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The Effect of State Competitive Food and Beverage Regulations on Childhood Overweight and Obesity

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Abstract

Purpose—Policy efforts for combating childhood obesity have sought stronger state policies for regulating competitive foods and beverages (CF&Bs) available in schools. However, the evidence linking state policies to children's overall diet and body weight outcomes is limited and mixed, and experts have called for more rigorous studies that are able to address concerns about selection bias. The present study leverages a rare natural experiment where children in military families are "assigned" to different state policies, due to their military parent's periodic relocation, to examine whether state CF&B policies were associated with children's BMI and overweight or obesity.

Methods—We analyzed data from 894 children (12–13 years old) in Army families attending public schools located near 25 installations across 23 states in 2013. State CF&B policy measures from the Bridging the Gap project were linked to the child data. Primary outcomes included BMI z-scores and indicator for overweight or obesity. For a subsample of children with self-reported food frequency measures, we also examined the link between state CF&B policies and overall diet. All regression analyses adjusted for a rich set of child and family covariates.

Results—Having strong or weak policies was significantly associated with lower BMI z-scores, lower odds of overweight or obesity, and better dietary outcomes, relative to no policy.

Conclusions—A portfolio of policies that includes multiple strong policies is likely needed to observe any meaningful changes in BMI and obesity.

Keywords

Body mass index; childhood obesity; state policies; competitive foods and beverages

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Competitive Foods and Beverages (hereafter, CF&B) are offered to students on school campuses, during the school day, outside of and in competition with the federally reimbursable and nutritionally regulated school meal programs. It is argued that CF&Bs, available through vending machines, school stores, a la carte lines and other venues (e.g. fundraisers, special events), provide children access to foods and beverages of minimal nutritional value (MNV).[1,2] In response to concerns that CF&Bs contribute to childhood obesity[3,4] policy actions at the federal, state, and local levels have been initiated that seek to regulate CF&Bs in schools. At the federal level, the Child Nutrition and WIC Reauthorization Act of 2004 required all school districts participating in the federal school meal programs to adopt and implement school wellness policies starting in the 2006–07 school year. In particular, school districts were required to develop guidelines for all CF&Bs available at school. These federal guidelines were re-authorized and strengthened with the passage of the Healthy, Hunger-Free Kids Act of 2010. The law's "Smart Snacks" rule requires that starting in school year 2014–15, *all* foods sold at school during the school day will need to meet revised nutrition standards. Meanwhile, there has also been an increase in the number of states enacting or strengthening legislation targeting CF&Bs.[5] These efforts have created considerable variation in the strength and comprehensiveness of CF&B policies across states. At the local level, although most districts have wellness policies, there is variation in both the strength and degree of implementation even within states.[6,7]

These policy actions are predicated on a growing literature demonstrating that stricter CF&B policies are associated with healthier school food environments and improved diet in school.[2] However, the nascent literature on whether these policies ultimately influence children's BMI has produced mixed findings thus far. Research has shown that while these policies may influence the school food environment and student purchases, they may not influence overall diet, (e.g. due to substitution in caloric intake from school to home).[8,9] The availability of foods of MNV in schools has been found to be associated with higher student BMI in some studies[10–13] although others find no significant relationship.[8,14] The existing literature is primarily based on cross-sectional study designs where the variation in policy environment is likely to be endogenous, which may introduce bias in either direction. On the one hand, states with significant childhood obesity problems might be more likely to adopt stricter policies, thereby leading to downward bias (reverse causality). On the other hand, families with a preference for healthier environments will not only have healthier behaviors and lower BMI, but might also self-select into areas with stricter regulations for school food environment, thereby leading to upward bias. Therefore, additional research is needed that is better able to address these concerns.

A unique contribution of our study is that it leverages a natural experiment. Children in military families are exogenously "assigned" to different state CF&B policies due to their military parent's compulsory assignment to specific installations. This design allows us to address concerns about reverse causality and self-selection that undermine the prior literature. We use this plausibly exogenous variation to test the hypothesis that children living in states with stronger CF&B policies will have lower BMI and overweight/obesity and exhibit healthier dietary behaviors.

Methods

Context

The data were collected during the Military Teenagers Environment Exercise and Nutrition Study (M-TEENS). The M-TEENS surveyed families of Army enlisted personnel located primarily at 12 Army installations in the continental U.S.: Joint Base Lewis-McChord (WA), Fort Carson (CO), Fort Drum (NY), Fort Bragg (NC), Fort Benning (GA), Fort Bliss (TX), Fort Campbell (KY-TN), Fort Hood (TX), Fort Polk (LA), Fort Stewart (GA), Fort Sill (OK) and Fort Riley (KS). These installations were chosen because they accounted for the majority of the active duty Army enlisted population in the continental U.S.

Participants

Using Army's personnel records, enlisted personnel who had a dependent child ages 12–13 years (as of March 31, 2013) located at these 12 Army installations for at least 18 months were contacted by M-TEENS. Recruitment was conducted during March-December of 2013 via emails sent to the service members' military email and mailings sent to their home addresses, which were obtained from the Defense Manpower Data Center (DMDC). Due to concerns regarding historically low response rates in this population (15%),[15,16] 8545 families were initially emailed or mailed recruitment materials, of which 2106 (25% response rate) completed the eligibility screener.

Families were eligible to participate if they met three eligibility conditions: 1) the service member did not intend to leave the military within the coming year; 2) the eligible child resided with the enlisted parent at least half-time; and 3) the eligible child was enrolled in a public or Department of Defense Education Activity (DoDEA) schools. Of those screened, 1794 (85%) were eligible. Sixty-six percent (1188) of eligible families consented to participate, and 90% (1,073) of consenting families completed either a parent or child survey. Families were spread across more installations (25 installations spanning 23 states) than the 12 originally expected due to a combination of relocations occurring after the personnel data were obtained and outdated information in the personnel data. Online surveys were completed by the children and one of their parents between Spring 2013 and Winter 2013/2014. Among these families, we analyzed data for the 894 families with an eligible child enrolled in public school (see Appendix for sample flow chart).

The study was approved by the Institutional Review Boards at RAND, University of Southern California, and the Army's Human Research Protection Office.

Measures

BMI and Obesity—Children's height and weight were collected multiple ways. Both child- and parent-reports of the child's height (in feet and inches) and weight (pounds) were obtained for all children via the child and parent surveys. In addition, height and weight measurements were also collected by the study staff during visits to the original 12 installations for a subsample of children who were able to attend the measurement visits on pre-specified days (N=522). There were no statistically significant differences between the

measured and unmeasured children in terms of their self-reported BMI or overweight/obese status or in family socioeconomic characteristics.

Because the subsample with measurements was rather small for separate analysis, we used it as a validation sample to correct measurement error in the reported height and weight of the children with no measurement data by estimating "correction models" that are a standard approach in the literature.[17,18] Details about our correction models are reported elsewhere[19] with a brief description provided in the Appendix. Using the "corrected" height and weight, we computed age- and gender-specific BMI z-score (zBMI) and an indicator for overweight or obese (BMI percentile >=85th) based on the 2000 BMI-for-age and gender growth charts issued by the Centers for Disease Control and Prevention.

Dietary Intake—Children's dietary intake was assessed via a modified version of the Beverage and Snack Questionnaire,[20] which asks about the number of times during the past 7 days that child consumed fruits, vegetables, diet and regular sodas, and types of salty snacks and sweets, among other beverages and foods. The response categories included: never, 1–3 times, 4–6 times, once a day, twice a day, thrice a day, 4+ times per day. No assumptions or guidance about portion size was provided. These responses were converted into counts of the number of *times per week* that the child reported consuming each food and beverage category. Mid-points of the range were used for response categories 1–3 times and 4–6 times in past 7 days. The dietary outcomes were available for children who completed the child survey (82% of the full sample).

State Competitive Foods and Beverage Policies—State policies governing CF&Bs in schools were obtained from Bridging the Gap (BTG) State Wellness Policy Data.[21] BTG is a research program supported by the Robert Wood Johnson Foundation[22] that has compiled state laws related to CF&Bs annually since 2006–2007 by conducting systematic searches of subscription-based legal databases Westlaw and Lexis-Nexis. All state laws were subsequently coded by the BTG researchers using a validated coding scheme.[23,24] The current analyses use BTG data from the 2012–13 school year.

State laws regulating CF&Bs in schools were classified by BTG researchers into 14 topic areas that were each scored as having : 0 "No law or provision", 1 "weak" policy, or 2 "strong" policy. Having "no law or provision" implied that there was no mention of any specific regulation or umbrella statement regulating all CF&Bs, although local agencies could voluntarily adopt policies. Having "weak" policies implied that the provisions included vague terms, suggestions or recommendations, as well as those that allowed exceptions to required action (e.g. for certain grade levels or times of day). Strong policy provisions were those that were definitely required and that specified an implementation plan or strategy. Laws that completely banned all CF&B sales during the school day (except water sales) were coded separately by BTG, but we included them in the strong policies category because there were not enough such states in our sample to estimate that group separately. Additional details about the scoring system and examples are provided in the Appendix.

Table 1 shows the distribution of policy scores in the M-TEENS sample of children and states. There was variation in the strength of a policy for only 10 out of the 14 policies, therefore, only these 10 are included in the analyses. Among these 10 that we focus on, 5 related to regulations (e.g., limits to fat, sugar, sodium and calorie content) for CF&B venues such as vending machines, a la carte lines, school stores, fundraisers, and class parties and celebrations; 1 policy related to the availability of free drinking water (beyond just mealtimes); 3 related to nutritional guidelines and nutrition information for foods and beverages outside of school meals; and 1 related to increasing whole, unprocessed, or fresh foods (hereafter, whole foods) at school. Correlations between the policy measures are reported in the Appendix.

Statistical Analysis

The associations between state CF&B policies and children's zBMI and overweight/obesity were estimated using linear and logistic regression models, respectively. We report unadjusted and adjusted models because if the observed characteristics of children are unrelated to the state CF&B policy measures (as they should be in a natural experiment), then estimates from unadjusted versus adjusted models should be similar. Next, due co-occurrence of some CF&B policies, which makes identifying the independent effect of each policy difficult, we also estimated models that examined whether children's zBMI and overweight/obesity were associated with the number of – (1) weak or strong policies, and (2) strong policies - instead of examining the effect of each policy separately. Last, we estimated the relationship between state CF&B policies and children's dietary outcomes using Negative Binomial Regression models to account for the count nature and over-dispersion of the dietary measures.

For four policies, there were <1% of cases in a specific policy category (see Table 1) and were combined with an adjacent (i.e. higher or lower) policy category to enable estimation on the full sample. Results from models that dropped these cases from the estimation sample or that included separate categories for these cases (when possible), yielded almost identical results (available from authors upon request).

All regressions controlled for a rich set of parent-reported covariates including child's age in months, gender, and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic/Latino, Other); parents' marital status, highest education level (less than high school, high school graduate or equivalent, some college, and college graduate or higher) among child's parents, military parent's rank (Corporal/Specialist or lower; Sergeant; Staff Sergeant; Sergeant First Class; Master Sergeant/First Sergeant or higher); household income (<= $40,000; $40,001–$50,000; $50,001–$75,000; $75,001 or higher), number children in the household, on-post residence, and months at current installation (12 or less, 13–24, 25–48 and 49 or more). Missing data for these covariates ranged from 9% missing for military parent rank to 1.3% missing for child's age; missing data were imputed using multiple imputation methods. Descriptive statistics for the analysis sample are reported in Table 2.

A unique aspect of M-TEENS is that Army personnel are periodically re-assigned to installations based on the Army's needs (Army Regulation 614–200; also see Lleras-Muney 2010[25] for additional background), which creates a natural experiment whereby children are

"assigned" to different state policy environments, at a given point in time. There are no statistically significant differences in the observed child and family characteristics by strength of CF&B polices (see Appendix). Therefore, estimates of the relationship between state CF&B policies and children's outcomes in our sample are unlikely to undermined by selection bias or reverse causality. Nevertheless, we conducted several sensitivity analyses and robustness checks. First, we addressed the potential concern that states with stronger CF&B policies might also have better neighborhood environments that promote healthier lifestyles by including additional controls for the neighborhood built environment based on parents' scores on the subscales of the Neighborhood Environment Walkability Scale – Youth Version.[26,27] Second, we estimated models that controlled for the strength of other state school wellness policies to address concerns that stronger CF&B policies might co-occur with other policies that influence BMI outcomes (details in appendix). Third, we estimated models that controlled for the state's adult obesity rate to control for other state-specific factors (e.g. other policies targeting obesity) that may be correlated with both CF&B policies and children's BMI outcomes. Finally, we conducted two falsification tests using child's height and parent's height as outcomes because they should not be associated with the state CF&B policies. These sensitivity analyses are reported in the Appendix.

All analyses were conducting using STATA 14.1 (StataCorp, College Station, TX). Standard errors were clustered at the state level because the primary explanatory variable of interest is the state CF&B policy.[28]

Results

BMI and Overweight/Obesity

Table 3 reports the unadjusted and adjusted association between each CF&B state policy and children's zBMI and odds of overweight/obesity. For zBMI, four policies showed statistically significant associations in unadjusted models but only two remained significant in adjusted models. Children in states even with a weak policy addressing availability of whole foods at school had 0.13 lower zBMI ($p<0.05$) compared to children in states with no policy. In addition, children in states with weak and strong policies for regulating fundraisers had 0.16 and 0.25 lower zBMI, respectively, relative to no policy.

For overweight/obesity, there were remarkable similarities between the unadjusted and adjusted estimates. Five policies had significant associations in adjusted models. A strong policy for vending contract compliance with nutritional guidelines was associated with 26% lower odds of being overweight or obese ($p<0.05$) compared to no policy or weak policy. Strong policies for fundraisers were also associated with significantly lower odds of overweight/obesity (AOR=0.58, $p<0.01$) compared to no policy. There were areas where even weak policies significantly lowered the odds of being overweight or obese relative to having no policy, such as nutrition information for competitive foods (AOR=0.73; $p<0.05$), regulating vending machine (AOR=0.71, $p<0.01$), and regulating fundraisers (AOR=0.74, $p<0.05$). Having a weak or strong policy for access to free drinking water was associated with significant lower odds of overweight/obesity compared to no policy (AOR=0.72; $p<0.05$).

Policies requiring nutritional guidelines for all foods at school had a small but statistically insignificant association with both zBMI and odds of overweight/obesity. And, two policies – regulations for foods and beverages sold at parties and through a la carte lines – were not associated with either outcome.

Overall, six of the ten policies had a statistically significant and sizeable association with zBMI and/or with overweight/obesity after adjusting for covariates.

Models that examined whether having more CF&B policies was associated with BMI and overweight/obesity suggest that having 7 or more policies, or having at least 2 strong policies, were both associated with significantly lower zBMI z-scores and lower odds of overweight/obesity, relative to having less than 5 policies, and having no strong policy, respectively (Table 4).

Sensitivity Analyses

Results from sensitivity analyses are summarized here and provided in the Appendix. Controlling for neighborhood built environment, strength of other state school-wellness policies, and the state's adult obesity rate yielded findings similar to those reported in Table 3.

Dietary Outcomes

Table 5 reports the adjusted association between each CF&B state policy and children's dietary outcomes. Several policies were associated with lower consumption of unhealthy foods and beverages such as salty snacks, sweets, or soda. In particular, strong policies for regulating school stores and vending machines were associated with an 18% and 22% reduction in the weekly consumption of salty snacks, respectively, compared to having no policy. Policies for regulating vending machines were also associated with lower weekly consumption of sweets – weak and strong policies were both associated with a 15% reduction although only the weak policy association was statistically significant.

None of the policies was significantly associated with soda consumption, with one exception where the association was counterintuitive: Having a weak policy for regulating fundraisers was associated with an *increase* in weekly soda consumption, and having a strong policy had no association.

The results for overall consumption of healthy foods showed several significant associations for fruit consumption but not for vegetable consumption, although the magnitudes were similar for several policies. Fruit consumption had the largest association with strong policies regulating vending machines and school stores. A strong policy was associated with a 28% increase in the weekly consumption of fruit, compared to having no policy. Even weak policies were associated with increased fruit consumption, including policies for the use of whole foods (9% increase in weekly fruit intake), and regulating vending machines (8% increase), school stores (8% increase), and parties (14% increase).

Discussion

While there is consensus in the literature that stronger CF&B policies are associated with reduced availability of CF&Bs in schools and better in-school dietary outcomes, the evidence on whether these policies impact overall consumption and BMI is limited and mixed. In a recent systematic review of the evidence on CF&B policies, Chriqui and colleagues[2] conclude that "..on-the-books laws and policies are doing what they were intended to do – namely, they are reducing the in-school student consumption of such items." However, Chriqui et al also emphasize the lack of rigorous evidence on how these policies impact BMI and obesity outcomes and concluded that "more research is clearly needed to truly understand the influence of CF&B polices on overall (in- and out-of-school) student consumption behaviors and student BMI and weight outcomes.[2] The existing literature is primarily based on cross-sectional data where the variation in policy environment is not exogenous; therefore, it is difficult to assess causality. Our study directly contributes to this important gap in the literature by leveraging a natural experiment design. Compulsory relocation of Army families created a natural-experiment whereby observationally-equivalent children were "assigned" to states with different CF&B policy regimes. Therefore, concerns about reverse causality or non-random policy adoption (e.g. states with higher obesity rates adopting stronger policies), were eliminated.

We found that, overall, state policies for CF&Bs mattered for children's BMI, overweight/obesity, and diet. Several policies—including regulations for fundraisers and vending machines; vending contract compliance with nutritional guidelines; emphasis on whole food availability; nutritional information for competitive foods; and access to free drinking water beyond mealtimes—were significantly associated with lower zBMI, lower odds of overweight/obesity, and/or better dietary outcomes. Moreover, CF&B policies were associated with reductions in consumption of unhealthy foods as well as increases in consumption of healthy foods. Importantly, our findings were robust to several sensitivity analyses and robustness checks.

Our results also show that both weak and strong policies were associated with better dietary and body weight outcomes, relative to having no policy provisions, which suggests that, on average, having a policy (weak or strong) is important for addressing overweight or obesity. This was further underscored by results from models that examined whether the number of policies mattered. Our results suggest that children living in states with several CF&B policies, some of which were strong, had significantly lower zBMI and odds of overweight or obesity.

Lastly, we found more significant associations for overweight/obesity than zBMI; most of the policies were associated with large reductions (22% – 48%) in the odds of overweight/obesity. CF&B policies might be particularly important for children at the higher end of the BMI distribution, which suggest that these policies may be a particularly important lever for reducing overweight and obesity.

Several prior studies have used the BTG data's policy classification to study the influence of state policies regarding school-wellness[9,29–31], yet none have examined how policies

governing CF&Bs in schools are related to BMI outcomes. Three studies[32–34] have used a similar database, the National Cancer Institute's CLASS data, to link state CF&B policies to BMI outcomes, with mixed results. The two cross-sectional studies[32,34] found opposite results, highlighting the limitations of cross-sectional designs. The third study[33] was longitudinal and found that state policies that were comprehensive and contained strong language were associated with lower BMI gains over time, which is consistent with our findings.

Our findings have important implications in light of the new federal Smart Snack standards for CF&Bs in schools, which have leveled the playing field by requiring stronger and more comprehensive CF&B policies across all states. Our findings support the idea that these newer standards will be a critical step for combating childhood obesity.

Our study has some limitations. Although the natural experiment context has advantages, there may be concern about whether findings from this population can be generalized to the broader U.S. child population. Military families, for example, may have higher socioeconomic status given that they are often two-parent families where at least one of the parents is employed full-time (by the military). However, the vast majority of military children attend public schools (>85%) and a majority also live off-base in civilian communities (70–80%).[35–37] Moreover, prevalence of childhood overweight or obesity in military families is comparable to that in civilian populations.[38,39] Therefore, findings from the present study may still have important implications for civilian populations. In addition, military families with children are a large, important, and understudied population in their own right. Other limitations of our study include - coarseness of our dietary measures (i.e. self-reports, lack of portion size specificity), absence of school-level data on CF&B policies, BMI measurements for only a subsample, and limited geographic representation. Lastly, we cannot identify the effects of individual CF&B policies since some co-occur (e.g. regulations for competitive food venues). Nor can we completely rule out the influence of other state policies or factors that may have co-occurred with stronger CF&B laws, although our sensitivity analyses reduce such concerns.

Conclusion

State CF&B policies can be important tools for the prevention of childhood overweight and obesity by improving dietary behaviors. A portfolio of policies, including multiple strong policies, is likely needed to observe meaningful changes in student BMI and obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Implications and Contributions

State policies for competitive foods and beverages available in schools can play an important role in combating childhood obesity. For these policies to be effective, a portfolio of policies that not only restrict access to unhealthy foods but also those that promote healthy eating will be needed.

Table 1

Distribution of State Competitive Food and Beverage Policies in the M-TEENS Sample

			% of M-TEENS Children with			% of M-TEENS States with		
		CF&B Policy Area	No Policy	Weak Policy	Strong Policy	No Policy	Weak Policy	Strong Policy
Policies Included in Analyses	1	Includes nutrition guidelines selected by the local education agency for all foods available on each school campus during the school day	<1%	60%	39%	17%	35%	48%
	2	Vending-competitive food contract compliance with nutritional guidelines	51%	<1%	49%	74%	4%	22%
	3	Addresses increasing “whole foods”- whole grains, unprocessed foods, or fresh products	32%	68%	0%	57%	43%	0%
	4	Nutrition information (e.g., calories, saturated fat, sugar) available for foods other than school meals	89%	11%	0%	96%	4%	0%
	5	Addresses access to (free) drinking water	88%	11%	<1%	91%	4%	5%
	6	Regulates vending machines	16%	68%	16%	26%	43%	31%
	7	Regulates school stores	25%	60%	15%	39%	39%	22%
	8	Regulates food service a la carte OR food sold as an alternative to the reimbursable school meal program (if not defined as to what this means)	<1%	84%	15%	17%	52%	31%
	9	Regulates food served at class parties and celebrations	61%	39%	0%	83%	17%	0%
	10	Regulates food sold for fundraising	57%	35%	8%	61%	17%	22%
Not Included	11	Competitive food ban-cannot be sold	98%	2%	0%	87%	13%	0%
	12	Restricts fast food sales at school (includes cafeteria, school stores, and other venues)	99%	1%	0%	96%	4%	0%
	13	Allows only fruit and-or vegetables and-or whole grains and-or related combination products	100%	0%	0%	100%	0%	0%
	14	Addresses food not being used as a reward and-or withheld as a punishment	100%	0%	0%	100%	0%	0%

Notes: N=894. Figures in the table are row percentages. State CF&B policy data was obtained from Bridging The Gap research program.

Policies 11–14 were not included in the analyses due to lack of policy variation in our sample.

States in the M-TEENS sample included (23): Alabama, Arizona, Colorado, Florida, Georgia, Hawaii, Kansas, Kentucky, Louisiana, Maryland, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Washington.

Installations in the M-TEENS sample included (25): Hood, Bragg, Benning, Bliss, Campbell, Carson, Stewart, JBLM, Drum, Riley, Polk, Sill, Rucker, Huachuca, Whiting, Schofield/Shafter, Knox, Detrick, Leonard Wood, Dix, McGuire, Wright-Patterson AFB, Jackson, Belvoir, Lee.

Table 2

M-TEENS sample characteristics

	% or Mean
Dependent Variables	
BMI outcomes	
zBMI	0.41
Overweight or Obese	26.6
Diet: Times per week drank/ate:	
Soda	4.6
Salty snacks	10.2
Sweets	12.4
Fruits	8.6
Vegetables	7.9
Covariates	
Child gender = female	46.8
Child's age in months	158.0
Child's Race-Ethnicity	
White, non-Hispanic	40.6
Black, non-Hispanic	20.4
Hispanic	24.8
Other	14.2
Parents married	92.1
Military Parent's Rank	
Sergeant or lower (<=E5)	32.1
Staff Sergeant (E6)	30.1
Sergeant First Class or higher (>=E7)	37.8
Household Income	
$40,000 or less	20.0
$40,001–$50,000	20.6
$50,001–$75,000	36.3
$75,000 or higher	23.1
Parents' Highest Education Level	
HS Diploma/GED or less	8.0
Trade school or some college	35.0
2-Year degree	27.0
4-Year degree and higher	30.0
Number of children in household	
1	12.4
2	34.1
3 or more	53.5
Months at current base	

	% or Mean
12 months or less	8.9
13–24 months	20.6
25–48 months	42.4
49 or more months	28.1
Live on-base	40.6

Notes: Sample size for all variables was 894, except for the dietary variables: Soda (n=735), salty snacks (n=723), sweets (n=706), fruits (n=731), and vegetables (n=730).

Table 3

Association between state CF&B policies and children's zBMI and Overweight/Obesity

	(1) zBMI b [SE]		(2) Overweight or Obese AOR [95% CI]	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**
(1) Nutritional guidelines for all foods at school (Ref=Weak Policy [a])				
Strong policy	−0.08 [0.07]	−0.11 [0.06]	0.87 [0.64 – 1.18]	0.83 [0.62 – 1.12]
(2) Vending contract compliance with nutritional guidelines (Ref=No Policy [b])				
Strong policy	−0.07 [0.07]	−0.1 [0.07]	0.78 [0.59 – 1.02]	**0.74** [0.56 – 0.97] *
(3) Whole, unprocessed & fresh food availability (Ref: No Policy) [c]				
Weak policy	**−0.16** [0.06] *	**−0.13** [0.06] *	**0.76** [0.59 – 0.99] *	0.77 [0.59 – 1.01]
(4) Nutrition information for competitive foods (Ref: No Policy) [c]				
Weak policy	**−0.13** [0.05] *	−0.07 [0.05]	**0.67** [0.50 – 0.88] **	**0.73** [0.53 – 0.99] *
(5) Access to free drinking water (Ref: No Policy)				
Weak policy [d]	**−0.13** [0.05] *	−0.07 [0.05]	**0.66** [0.50 – 0.87] **	**0.72** [0.52 – 0.99] *
(6) Regulates vending machines (Ref: No Policy)				
Weak policy	−0.09 [0.08]	−0.11 [0.07]	**0.76** [0.59 – 0.99] *	**0.71** [0.55 – 0.92] **
Strong policy	−0.06 [0.12]	−0.09 [0.10]	0.78 [0.49 – 1.26]	0.73 [0.47 – 1.13]
(7) Regulates school stores (Ref: No Policy)				
Weak policy	−0.12 [0.06]	−0.12 [0.07]	0.78 [0.60 – 1.02]	0.76 [0.57 – 1.00]
Strong policy	−0.08 [0.12]	−0.09 [0.10]	0.81 [0.49 – 1.32]	0.78 [0.48 – 1.25]
(8) Regulates a la carte (Ref: Weak Policy [a])				
Strong policy	0.06 [0.11]	0.04 [0.09]	1.09 [0.67 – 1.76]	1.07 [0.67 – 1.73]
(9) Regulates parties (Ref: No Policy) [c]				
Weak policy	−0.07 [0.07]	−0.08 [0.07]	0.97 [0.69 – 1.38]	0.95 [0.66 – 1.38]
(10) Regulates fundraisers (Ref: No Policy)				
Weak policy	**−0.18** [0.04] **	**−0.16** [0.06] **	**0.72** [0.57 – 0.91] **	**0.74** [0.57 – 0.97] *
Strong policy	**−0.29** [0.08] **	**−0.25** [0.09] *	**0.51** [0.31 – 0.81] **	**0.52** [0.31 – 0.88] *
Observations	894	894	894	894

Notes: AOR: Adjusted Odds Ratio. SE: Standard error. Estimates in column 1 are beta coefficients (b) from linear regressions (b=0 for reference category). Estimates in column 2 are AOR from logistic regression (AOR=1 for reference category). Adjusted regressions controlled for child's

age, gender, and race/ethnicity, parents' marital status, education, military parent's rank, household income, number children in the household, on-post residence, and time at current installation. These covariates were not included in the unadjusted regressions.

[a] There were <1% cases with "no policy" that were combined with "weak policy".

[b] There were <1% cases with "weak policy" that were combined with "no policy".

[c] There were no cases with "strong policy".

[d] There were <1% cases with "strong policy" that were combined with "weak policy".

** p<0.01,

* p<0.05.

Table 4

Association Between Number of Weak or Strong State CF&B Policies and Child zBMI and overweight/obesity

	Dependent Variable	
	zBMI b [SE]	**Overweight or Obese AOR [95% CI]**
Model 1:		
Number of *weak or strong* CF&B policies in the child's state of residence		
0–4 policies (Reference)	0.00	1.00
5–6 policies	−0.04 [0.06]	0.87 [0.62 – 1.23]
7–9 policies	**−0.18** * [0.07]	**0.69** * [0.51 – 0.92]
Model 2:		
Number of *strong* CF&B policies in the child's state of residence		
No strong policy (Reference)	0.00	1.00
1 strong policy	−0.10 [0.07]	0.72 [0.51 – 1.01]
2–5 strong policies	−0.13 [0.06]	**0.74** * [0.57 – 0.98]
Estimation Model	Linear	Logistic
Mean or percent of dependent variable	0.41	27%
Observations	894	894

Notes: CF&B: Competitive Food and Beverage; AOR: Adjusted Odds Ratio; b=coefficient from linear regression; zBMI: Body Mass Index z-score. Percent of sample with no strong policy = 41%, 1 strong policy = 21%, and 2–5 strong policies = 38%. Percent of sample with 0–4 weak or strong policies = 25%, 5–6 weak or strong policies = 38%, and 7–9 weak or strong policies = 37%. All regressions were adjusted for child's age, gender, and race/ethnicity, parents' marital status, education, military parent's rank, household income, number children in the household, on-post residence, and time at current installation. Standard errors were clustered at the state level.

* $p<0.05$

** $p<0.01$.

Table 5

State CF&B Policies and Children's Dietary Outcomes

	Soda	Salty Snacks	Sweets	Fruits	Vegetables
(1) Nutritional guidelines for all foods at school (Ref=Weak Policy [a])					
Strong policy	1.11 [0.94 – 1.30]	0.94 [0.84 – 1.04]	1.02 [0.89 – 1.17]	**1.11** [1.01 – 1.22] *	1.02 [0.88 – 1.19]
(2) Vending contract compliance with nutritional guidelines (Ref=No Policy [b])					
Strong policy	1.12 [0.91 – 1.37]	1 [0.87 – 1.15]	0.94 [0.80 – 1.11]	1.03 [0.95 – 1.12]	1.01 [0.89 – 1.15]
(3) Whole, unprocessed & fresh food availability (Ref: No Policy) [c]					
Weak policy	0.96 [0.79 – 1.17]	0.88 [0.75 – 1.04]	0.98 [0.82 – 1.17]	**1.09** [1.02 – 1.16] **	1.01 [0.92 – 1.11]
(4) Nutrition information for competitive foods (Ref: No Policy) [c]					
Weak policy	1.04 [0.88 – 1.23]	1.04 [0.94 – 1.15]	**0.91** [0.83 – 1.00] *	0.98 [0.91 – 1.06]	1.08 [0.97 – 1.21]
(5) Access to free drinking water (Ref: No Policy)					
Weak policy [d]	1.05 [0.88 – 1.25]	1.03 [0.94 – 1.14]	0.91 [0.83 – 1.01]	0.97 [0.90 – 1.04]	1.07 [0.96 – 1.19]
(6) Regulates vending machines (Ref: No Policy)					
Weak policy	0.86 [0.69 – 1.08]	0.82 [0.64 – 1.04]	**0.85** [0.75 – 0.97] *	**1.08** [1.03 – 1.14] **	1.03 [0.93 – 1.14]
Strong policy	0.85 [0.71 – 1.00]	**0.78** [0.62 – 0.99] *	0.85 [0.67 – 1.08]	**1.28** [1.04 – 1.58] *	1.24 [0.99 – 1.54]
(7) Regulates school stores (Ref: No Policy)					
Weak policy	0.94 [0.77 – 1.15]	0.85 [0.71 – 1.02]	0.91 [0.78 – 1.06]	**1.08** [1.04 – 1.13] **	1.03 [0.93 – 1.14]
Strong policy	0.91 [0.78 – 1.07]	**0.82** [0.69 – 0.98] *	0.91 [0.72 – 1.16]	**1.26** [1.02 – 1.56] *	1.24 [0.99 – 1.55]
(8) Regulates a la carte (Ref: Weak Policy [a])					
Strong policy	0.93 [0.80 – 1.07]	0.91 [0.83 – 1.01]	0.94 [0.75 – 1.18]	1.13 [0.92 – 1.39]	1.16 [0.94 – 1.43]

	Soda	Salty Snacks	Sweets	Fruits	Vegetables
(9) Regulates parties (Ref: No Policy) [c]					
Weak policy	1.02 [0.78 – 1.34]	0.93 [0.83 – 1.05]	1.03 [0.89 – 1.19]	**1.14** [1.05 – 1.23] **	1.06 [0.92 – 1.21]
(10) Regulates fundraisers (Ref: No Policy)					
Weak policy	**1.22** [1.02 – 1.45] *	1 [0.89 – 1.13]	1.05 [0.89 – 1.23]	1.09 [0.99 – 1.20]	1.02 [0.89 – 1.17]
Strong policy	0.99 [0.81 – 1.22]	0.91 [0.79 – 1.05]	1.07 [0.90 – 1.28]	1.15 [0.85 – 1.57]	1.01 [0.78 – 1.31]
Observations	735	723	706	731	730

Notes: Estimates are Incidence Risk Ratios (IRR) from Negative Binomial Regressions. IRR=1 for reference category. Figures in parentheses are standard errors. All regressions were adjusted for child's age, gender, and race/ethnicity, parents' marital status, education, military parent's rank, household income, number children in the household, on-post residence, and time at current installation.

[a] There were <1% cases with "no policy" that were combined with "weak policy".

[b] There were <1% cases with "weak policy" that were combined with "no policy".

[c] There were no cases with "strong policy".

[d] There were <1% cases with "strong policy" that were combined with "weak policy".

** p<0.01,

* p<0.05.