

# An Egg-Based, Universally-Free 'Breakfast in the Classroom' Program Increases School Breakfast Participation and Improves Diet Quality in Middle-School Adolescents: A Feasibility, Pilot Study

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# **INTRODUCTION:**

Breakfast skipping in young people has been strongly associated with reduced cognitive performance and school grades, attendance and disciplinary concerns, reduced health and well-being, and an increased risk of obesity (Adolphus et al., 2016; Ardeshirlarijani et al., 2019; Deshmukh-Taskar et al., 2010; Kingshipp et al., 2022; Rampersaud et al., 2005; Ramsay et al., 2018). Several tightly controlled intervention trials have been completed to examine the impact of breakfast consumption on adolescents who skip breakfast and have reported improved outcomes (Adolphus et al., 2016; Gwin & Leidy, 2018; Maki et al., 2016). However, the composition of the breakfast meal appears to play a significant role.

For example, data from our lab illustrates that the daily consumption of a higher-protein breakfast elicits improved glucose control, increased appetite control and satiety, prevention of unhealthy body fat gain, and reductions in unhealthy snacking behavior compared to skipping breakfast and/or consuming a high-carbohydrate breakfast (Bauer et al., 2015; Gwin & Leidy, 2018; Leidy et al., 2013). Additionally, the consumption of protein-rich foods at breakfast is generally well-liked and reduces nutrient inadequacy of key nutrients (i.e., protein, calcium, magnesium iron, phosphorus, choline, vitamin D, vitamin A, vitamin B6, vitamin B12) in teens, especially females (Agarwal & Fulgoni, 2023; Bauer et al., 2015; Fulgoni & Fulgoni, 2023; Gwin & Leidy, 2018; Hess et al., 2020; Leidy et al., 2013; Papanikolaou & Fulgoni, 2019). Although the current tightly controlled intervention trials identify dietary strategies that improve teen health, well-being, and diet quality, it is unclear whether these strategies are feasible within a free-living environment like the school breakfast program (SBP).

The SBP was implemented to improve nutrition and diet quality for all school-aged children and teens, but it is especially important for students from low-income households experiencing food insecurity (Kingshipp et al., 2022). However, only about one-fourth of all adolescents participate in the SBP (Kingshipp et al., 2022). The most frequently cited reasons for not participating include the following: lack of awareness about SBPs; lack of time in the morning upon arriving to school; the perception of poor nutritional/taste quality of the foods; and





the social stigma attached to consuming breakfast in the school cafeteria (Cohen et al., 2003; Food Research & Action Center, 2017; Hearst et al., 2016; McDonnell et al., 2004; Reddan et al., 2002). Thus, to improve SBP participation, schools have implemented various programs that offer easier access to breakfast for all students.

First, several states have moved towards a "Universally-Free" (UF) school breakfast system to remove the cost barrier of school breakfast participation and to potentially reduce the social stigma associated with eating breakfast at school. Although limited, current evidence suggests that establishing a UF breakfast program increases breakfast participation by ~4% (Bullock et al., 2022; Spill et al., 2024; Turner et al., 2019). Another program, "Breakfast in the Classroom" (BIC), serves breakfast either at conveniently located school hallway kiosks or directly in the students' classrooms (NEA Healthy Futures; Partners for Breakfast in the Classroom, 2004). BIC allows for additional time to eat breakfast and eliminates the social stigma of eating breakfast in the school cafeteria. In schools where BIC has been implemented, participation in school breakfast increased between 30–60 percent (Anzman-Frasca et al., 2015; Corcoran et al., 2016; Moeltner et al., 2018; Polonsky et al., 2019). However, continued concerns from parents and students exist regarding the nutrition, quality, and taste of the foods served at school (Cohen et al., 2003; Food Research & Action Center, 2017; Hearst et al., 2016; McDonnell et al., 2004; Reddan et al., 2002; United States Department of Agriculture Food and Nutrition Service, 2019).

In July 2024, the USDA updated school meal requirements to allow schools to substitute grains for meat/meat alternatives, including eggs, as part of the school breakfast meal (*Child Nutrition Programs: Meal Patterns Consistent With the 2020-2025 Dietary Guidelines for Americans*, 2024). This change was implemented to "increase the variety of appealing breakfast options available to students; decrease the added sugars in school breakfasts; simplify menu planning; deliver filling, protein-rich breakfasts that students enjoy; encourage student participation; and reduce food waste." (*Child Nutrition Programs: Meal Patterns Consistent With the 2020-2025 Dietary Guidelines for Americans, 2024*) Given the new reimbursable policies for meat/meat alternatives, the benefits associated with increased dietary protein at breakfast in intervention-based studies, and the increased participation in school breakfast with BIC, our pilot study is well-suited to explore the following question: Does a novel, egg-based UF-BIC program increase school breakfast participation, consumption, and diet quality. To answer this question, a quasi-experimental study was completed on adolescents from an urban middle school containing a high prevalence of low-income households at risk of food insecurity. The primary outcomes were school breakfast participation and consumption. Secondary outcomes included afternoon/evening snacking and qualitative assessments of the perceived importance of breakfast.

# **METHODS:**

# **School Setting & Study Participants**

The study occurred during the spring of 2018 at the Center Middle School in Kansas City, Missouri. The school is in an urban, majority-minority (82%), low-income (74% free or reduced school meals-eligible) district. All





eighth-grade students (n=164) were invited to participate in the study. Of those, 91 students provided assent and had at least one parent who provided consent. Participant demographic information was assessed prior to the start of the study through questionnaires. The Purdue University Biomedical Sciences Institutional Review Board approved the study, and participants received a \$25 gift card for completing the study procedures. This trial is registered at clinicaltrials.gov as NCT03536676.

# **Experimental Design**

This study incorporated a quasi-experimental design in which participants were offered breakfast (for purchase) for three weeks within the habitual Traditional School Breakfast (TSB) program, which provided breakfasts served in the cafeteria. Following TBS, the students were offered a UF-BIC for three weeks, which provided egg-based breakfasts from hallway kiosks to be eaten in the classroom. At the end of each program, students completed validated surveys assessing school breakfast participation and consumption (Lazzeri et al., 2013; Neuhouser et al., 2009), afternoon/evening snacking, and perceived benefits of breakfast.

# **School Breakfast Programs**

TSB provided breakfasts within the cafeteria prior to the start of the school day between 7:25 and 7:50 a.m. The breakfasts contained foods that met USDA requirements for Grades 6–8 ("Child Nutrition Programs: Flexibilities for Milk, Whole Grains, and Sodium Requirements. Final rule," 2018) and included fruit/fruit juice, whole grains, and milk (flavored and unflavored). UF-BIC provided breakfasts at hallway kiosks outside of classrooms between 7:25 and 7:50 a.m. If the students chose to participate, they would take their breakfast to their first-period classroom and eat it before class started. The students would have 20 minutes to eat breakfast before class started. UF-BIC breakfasts were similar to those provided in TSB but included an additional serving of eggs to increase protein content (5–10 oz eq/week; 1–2 oz eq/day) as familiar breakfast foods. The UF-BIC was referred to by the food service staff and teachers as the "Egg-cellent BIC" (Supplemental Table 1).





Breakfast Meal	Quantity (Per Student)
Egg & Cheese Burrito with Orange Slices and Milk	
Whole Eggs, Liquid (scrambled)	3.5 oz
Whole Grain Tortilla	1 tortilla
Reduced Fat Cheddar Cheese, Shredded	0.5 oz
Orange Slices	½ cup
1% Milk	8 oz
Egg Quesadilla with Salsa, Mixed Fruit, and Milk	
Whole Eggs, Liquid (scrambled)	3.5 oz
Whole Grain Tortilla	1 tortilla
Reduced Fat Cheddar Cheese, Shredded	0.5 oz
Salsa	2 Tbsp
Mixed Fruit Cup	½ cup
1% Milk	8 oz
Egg Muffins, Cereal, Apples, and Milk	
Whole Eggs, Liquid	3.5 oz
Reduced Fat Cheddar Cheese, Shredded	0.5 oz
Bell Peppers	1.6 oz
97% Fat-free Ham	0.2 oz
Apple - Medium	1 apple
Cereal, Assorted	³⁄₄ cup
1% Milk	8 oz
Breakfast Pizza, Grapes, and Milk	
Whole Eggs, Liquid	3.5 oz
Reduced Fat Mozzarella, Shredded	0.5 oz
Mini 4' Pita	1 Pita
Pizza Sauce	1⁄4 cup
Grapes	½ cup
1% Milk	8 oz

**Supplemental Table 1:** Example Universally-Free "Egg-cellent" Breakfast in the Classroom Breakfast Meals

Concerning food preparation, the eggs were prepared as scrambled eggs and included with each entree for all meals except for the egg muffins. For those, liquid eggs were added to muffin cups and cooked accordingly. After cooking/preparation, all egg-based entrees were wrapped in aluminum foil and placed in a hallway warmer until being given to the students upon request. The fruit and milk were stored in hallway coolers and given to the students upon request. All contents were placed in bags and transported by the students to their respective classrooms for consumption.





#### Assessments

School breakfast participation was determined by an electronic school meal tracking system that logged student breakfast participation each day during the TSB and UF-BIC periods.

The following questionnaires were provided at the beginning of a lunch period for ease of distribution. Student demographics were collected via a questionnaire asking age, height, weight, ethnicity, race, and reduced/free school meal eligibility. Breakfast consumption was assessed using a modified food frequency questionnaire to determine the frequency and types of breakfast consumed over the past week (Lazzeri et al., 2013). The question stated the following: "Over the past week, how frequently did you consume the following foods or beverages at breakfast:" with the following answers of "Never, 1–2 times/wk, 3–4 times/wk, 5–7 times/wk."

Student perceptions of breakfast were assessed using a questionnaire similar to that of Hearst et al. (Hearst et al., 2016, 2018) that asked, "How does eating breakfast help you?" A multiple-selection answer format was utilized that included commonly cited responses among adolescents.

Snacking was assessed using a modified food frequency questionnaire to determine the frequency and types of snacks consumed over the past week (Neuhouser et al., 2009).

#### **Data and Statistical Analyses**

School breakfast participation throughout the TSB and UF-BIC was quantified in two ways. First, the average participation throughout the three-week periods was determined. In addition, the frequency of breakfast participation was categorized as "rarely" when students participated 0–4 times (0–30%), "infrequent" when participation was between 5–10 times (31–70%), and "often" when participation occurred >10 times (>70%).

All data are reported as mean  $\pm$  standard error of the mean (SEM). Paired-sample t-tests were applied to compare the effects of TSB vs. UF-BIC on school breakfast participation, breakfast consumption, and snacking. A  $\chi$ 2 test for independence was applied to compare the perceptions of the importance of breakfast following the TSB vs. UF-BIC periods. P≤0.05 was considered significant. Analyses were conducted using the Statistical Package for the Social Sciences (SPSS; version 29.0; Chicago, IL, USA).

#### **RESULTS:**

The study participants were middle-schoolers (age:  $14\pm1y$ ), majority-healthy weight (BMI percentile, ageadjusted:  $73.1\pm3.0\%$ ), and majority-minority (66% black or African American). Although 60% were eligible for free or reduced school breakfast, less than 20% habitually consumed school breakfast.

Daily participation in TSB vs. UF-BIC across the three-week periods is shown in Supplemental Figure 1. Average participation across the three weeks for TSB was  $37.2\pm2.9\%$  compared to the three weeks for UF-BIC, which was  $94.4\pm0.8\%$  (p<0.001). Restated, the UF-BIC increased breakfast participation by 57.2% vs. TSB (p<0.001). When





participation is expressed in terms of categorical criterion, 42.9% of students in TSB rarely participated in school breakfast, 31.9% infrequently participated, and 16.5% often participated. During UF-BIC, 100% of students often participated between 4–5 days/week.

**Supplemental Figure 1:** Participation in the Traditional School Breakfast (TSB, ) Compared to an Egg-Based, Universally-Free Breakfast in the Classroom (UF-BIC, ) Programs in 86 Middle-School Students



\*denotes significance, TSB vs. BIC, P < 0.01 based on paired t-tests

The frequency of breakfast foods consumed during the TSB and UF-BIC periods is shown in Figure 1. When compared to TSB, UF-BIC participation increased the consumption of cereal (p=0.02), grain with eggs (p<0.001), eggs alone (p=0.02), and dairy (p=0.004).









\*denotes significance, TSB vs. BIC, P < 0.01 based on paired t-tests

Regardless of the school breakfast program, 64% of the students perceived that breakfast gives them more energy, 61% said it improves their mood, and 56% indicated it "wakes them up" (data not shown).

Afternoon snack habits during the school breakfast programs are shown in Figure 2. Compared to TSB, UF-BIC decreased the frequency of consuming salty snacks (p=0.02) and cookies and cakes (p=0.03).









\*denotes significance, TSB vs BIC, P < 0.01 based on paired t-tests; data are means ± SEM

# **DISCUSSION:**

Implementing an egg-based UF-BIC program increased school breakfast participation and breakfast consumption of nutrient-dense foods while decreasing afternoon snacking. Collectively, these data suggest that a free, egg-based school breakfast eaten in the classroom setting is feasible, accepted by middle schoolers, and may improve diet quality. Further work is needed to examine whether similar nutrition-focused, non-traditional school breakfast programs increase breakfast consumption, diet quality, and health outcomes over the longer term.

A recent review by the USDA Nutrition Evidence Systematic Review team was completed to 1) examine the impact of breakfast consumption (at home and/or school) on school performance and weight and health





outcomes in school-aged children and adolescents and 2) identify which U.S. school breakfast programs are effective in increasing school breakfast participation and improving diet guality (Kingshipp et al., 2022). The UF and BIC programs consistently and robustly increased school breakfast participation compared to TSB in large, well-designed studies across the majority of school grades and socioeconomic groups. Although the data is limited, UF and BIC improved diet guality through changes in the consumption of nutrient-dense foods compared to TSB. Whether these programs also improve learning, weight management, or other health outcomes remains unknown due to lack of evidence. The current study supports the findings from this review as the UF-BIC increased breakfast participation and overall diet guality through the increased consumption of nutrient-dense foods at breakfast in combination with reductions in snacking. However, it is important to note that the implementation of the UF-BIC in the current study was accompanied by improved breakfast quality by adding protein-rich eggs. Previous clinical trials from our research team illustrate that consuming a higherprotein breakfast, such as the breakfast provided in the current study, reduces hunger, increases satiety, and reduces unhealthy evening snacking compared to a lower-protein breakfast and/or breakfast skipping (Leidy et al., 2015; Leidy et al., 2013). Given the published benefits of increased dietary protein at breakfast, it would seem plausible that the improved quality of the breakfast in this study elicited the greatest impact on breakfast consumption and snacking behavior compared to the change in breakfast modality (TSB vs. BIC). Regardless, improving the guality of the breakfast served via BIC may be an ideal way to address the lack of school breakfast participation and nutrient inadequacy concerns observed in this sensitive life stage.

One potential barrier to implementing a higher-protein breakfast includes the inherent challenges and costs associated with purchasing, producing, and distributing higher-protein foods that need to be prepared as "hot" meals served via BIC (Polonsky et al., 2019). This study, however, demonstrated the feasibility of distributing higher-protein "hot" meals via BIC using hallway warming stations. Given that the eggs were provided to the school free of charge, the only additional cost was related to food service and preparation. A recent cost analysis was performed by Papanikolaou and Fulgoni (Papanikolaou & Fulgoni, 2020) to assess the cost of eggs in relation to their nutrient density and compare them to other foods. Whole eggs were the third lowest cost per 100g of foods at \$0.35/2 eggs, with only dairy and grains being less expensive. Further, whole eggs were ranked as the most cost-efficient food in terms of providing protein, choline, vitamin A, vitamin E, and vitamin D in children and adolescents. The current study serves as evidence that it is feasible to serve nutrient-rich, egg-based, hot foods to students via a "grab-n-go" BIC delivery program, but food costs, additional staff, storage, and equipment needs must be considered prior to initiation.

# Limitations

Limitations to this pilot study exist and should be considered. First, the study incorporated a quasiexperimental design in which TSB was completed, followed by the egg-based UF-BIC. Randomization and simultaneous implementation of different breakfast programs was impractical since the study was conducted in a single school building, requiring the availability of food kiosks in hallways and making it impossible to conceal from the potential control, TSB. This approach has been used in previously published studies for similar reasons (Moeltner et al., 2019; Nanney et al., 2011) and provides the foundation for future randomized controlled trials.





The programs were only three weeks; thus, long-term implications for weight management, health promotion, breakfast perceptions, and habitual participation cannot be established. Future studies should determine whether the current study's findings extrapolate to long-term improvements.

Lastly, the TSB was not a UF system and did not include eggs, whereas the BIC program offered free, eggbased breakfasts to all 8th-grade students. Thus, we are unable to determine whether school breakfast participation was a result of the type of breakfast provided, the type of breakfast delivery, or simply due to the increased availability of free breakfast to all students. Since two-thirds of the students already qualified for free and/or reduced school meals, providing daily, free breakfasts as part of the study intervention may not have substantially impacted the study findings. Thus, it seems likely that the BIC intervention had the greatest impact on school breakfast participation, while providing egg-based breakfast foods may have also contributed to this positive finding.

In summary, implementing an egg-based UF-BIC program appears to be a feasible strategy to increase school breakfast participation and improve diet quality in urban middle school students from primarily low-income households.

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The authors' responsibilities were as follows: SMD and HJL designed the research project and completed all study procedures; SMD and HJL completed all statistical analyses; SMD and HJL developed the first draft of the manuscript; KAG and HJL substantially contributed to the completion of the manuscript. All authors have read and agreed to the published version of the manuscript. Sources of Support: Egg Nutrition Center provided the eggs for the study.

#### **Conflict of Interest:**

HJL, SMD, and KAG have no conflicts of interest.





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