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Cross-sectional study of associations between fruit and vegetable (F&V) at school lunch and food-based programming

Why and Design: To explore relationships between food-related programming and fruit and vegetable (F&V) consumption at school lunch.

Methods: Sample was 20 schools from 8 states. Schools were chosen to have wide range of food-related programming (measured by Healthy School Progress Report). F&V consumption at school lunch was measured by before and after meal digital photography over 2 consecutive days at each school.

Results: There was a significant correlation between nutrition education (Hand-on Learning—Knowledge Progress Report score) and F&V consumption, with a tripling of consumption from low to high score.

Conclusion: The potential impact of food-related programming that incorporates nutrition education on F&V consumption warrants future pre-post, controlled studies.

Why explore programming and F&V consumption

There is increasing food-related programming in schools across the country. There is also interest in understanding what types, intensity, and qualities of programming lead to increased F&V consumption at school lunch.

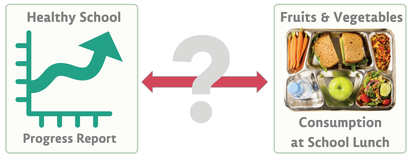
FoodCorps is an Ameri-Corps service program that connects kids to healthy food in schools. Teachers College, in collaboration with FoodCorps, developed a tool to measure level of programming, the FoodCorps Healthy School Progress Report (Progress Report).

The purpose of this study was to explore associations between food-related programming (as measured by the Progress Report) and consumption of F&V at school lunch.

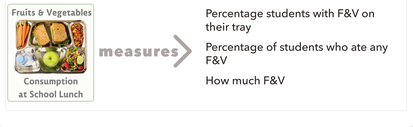
Design

Cross-sectional study with 20 representative FoodCorps schools from 8 states to examine the association between Progress Report score and F&V consumption at school lunch(See Figure 1).

Figure 1:
Study Design



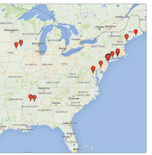




Sample:

FoodCorps schools which completed the Progress Report in fall 2015 were eligible (n=313). Eligible schools were narrowed to schools in the 1st, 3rd, and 5th quintiles of Progress Report score (n=100 excluded) to assure a range of Progress Report scores. Schools without second and 3rd grade and private schools were excluded (n=92). Twenty schools (of the 121 eligible) were enrolled. We sampled 2nd and 3rd grade students (See Figures 2 and 3). We aimed for 100 total matched before and after meal photos from each of the 20 schools over 2 consecutive days of data collection.

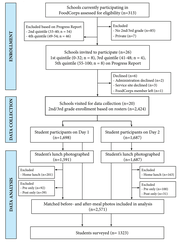
Figure 2:
Map of Schools in the Sample



Sample:

Connecticut (n=4)
Iowa (n=2)
Maine (n=2)
Mississippi (n=2)
Montana (n=2)
New Jersey (n=2)
New York City (n=4)
Washington DC (n=2)

Figure 3:
Study Flow



Progress Report Overview (total 100-points)

HANDS-ON LEARNING

Hands-on Learning—Knowledge (25 points)

- How many classes in each grade that received any classroom nutrition education lessons about F&V and how many lessons did they receive?
- How many of the lessons involved eating F&Vs (tasting and/or cooking)?
- Did the lessons involve the best practices in Hands-on Learning (See Figure 6)?

Hands-on Learning—Engagement (25 points)

- How many classes in each grade participated in gardening lessons and how many gardening lessons did they receive?
- How many of the gardening lessons involved eating F&Vs (tasting and/or cooking)?
- Did the lessons involve the best practices in Hands-on Learning (See Figure 6)?

HEALTHY SCHOOL MEALS

Healthy School Meals (25 points)

- Questions about the lunch line and salad bar and whether it was set up to make eating F&Vs inviting, the easy choice, and/or the social norm.
- Questions about the cafeteria atmosphere.
- Questions about tastings of F&Vs in the cafeteria.
- How often was local food (excluding milk) served?

SCHOOLWIDE CULTURE OF HEALTH

Schoolwide Culture of Health (25 points)

- Questions about the healthy food being the dominant choice.
- Questions about the school respecting healthy eating.
- Questions about involving families in food-based programming.
- Questions about learning about local food production, farms, and composting
- Questions about the schools physical space supporting eating F&Vs.

F&V Consumption Data Collection Methods



We set up 4 photography stations in the cafeteria before the lunch period with cameras attached to tripods at a 60-degree angle. We placed 3 stations at the point where students exited the lunch line and one near the disposal area. As students exited the lines we photographed students' tray affixed with a unique ID number.

Students' trays were photographed again after they finished eating.

The photographer conducted a visual inspection of the tray to assure all foods, as well as the ID label, were fully visible. Empty bags (e.g., chips, cookies) were flattened with a corner placed under the tray. A rubber band was used to mark the level of milk left in the container. See Figure 4 for examples of before and after meal photos.

Data collection staff attended a one-hour training session prior to data collection on the first day at each school.

Figure 4:
Sample before and after meal photos



F&V Consumption Coding Methods

Six trained research staff coded the matched pairs of before and after meal photos.

From the before meal photos, coders recorded items on tray and portion size for each item.

Comparing the before and after meal photos, coders rated amount consumed in 10% increments.

One lead research (MMG) conducted interrater reliability (IRR) for 5 meals from each day of data collection (n=200). We calculated IRR for matches on items on tray. For amount consumed, we calculated exact match and adjacent match rates (See Table 1). Questions on photos were reviewed by at least 3 coders and discrepancies were resolved by majority consensus.

Table 1:
Inter-rater Reliability

Inter-rater reliability (% agreement)			
School	Food on Tray	% Eaten = Exact *	% Eaten = Adjacent †
C	97.3	78.8	92.8
D	100.0	85.3	94.5
E	98.8	77.0	95.5
F	100.0	89.5	99.0
G	100.0	89.5	97.3
H	99.5	86.5	94.8
I	100.0	91.0	97.3
J	100.0	93.3	98.0
K	100.0	69.8	92.0
L	100.0	84.5	93.0
M	97.5	83.0	96.5
N	100.0	69.8	96.5
O	100.0	93.8	99.3
P	99.0	74.5	90.8
Q	98.5	76.3	96.5
R	100.0	76.0	95.5
S	100.0	80.3	97.0
T	99.3	96.5	100.0
U	100.0	96.0	96.0
V	100.0	79.9	100.0
Overall	**99.5**	**83.0**	**95.8**

* Exact match was the % of items when the 2 observers' estimates were identical on a scale from 0 – 100% to ten percent increments.
† Adjacent match was the % of items when the 2 observers' estimates within an adjacent category between two items on a scale from 0 – 100% to ten percent increments.

Descriptive Statistics for Progress Report and F&V Consumption

The schools were diverse (from 32–100% FRPL) and there was a wide range of Progress Report scores (24–97 out of 100) (See Table 2). While most schools had a high percentage of students that had a F&V on their tray (76.3–100%), there was a wide range (0.18–0.84 cup equivalents) of the amount of F&V eaten (See Table 3).

Table 2:
Descriptive statistics for school data, Progress Report scores and number of lunch observations

School	State	Urban ity*	FRPL (%)†	White (%)†	Hisp (%)†	Black (%)†	Overall	Healthy School Progress Report Spring HL-K	HSM	SCH	Enrollment 1 2nd	3rd	Both	Lunch tray observations (n) Day 1	Day 2	Total
C	MT	Rural	59	59	1	1	67	14	14	18	91	46	69	73	76	149
D	MT	City	70	73	7	5	97	20	18	33	46	49	95	75	80	155
E	MS	Town	66	44	7	44	50	17	12	10	11	150	105	97	202	
F	MS	Rural	93	3	3	96	93	24	19	12	18	94	81	67	148	
G	IA	City	93	10	8	74	28	16	0	5	7	81	74	155	112	114	226
H	IA	Rural	33	86	0	3	82	23	16	12	11	39	34	73	62	135
I	ME	City	94	38	6	41	64	16	14	18	18	61	70	131	74	75	149
J	CT	Suburb	83	17	67	19	49	13	9	11	12	46	49	97	83	76	159
K	CT	Rural	75	35	34	16	54	14	11	17	12	69	73	142	123	116	239
L	DC	City	95	9	3	87	94	11	12	11	21	74	59	133	68	201	
M	DC	City	100	1	12	87	72	20	23	13	17	33	27	60	46	48	94
N	NJ	City	41	1	12	82	97	25	25	24	23	43	42	85	81	83	164
O	CT	City	100	14	65	17	28	5	11	6	6	48	50	98	85	87	172
P	NY	City	100	4	50	41	21	18	7	15	15	68	146	103	92	195	
Q	NY	City	92	0	34	65	44	15	0	16	14	42	43	85	75	73	148
R	NY	City	93	1	19	82	59	14	11	17	12	125	116	241	111	108	219
S	NJ	City	81	0	10	90	24	12	0	3	9	45	46	91	59	70	129
T	CT	City	72	7	76	12	44	15	12	11	7	129	100	229	115	166	281
U	NY	City	79	4	39	49	51	16	13	12	11	-	-	46	49	45	94
V	ME	Rural	52	92	1	3	64	24	14	12	14	-	-	28	24	24	48
ALL			**77**	**28**	**22**	**41**	**55**	**17**	**12**	**13**	**13**	**1442**	**958**	**2424**	**1591**	**1606**	**3197**

* Urbanicity: City, Suburb, Town, Rural, as defined by the National Center for Education Statistics
† FRPL=Free/Reduced Price Lunch, Hisp=Hispanic/Latino, Black=Black/African American, White=White
HL-K=Healthy at Last=Hands-on Learning—Knowledge
HSM=Healthy School Meals, SCH=Schoolwide Culture of Health

Table 3:
Descriptive statistics for F&V consumption data for matched before and after meal photos

	Sample size	On tray	On tray, cup equivalents*	Eat any*	Eaten, cup equivalents*	Eaten, cup equivalents*
	n	%	Mean (SE)	%	Mean (SE)	Mean (SE)
C	48	97.9	0.84 (0.05)	95.8	0.79 (0.05)	0.79 (0.05)
D	133	98.5	0.86 (0.03)	95.4	0.55 (0.03)	0.57 (0.04)
E	157	98.7	0.86 (0.03)	94.6	0.56 (0.02)	0.62 (0.03)
F	106	97.2	0.87 (0.03)	90.0	0.45 (0.03)	0.50 (0.04)
G	191	100.0	0.92 (0.03)	97.9	0.65 (0.03)	0.66 (0.03)
H	106	100.0	1.05 (0.03)	100.0	0.76 (0.03)	0.76 (0.03)
I	120	76.8	0.56 (0.03)	61.8	0.35 (0.03)	0.43 (0.03)
J	145	98.6	0.88 (0.03)	79.8	0.26 (0.03)	0.34 (0.03)
K	209	97.6	0.83 (0.03)	84.4	0.32 (0.03)	0.38 (0.03)
L	142	100.0	1.15 (0.03)	76.8	0.33 (0.03)	0.43 (0.03)
M	71	98.6	0.82 (0.05)	80.6	0.32 (0.05)	0.39 (0.05)
N	149	99.3	1.37 (0.05)	95.8	0.61 (0.05)	0.66 (0.05)
O	106	98.1	0.77 (0.03)	66.2	0.18 (0.03)	0.28 (0.03)
P	196	99.0	0.69 (0.03)	62.5	0.30 (0.03)	0.42 (0.04)
Q	132	99.2	1.14 (0.03)	73.1	0.26 (0.03)	0.35 (0.04)
R	143	95.8	1.02 (0.03)	58.8	0.25 (0.03)	0.42 (0.04)
S	115	100.0	0.83 (0.03)	67.3	0.18 (0.03)	0.26 (0.03)
T	227	97.4	1.39 (0.03)	87.3	0.61 (0.03)	0.70 (0.03)
U	78	94.9	1.14 (0.05)	83.3	0.47 (0.05)	0.56 (0.05)
V	37	94.6	1.15 (0.07)	94.1	0.84 (0.06)	0.89 (0.06)
Overall	2571	96.0	0.96 (0.01)	84.2	0.45 (0.01)	0.53 (0.01)

* Cup equivalents include juice but not potatoes
† For students who had fruits and vegetables on their tray
‡ For students who had fruits and vegetables on their tray and ate at least a bite

Associations between Progress Report and F&V Consumption

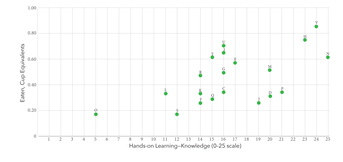
Table 4:
Association between Progress Report and F&V consumption

	Photos	On tray		Ate any F&V, cups equivalents*		Cups on tray equivalents* in F& on tray†		Cups eaten equivalents* in F& on tray†	
	n=3571	OR	95% CI	OR	95% CI	B	P	B	P
Fruit and Vegetables									
	Overall Progress Report	0.97	(0.931,1.014)	1.02	(0.986,1.056)	0.0008	0.818	0.004	0.119
	Hands-on Learning—Knowledge	0.97	(0.830,1.141)	**1.14***	**(1.032,1.260)**	0.005	0.419	**0.022**	**0.004**
	Hands-on Learning—Engagement	0.91	(0.810,1.021)	1.02	(0.942,1.112)	0.001	0.768	0.006	0.288
	Healthy School Meals	0.88	(0.798,1.020)	1.03	(0.924,1.152)	0.002	0.742	0.007	0.381
	Schoolwide Culture of Health	0.96	(0.820,1.125)	1.02	(0.906,1.155)	0.002	0.800	0.005	0.579
Fruit									
	Overall Progress Report	0.99	(0.964,1.024)	1.02	(0.989,1.043)	0.0007	0.584	0.003	0.102
	Hands-on Learning—Knowledge	1.02	(0.909,1.142)	**1.14***	**(1.056,1.241)**	0.004	0.353	**0.018**	**0.004**
	Hands-on Learning—Engagement	0.98	(0.904,1.060)	1.02	(0.948,1.092)	0.004	0.192	0.006	0.166
	Healthy School Meals	0.95	(0.857,1.043)	1.03	(0.939,1.128)	-0.001	0.736	0.006	0.33
	Schoolwide Culture of Health	1.00	(0.894,1.126)	1.01	(0.909,1.114)	-0.002	0.732	0.002	0.731
Vegetables									
	Overall Progress Report	1.01	(0.959,1.062)	1.02	(0.964,1.054)	0.0002	0.839	0.003	0.148
	Hands-on Learning—Knowledge	0.99	(0.820,1.193)	1.12	(0.996,1.270) (p=.057)	0.0003	0.950	**0.015**	**0.028**
	Hands-on Learning—Engagement	0.95	(0.837,1.087)	1.04	(0.950,1.139)	0.0012	0.684	0.007	0.258
	Healthy School Meals	1.08	(0.908,1.272)	1.04	(0.918,1.167)	0.002	0.536	0.007	0.332
	Schoolwide Culture of Health	1.16	(0.969,1.383)	1.01	(0.886,1.157)	-0.000	0.971	0.004	0.602

* Proportional Odds Ordinal Logistic Regression Model. Cups equivalents include juice but not potatoes
† For students who had fruits and vegetables on their tray
OR: Odds Ratio
CI: Confidence Interval
B: The "B-1" Beta means approaching to significance at .05

We used hierarchical linear regression models to determine associations between Progress Report Scores and F&V consumption. There was a positive association between Hands-on Learning—Knowledge and F&V consumption (See Table 4 and Figure 5).

Figure 5:
Scatterplot of Hands-on Learning—Knowledge Progress Report score and amount of F&V consumed at school lunch (in cup equivalents)



We conducted a correlation analysis to determine Progress Report score and school level factors correlated with F&V consumption. Hands-on Learning—Knowledge, and more specifically questions on the Best Practices in Hands-on Learning (Column D, See Figure 6) were correlated with F&V consumption. Three school level factors were also correlated with F&V consumption: number of F&V items offered (+ correlation), % White Students (+ correlation) and % students who quality for free and reduced price lunch (- correlation) (See Table 5). The relationship between Hands-on Learning—Knowledge and F&V consumption persisted even after excluding the 5 schools that had the larger % white population.

Table 5:
Correlation analysis of Progress Report and school-level factors with F&V consumption

	Spring PR Score	HL-K*	r^2	B^*	r^2	G^*	r^2	HL-K†	HSM†	SCH†	White (%)	FRPL (%)	Hisp (%)	%Black	FV eaten in cups‡	FV eaten in cups‡
Spring Progress PR	1	.726*	.244	.728*	.400	.547*	.868*	.845*	.817*	.497*	.238	-.533*	-.297	-.191	.547*	.387*
HL-K*		1	.420	.745*	.666*	.844*	.510*	.452*	.458*	.380	.301	-.574*	-.338	-.179	.612*	.398*
r^2			1	.550	.185	.734	.266	.184	.185	.205	.207	-.342	-.276	-.255	.374	.241
B*				1	.223	.946*	.719*	.590	.502*	.340	.358	-.345	-.328	-.325	.364	.357
r^2					1	.894	.183	.270	.327	.276	.154	-.303	-.283	-.316	.373	.364
G*						1	.390	.377	.205	.439	.210	-.360*	-.115	-.171	.494*	.810*
r^2							1	.410	.662	.439	.195	.414	-.118	-.138	.243	.257
HSM†								1	.697*	.492	.144	-.477*	-.106	-.145	.202	.231
SCH†									1	.157	.127	-.283	-.470	.164	.136	.099
FV items offered‡										1	.289	-.565*	.090	-.354	.596*	.657*
White (%)											1	.510	-.477	-.995*	.612*	.637*
FRPL (%)												1	-.357	.295	-.559*	-.644*
Hisp (%)													1	-.273	-.063	-.055
Black (%)														1	-.416	-.380
FV eaten in cups‡															1	.990*
FV eaten in cups‡																1

* Pearson's r is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
HL-K: Healthy at Last=Hands-on Learning—Knowledge
B: HL-K's Hands-on Learning—Knowledge
G: HL-K's Hands-on Learning—Engagement
HSM: # number of nutrition education lessons
SCH: # number of schoolwide nutrition education
† HL-K, B, Hands-on Learning—Engagement, HSM= Healthy School Meals, SCH=Schoolwide Culture of Health
‡ FV items offered= Number of Fruit and Vegetable items offered at school lunch
‡ FV eaten in cups= Fruit and Vegetables eaten in cup equivalents
‡‡ FV eaten in cups = For students who had fruits and vegetables on their tray
‡‡ FV eaten in cups = For students who had fruits and vegetables on their tray and ate at least a bite

Discussion

Almost all students (96%) across the 20 FoodCorps schools had F&V on their tray. This is not surprising as having a F&V on the tray is a requirement for a reimbursable meal in the National School Lunch Program (NSLP). All schools in this study were in the NSLP.

Schools that scored the highest on Hand-on Learning—Knowledge were eating about triple the amount of F&Vs than schools that scored the lowest (p<0.01), with intake ranging from 0.18 cups with the lowest scores to 0.61 cups with the highest. More specifically, there was a significant and positive correlation (0.62, p<0.01) between conducting the Best Practices and Hands-on Learning and F&V consumption. This suggests that incorporating the Best Practices in Hands-on Learning (See Figure 6) into food-related programming with nutrition education may help to increase F&V consumption at school lunch.

This study also found three school-level factors correlated with F&V consumption. Offering more F&V options had a positive correlation with consumption. The range for offered options was 3 to 14, mean 7.4 (data not shown), often related to the number options on salad bars.

Two school-level demographic variables also had a correlation with consumption. The percentage of students who qualify for free or reduced price lunch had a negative correlation, while the percentage of white students had a positive correlation. This suggests that increased food-related programming may be especially beneficial in schools with high percentage of students who qualify for free or reduced lunch and high percentage of student of color.

Pre-post studies that investigate how programming impacts F&V consumption are warranted to build on and better understand the results found this cross-sectional study.



> "Schools that scored the highest on Hands-on Learning—Knowledge were eating about triple the amount of fruits and vegetables."

Figure 6:
Best Practices in Hands-on Learning

a. Include opportunities to eat fruits and vegetables through tastings and cooking
b. Create positive social norms that make fruits and vegetables cool
c. Decrease fears of trying new foods
d. Focus on health benefits of eating fruits and vegetables
e. Compare the nutritional value of healthful and less healthful snacks
f. Use MyPlate visual to encourage students to make half their plate fruits and vegetables
g. Promote eating fruits and vegetables at school lunch
h. Help students set personal goals for eating more fruits and vegetables
i. Have students monitor progress toward their goals to eat more fruits and vegetables
j. Share recipes for students to take home to prepare with their family
k. Include activities that build cultural appreciation
l. Create appreciation for plants by exploring what they need to grow and their lifecycle
m. Have students work with plants in the garden
n. Harvest what is grown in the garden
o. Introduce the concept of composting and provide opportunities to compost
p. Teach students how our "farm to plate" food system works
q. Focus on inequity in access to healthy foods and resources that build toward equity

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Funding Source

FoodCorps

