COVID hit, they [administration] don't want us bringing in any kind of anything that children might touch. So, [FBL] has become very taboo" (Alex). Teachers commented that centerwide and classwide changes related to COVID-19 (eg, social distancing, masks, no outside visitors) had counteracted open exploration, like FBL, in the classroom. Teachers expressed concerns about the up-and-down attendance during COVID-19, which has thrown everyone's rhythm off and prevented children from establishing a sense of normalcy within the classroom. During remote learning, it was not feasible for teachers to assume parents had materials at home to do FBL:

> *We could talk about food, but we don't do any type of experiments or anything, because we just don't want to offend anybody by asking, "Do you [parents/children] have this in your home or can you go out and get this."* (Sean)

Level 4: Teachers' Mental Models for FBL

Regardless of the capacity at which they did FBL in their classroom, most teachers expressed their beliefs and values about FBL by describing their motivations, perceptions of themselves as successful, and understanding of FBL's role in achieving their overall goals. According to the Systems Thinking Iceberg Model, the mental models teachers have created for FBL keep the current system of FBL in place.[39]

Teachers are motivated to use FBL to impact children's social, cultural, and health outcomes. All teachers believed that FBL had value for the children in their classroom. Teachers were motivated by the social, cultural, and health benefits of FBL.

Socially, teachers believed that FBL created a connection for children. Many teachers felt that FBL was beneficial because all kids eat. Teachers expressed that food is an object that connects children's home and school lives. Sally explained, "it's daily life... whether they're at school or at home at a restaurant, they're able to make connections with." Teachers perceived that this unifying characteristic of food enabled FBL to help children build relationships and social skills with teachers, peers, and families. Alex believed that FBL, specifically cooking, created powerful bonds between children and caregivers: "I think it's really important to teach children in the scope of relationships...cooking naturally has that relationship aspect to it."

Teachers were also motivated to include integrative FBL experiences, like cooking, in the classroom because of its benefits in improving children's cultural awareness. Teachers explained that children might be unaware that different families prepare and eat different foods from their own. Food-based learning can facilitate learning and appreciating differences among their peers. Teri referenced an instance when

> *(One child) had hummus. It smelled different than what they were possibly used to. We used that as a tool to say they eat some different foods that maybe you haven't been exposed to.*

Teachers also invited children's parents to come into the classroom and prepare a traditional dish from their culture to share:

> *We have a staff person in our program that's Hmong so we had her to come into our classroom, and show us how to make fried rice in the authentic way, and then let the children taste test it.* (Lily)

Teachers also reported being motivated to integrate FBL because it improves children's health. Many teachers commented that FBL increased children's familiarity with healthy foods. Some teachers emphasized that children may not have had exposure to these foods outside of the program, so FBL served as an avenue to expose children to new healthy foods: "Once you bring in foods that children maybe have never seen before, to let them try something that they've never even heard of" (Valerie).

Teachers also considered FBL as beneficial for impacting the long-term health of children. Teachers expressed concern about childhood obesity and sedentary behaviors of children and stated that this reinforced the necessity of FBL:

> *We think about the children that I teach are from low-income families. So, one of the things we really talk to them about is nutrition and exercise, so that we don't have childhood obesity, things like that.* (Tasha)

Most teachers felt personally responsible for ensuring that children grew up to be healthy and emphasized that the knowledge and experiences children gained from their classroom could positively impact their future lives.

Teachers believed that exposing children to healthy foods during FBL in their classroom could impact not only children's health but the health of their families as well. In this sense, teachers felt children could act as agents of change by advocating for healthier foods at home. One teacher explained,

> *[Say there is] something that we present to the class, like say, Brussels sprouts or raw broccoli, that, "Maybe I didn't get this at home," and I can introduce that and let my mom know, "Hey, I like this." "Okay, well, I'll continue to buy this for you."* (Aaliyah)

Teachers define their FBL success by children eating food. Teachers believed they were successful at FBL through various indicators, the strongest of which was whether children consumed the presented foods: "[I know I'm doing a good job] when they're stuffing food in their mouth" (Mia). Some teachers expressed having an active role in helping children try foods by using strategies (eg, no thank

you bite) to encourage children to try the food. Although many teachers defined their FBL success by children's willingness to eat the food, teachers simultaneously expressed feelings of helplessness in getting children to try foods because of preschoolers' unwillingness or hesitancy to try new foods (neophobia). In some cases, teachers described that children might be familiar with food but did not want to try it when presented in a new form (eg, raw vs cooked) and emphasized the unpredictable nature of their preferences (eg, will eat carrots one day but not the next).

Other less frequent perceptions of success were children being engaged in the FBL activity, facilitating conversations with their parents about the activity, and retaining or expanding on information from the activity. Children were engaged in an activity if they were paying attention (eg, not being disruptive) and asking questions. Teachers also emphasized that they felt successful if children told their parents about the FBL activity during pick-up. Finally, teachers indicated that they perceived themselves to be successful if children retained or expanded on the content of an FBL activity. For example, Mia stated,

> *Not only are they eating it, but they're talking about it. They're making that connection when they go into housekeeping, like 'Hey, we tried oranges today. Here's an orange.'*

Teachers don't make the connection between integrating FBL and science to promote kindergarten readiness. Teachers stressed the importance of preparing children for kindergarten by focusing on core academic domains such as science, mathematics, and literacy. Many teachers connected the science-learning environment and preparing children for kindergarten. Teachers commented that science naturally lent itself to teaching children concepts critical for kindergarten readiness. One teacher stated,

> *I think that it's (science) a huge skill that kids need to know. Science is a lot of what our world is coming to, like the medical field and technology, all of that is based in science, and science really builds critical thinking skills, which are important in any field of work that they go into, and even just going into kindergarten and elementary school, just building those critical thinking skills*. (Nicole)

A few teachers made a connection between integrative FBL and kindergarten readiness. One teacher mentioned that integrating FBL could help children learn math concepts, such as measuring:

> *I think it's wonderful to teach food experiences in the classroom because children are learning about measurement. They're learning about food groups and food items. They're learning about the colors of the food*. (Tasha)

However, most of the time, the benefits of FBL were associated with the mealtime environment and health outcomes, such as consuming more fruits and vegetables or growing up healthy, rather than connected to science learning and kindergarten readiness. Although teachers expressed that FBL was beneficial, the connection between FBL and preparing children for kindergarten through science learning was minimal. Teachers expressed that they desired to prepare children for kindergarten but did not see how FBL could help them achieve that goal. Teachers detailed other valuable characteristics of FBL that made them want to do FBL in their classroom, but very few of the benefits teachers mentioned were academic.

DISCUSSION

This phenomenological study explored *Head Start* teachers' use and integration of FBL with science in the preschool classroom. Exploration with teachers revealed a complex system of events, patterns, underlying structures, and mental models that impact FBL in the classroom. Eleven primary themes were identified and categorized within the 4 levels of the Systems Thinking Iceberg Model.[60] Study findings provided unique, in-depth insight into teachers' experiences and perceptions of FBL as acknowledged by teachers.

Although teachers reported implementing FBL in the classroom, FBL was limited to mealtimes, and teachers presented many barriers which underscore the need for professional development. Specifically, when implementing FBL during mealtimes, teachers reported using evidence-based, positive feeding practices (eg, role modeling, descriptive words) to engage children's senses.[65,66] Although teachers' positive feeding practices are praiseworthy, it is concerning that teachers described the intentional use of detrimental feeding practices (eg, rewards for eating and encouragement to eat beyond satiety for happy plates). These behaviors were embedded in teachers' narratives as intentional and desirable to enhance the mealtime environment; however, research suggests that these practices may lower fruit and vegetable consumption in children.[67,68] To support the efficacy of FBL, future training efforts may need to precede FBL curricula for the uptake of evidence-based feeding practices and/or removal of detrimental ones.[69]

In addition, many teachers did not use FBL outside the mealtime environment. Prior research suggests that exposing children to FBL outside of the mealtime environment has the potential to allow children to freely explore healthy foods with all 5 senses without the added expectation of consuming the food or distracting children from practicing self-regulation.[20,21] Food-based learning outside the mealtime environment has also been suggested to improve the liking and consumption of healthy foods in children[7,70,71] and may impact kindergarten readiness outcomes like science, math, and literacy.[5,39] Therefore, professional development regarding FBL should highlight these benefits to influence teachers' mental models regarding FBL implementation.

Furthermore, expanding teachers' mental models regarding what successful FBL looks like may positively impact teachers' inherent beliefs and values about FBL. Teachers assumed that children must eat food during an activity to be successful at FBL.

This often causes teachers to experience feelings of helplessness during FBL activities when children consistently reject foods.[72,73] Redefining successful FBL as using healthy foods to impact academic outcomes would positively impact teacher attitudes toward FBL and increase children's exposure to healthy foods.[2] Helping teachers redefine these beliefs of FBL is critical because perception is an important determinant in teachers' commitment to continue to deliver nutrition education in the classroom.[52] For example, if the teachers' perspective of success shifted from "I need to make Kaysan eat broccoli so that he will have eaten some vegetables" to "I need to encourage Kaysan to explore broccoli using his sense of sight and touch so he can learn about the science of broccoli's plant parts (eg, root, stem, leaf)", teachers would be set up for success rather than failure. Helping teachers redefine their success in achievable terms is important, as prior research suggests that teachers are motivated by their ability to make a difference in children's lives.[72,74]

In addition, teachers were unsure how to integrate FBL into other learning domains, and the majority did not see how to integrate FBL and the science environment. The FBL activities that teachers considered integrative, such as building a butterfly with celery and tomatoes, often did not address science learning and instead used food as art. Although the activity exposes children to healthy foods, it often misses the opportunity to support children's academic learning (eg, learning about the lifecycle of butterflies). Prior literature establishes that FBL and exposure to healthy foods in the preschool environment can improve long-term healthy eating[10]; however, the lack of connection between FBL and academic learning in the *Head Start* classroom is concerning because teachers may consider nutrition a lower priority than preparing children for kindergarten.[39] Prior FBL interventions suggest that FBL can successfully be integrated into preschool learning domains for kindergarten readiness.[1,2] For example, *Together, We Inspire Smart Eating* (WISE) is an 8-month nutrition education curriculum that exposes children to fruits and vegetables through weekly hands-on, integrative FBL activities.[2] *Together, We Inspire Smart Eating* provides teachers with FBL activities that address preschool benchmarks and early learning standards (eg, learning the mathematical concept of patterns through the organization of tomatoes, spinach, and low-fat mozzarella). These activities teach vocabulary skills (literacy) and observational skills (science) and encourage sensory exploration using all 5 senses.[2] Highlighting the promise of FBL to address kindergarten readiness goals, such as science learning, is critical to improve teachers' attitudes about FBL and increase buy-in.[39]

Although impacting events at the surface level (eg, interventions to teach teachers how to do FBL outside the mealtime environment) is important, the Systems Thinking Iceberg Model proposes that individuals must also work to change the overall system to enact systemic change.[63,64] To do this, multilevel collaborations between researchers, nutrition educators, policymakers, and *Head Start* administrators, which focus beneath the surface to change the underlying structures and inherent mental models of teachers toward FBL, are needed. For example, in this study, teachers held that the mental model that prepares children for kindergarten is important, but teachers did not believe that FBL could help them reach that goal. Teachers' belief that FBL is unrelated to kindergarten readiness is unsurprising as many nutrition interventions do not discuss academic benefits and solely emphasize health outcomes as primary goals. Although the correlation between a healthy diet and improved academic success is not novel,[75,76] nutrition professionals and researchers may evaluate the differential value of emphasizing the health benefits of FBL vs FBL's academic benefits related to kindergarten readiness. Helping teachers connect FBL and preparing children for kindergarten through science learning may increase teacher buy-in to see FBL as a classroom practice that supports, rather than deters from, their goals.[5,77]

Finally, efforts to address the challenges teachers face, such as policy misconnections, are critical to improving the integration of FBL in *Head Start*. Prior research supports the findings of this study that policy misinterpretation is a significant barrier to FBL.[16,52] In 2016, *Head Start* removed FBL as a requirement in the classroom.[78] Although programs still support the use of food in the classroom, the lack of direction at the federal level has caused widespread uncertainty.[39,53] In one instance, state sanitation policies regarding FBL cooking activities were misinterpreted by local centers to prohibit any cooking activities. Other federal *Head Start* policies, such as no outside food, intended to prohibit unhealthy food from entering the classroom, have been misinterpreted to prohibit all food, inhibiting FBL such as taste-testing healthy foods.[53] These misinterpretations have historically caused lower teacher efficacy and infrequent FBL, hindering teachers' ability to impact children's long-term dietary quality.[16,53] Consolidation of policies and clearer communication to teachers from both the federal and local levels will promote a positive learning environment in which teachers feel supported in the use of FBL.[39,53]

Although teachers interviewed were from a large geographic span of the state, because of the qualitative nature of the study, findings are not generalizable outside the NC *Head Start* teachers represented in the study. Teachers in this study were also mostly female and primarily White or Black/African American, limiting the gender and ethnic diversity of the findings. However, participants in this study are like the national demographics of Head Start teachers who are 56.30% White and 35.14% Black and a high proportion female.[79] Teachers who were more interested in FBL or science education topics may have been more likely to participate and may have different perceptions on this topic than those who chose not to participate. Nevertheless, convenience sampling is the best practice when working with community partners.[80] In addition, telephone interviews were used in this study, which prohibited researchers from evaluating participants' nonverbal cues and increased the difficulty of

establishing rapport with participants.[80] However, telephone interviews have been cited as beneficial when sampling teachers across large geographic areas.[81] Further, there has not been evidence that telephone interviews diminish the quality of qualitative data,[81] and on the contrary, telephone interviews have been identified as an ideal medium to conduct semistructured qualitative interviews.[82] Finally, social desirability bias may also have impacted study findings as participants may have responded in ways that made their classroom practices appear more favorable or unfavorable. We used strategies to limit this effect, such as introducing the study, establishing rapport, and asking follow-up questions.[81]

IMPLICATIONS FOR RESEARCH AND PRACTICE

This study qualitatively explored teachers' experiences with FBL in the preschool classroom. Understanding how teachers perceive FBL is critical for changing the overall system to support FBL and align with teachers' goals and values. Integrating FBL into learning domains in the *Head Start* environment may present a unique opportunity to improve preschoolers' exposure to healthy foods while preparing children for kindergarten through the science-learning environment. However, our distinct themes of teachers primarily implementing FBL during mealtime and teachers being unsure how to integrate FBL into other learning domains suggest the need for a multipronged definition of FBL that includes the use of healthy food as a teaching tool by (1) providing repeated exposure to healthy foods for improving children's dietary behaviors and (2) improving academic learning related to knowledge (eg, science, mathematics, literacy) and skills (eg, gross motor, fine, physical). Prior studies in preschool populations indicate that FBL can be integrated into kindergarten readiness outcomes (eg, science, mathematics, literacy).[1,2,39] Additional research is warranted to quantitatively investigate the potential impact of FBL on academic outcomes in preschool populations.

Teacher professional development programs within *Head Start* programs may be an opportunity to impact all 4 levels of the Systems Thinking Model. Professional development at level 1 (events) could focus on expanding teachers' perceptions of FBL outside the confines of mealtime by teaching teachers how to integrate FBL into academic learning domains and providing guidance for benchmarks of success of FBL beyond food intake. Newly developed professional development may specifically address shortcomings of previous training by comprehensively addressing teachers' current practices related to FBL.[83] Efforts to impact teachers' beliefs, values and mental models related to FBL are needed. Dialogue with teachers about FBL could highlight FBL's potential to prepare children for kindergarten, supporting teachers' personal goals and motivations. Finally, future interventions could evaluate the benefit of impacting underlying structures, such as the policy environment and food purchasing, which presently hinder teachers' ability to do FBL. For example, local *Head Start* centers could coordinate with the center's monthly CACFP ordering such that FBL fruit and vegetable items be ordered alongside other foods. Specifically, pairing the CACFP snack with an FBL activity could reduce teacher out-of-pocket costs for FBL.

However, intervening on areas "underneath the surface" in the Systems Thinking Iceberg Model (levels 2-4) is critical to change the overall FBL system. Although teachers have reported feeling happy engaging in common child care tasks like nurturing children, lunchtime, and interactions with parents, teachers face additional stress over ever-growing pressures to meet ever-increasing state and federal requirements while also caring for the social and emotional needs of children.[84,85] In addition to this stress, prior research acknowledges that Head Start staff are generally paid lower wages,[86] which combined negatively affect teachers' physical and mental health.[86,87] If future FBL interventions occur solely at the surface level (level 1), without addressing the need for overall improved support for teachers, the same underlying factors and mental models that teachers currently hold will continue to dictate the outcome of the system. However, consistent with the Systems Thinking Model, by addressing the underlying structures and mental models affecting teachers, the broader system can be fundamentally changed, and a new system, supportive of teachers, supportive of FBL, and aligned with teachers' inherent values and beliefs, emerges.[88]

ACKNOWLEDGMENTS

The research reported in this manuscript was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award no. R25GM132939. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

The authors would also like to thank Zachary Paramore for his assistance in collecting data and Narmin Zeidan for her assistance in collecting and analyzing the data. Finally, we acknowledge our study participants who graciously gave their time to participate in this study.

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