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# Associations between select state policies and the nutritional quality of household packaged food purchases in the U.S. from 2008-2017

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## Abstract

**Background:** Policy interventions are important public health tools because they can reach large numbers of people. State context has been associated with health outcomes, yet few studies have examined the extent to which state-level policies are associated with dietary quality.

**Objectives:** The objective of this study was to evaluate whether state policies are associated with the nutritional quality of household packaged food purchases (PFPs).

**Design:** This observational study used data from Nielsen Homescan, an open-cohort household panel where participants track purchases, and a combination of state-level food and social safety net policy variables from 2008-2017.

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**Conflict of Interest:** The authors have no conflicts of interest of any type with respect to this manuscript.

**Participants/Setting:** This study included 615,634 household-year observations in the U.S. from 2008-2017. Household-year observations were excluded if a household did not make a minimum number of purchases and if they had incorrect geographic information. The final analytic sample was 611,719 household-years.

**Main outcome measures:** Study outcomes included a set of nutritional measures of public health interest, including nutrients of concern (sugar, saturated fat, sodium) and calories from specific food groups (fruits, non-starchy vegetables, processed meats, mixed dishes, sugar-sweetened beverages and desserts and snacks).

**Statistical Analysis:** This study used multilevel generalized linear models with state fixed effects on three samples: all households, only households with low income, and only households with low educational attainment.

**Results:** Few significant associations were found between Healthy Food Retail policies and the nutritional quality of purchases, and mixed associations were found between social safety net policies and lower or higher quality PFPs.

**Conclusions:** Little evidence was found that state policy context in 2008-2017 was associated with the quality of PFPs. However, variation in state policies is increasing over time, warranting future research into the relationship between these policies, the quality of PFPs, and the rest of the diet.

### Keywords

state policy; packaged food purchases; nutrition; diet quality; socioeconomic disparities

## Introduction

Despite recent improvements, the average American diet is unhealthy,[1] and disparities in diet quality are increasing.[2-5] Diet quality, like many health behaviors, is influenced by both individual and contextual factors.[6] Several conceptual models integrate individual and contextual determinants of health, including the Socioecological Model[7] and Fundamental Cause Theory.[8, 9] Context matters because the association of individual characteristics and health outcomes is conditional on the socioeconomic, cultural or policy context in which people live.[10] Contextual factors that influence dietary quality include those that affect the relative cost and availability of healthy and unhealthy foods.[11, 12]

Research on how diet is influenced by individual, neighborhood, state, and national contexts is important for a comprehensive understanding of diet quality and opportunities for potential interventions, yet state context is understudied. There is reason to hypothesize that state context may be associated with diet. There is state-level variation in many diet-related diseases, such as obesity and type 2 diabetes.[13] State context is associated with food security[14] and disparities in self-rated health[15] and mortality[16] by educational attainment. Furthermore, the importance of differences between states in explaining mortality increased from 1999 to 2017.[17] State context may be associated with diet through policies that improve access to healthier foods. For example, Healthy Food Retail Legislation[18] refers to policies that are designed to improve access in food retail by attracting full-service grocery stores to underserved communities and improve the quality of foods that are sold.

State context is also increasingly influential due to devolution and preemption laws.[19] *Devolution*, or decentralization, of political power from the federal to the state level has resulted in varied implementation of public health policies[20] and federal social programs.[21] Federal nutrition and social policies that aim to increase household resources are relevant to diet because higher incomes are associated with better dietary quality[22] and disparities in diet are mediated by the cost of food.[23] For example, administration of the Supplemental Nutrition Assistance Program (SNAP) varies by state because each state can expand the population eligible to receive benefits through Broad Based Categorical Eligibility (BBCE), allowing families with assets or income exceeding the national threshold to qualify for SNAP.[24] The Supplemental Nutrition Program for Women, Infants and Children (WIC) has an even more explicit focus on nutrition, and states vary in the resources they invest in program outreach to enroll eligible women and children.[25] Therefore, although SNAP and WIC are federal programs, administration of these programs, and therefore access to them, varies widely by state. While SNAP and WIC benefits can only be used on food purchases, other social programs may increase a household's food budget by making other household needs more affordable (e.g., Medicaid expansion, financial aid for college) or increasing overall income (e.g., a larger Earned Income Tax Credit).[26, 27] In contrast, *state preemption laws* limit the power of local (e.g., county or city) governments and have stymied addressing a range of public health issues.[28] These include laws directly affecting food purchases, like prohibiting taxes on sugar-sweetened beverages (SSBs) even though SSB taxes have been shown to reduce disparities in SSB purchases,[29, 30] as well as preemption laws indirectly affecting food purchases, like those against labor laws that would increase household income, like local ordinances to raise the minimum wage.

While diet includes food eaten at home and eaten out, it is important to understand what drives the quality of packaged foods purchases (PFPs). Packaged foods (or foods with a universal barcode, e.g., a bag of onions, frozen entrees, etc) are a subset of foods purchased from stores. Other store foods include unpackaged foods (e.g., loose onions, meat from a butcher) which are not included in this analysis. This study focuses solely on PFPs for several reasons. First, PFPs contribute significantly to overall dietary quality as they make up about 50% of total caloric intake (estimated by multiplying 70%, the proportion of total caloric intake from stores,[31] by 70%, the proportion of calories purchased in stores that come from PFPs among adults[32]). Second, the average American consumes excess saturated fat, sugar and sodium, and the types of PFPs most purchased are high in these nutrients of concern.[33] Linking Nutrition Facts Panel data to brand-specific PFPs allows for an accurate analysis of trends in these nutrients of concern. Third, a healthier selection of PFPs can be induced through targeted policy interventions, like the 2016 beverage tax in Philadelphia which caused some retailers to stock fewer and smaller-sized sugar-sweetened beverages (SSBs).[34]

The objective of this study was to evaluate whether state context is relevant to the nutritional quality of PFPs using a dataset with a large sample of households and extensive coverage of the contiguous United States. The first aim was to assess whether individual state policies were associated with the quality of PFPs using all households. The study hypothesized that state policies would be associated with nutritional outcomes. Since these policies may be more relevant for low socioeconomic households, the second aim was to repeat the analysis limiting the sample to only households with low income and only households with low educational attainment. The study hypothesized that the magnitude of the associations between state-level policies would be larger when restricting the sample to low socioeconomic groups.

## Methods

### Household Panel and Nutritional Outcomes

This study used data from the 2008-2017 Nielsen U.S. Homescan Panel[35] (n=615,634 household-year observations). Participating households scan barcodes on all purchased items. Nielsen uses direct mailing (targeting low-income and racial/ethnic minority groups) and the Internet to recruit households. An open cohort study design allows households to participate for multiple years but drop out at any time; once households drop out, they cannot reenter, and new households are enrolled to replace dropouts based on demographic and geographic targets. Households are sampled from 52 metropolitan and 24 non-metropolitan markets and are weighted to be nationally representative. This study was deemed exempt from IRB approval by the University of North Carolina Office of Human Research Ethics, as it does not constitute human subjects research as defined under federal regulations [45 CFR 46.102 (d of f) and 21 CFR 56.102 (c)(e)(l)].

For inclusion in the Nielsen panel, households needed to report at least ten months of purchases. Households were further excluded if they did not purchase a minimum amount of food and beverages every three months ($45 for a single-person household and $135 for households with two or more people) (n=3,311). Finally, households with incorrect geographic information were excluded (i.e., located in counties outside the boundaries of their identified markets, n=604) for a final analytic sample of 611,719 household-year observations.

Household PFPs were linked to Nutrition Facts Panel[36] data, which includes data on calories, saturated fat and sugar content. These matches were updated annually to account for product reformulation as well as product entry and exit in the market, as detailed elsewhere.[31] Outcomes included nutrients of concern: total sugar (as % kcal purchased and as grams per capita per day), saturated fat (as % kcal purchased and as grams per capita per day), sodium (mg per capita per day), total calories (per capita per day); calories (per capita per day) from food groups to limit (processed meats, mixed dishes, sugar-sweetened beverages (SSBs) and desserts and snacks); and calories (per capita per day) from encouraged food groups (fruits and non-starchy (NS) vegetables). Food groups were created by aggregating Nielsen product categories. Mixed dishes included foods such as canned soups and frozen entrees and desserts and snacks included desserts, candies, and salty snacks. A list of Nielsen products included in each food grouping and the public health relevance for each outcome can be found in Figure 1 (online only).

## Household Sociodemographic Data

Demographic data was self-reported annually via questionnaire. Household characteristics were included that have been associated with dietary quality.[47, 48] Differences in the cost of living across the country were accounted for by adjusting the self-reported household income using Regional Price Parities from the Bureau of Economic Analysis.[49] Income was then recalculated as a percent of the Federal Poverty Level[50] (FPL) and updated every year to reflect annual changes in household composition and changes to the FPL. This measure of cost-of-living-adjusted income was then divided into tertiles.

Education was defined as the highest level of self-reported educational attainment by a head of household and categorized as high school or less, some college, college graduate or post college graduate. Race and Hispanic ethnicity were self-reported by only one head of household and were combined into five categories: Hispanic (any race), Non-Hispanic (NH) White, NH Black, NH Asian, and NH Other Race. To control for household age composition, a series of count variables on the number of people in the household were included as follows: 0-1 years, 2-5, 6-11, 12-18, 19-64 and 65 and older.

## State Context and Policy Data

State policies were chosen that had the potential to impact food purchasing behavior directly or indirectly. Direct factors included the flexibility states have in facilitating access to food assistance programs, state-level healthy food retail policy, and preemption laws relevant to food purchases. Indirect factors included social policies. Since household education and income are associated with the quality of food purchases,[51, 52] policies were chosen that improve access to educational and economic opportunities. These included per capita expenditures on higher education,[53] per capita expenditures on housing and financial assistance programs,[53] the proportion of the Earned Income Tax Credit (EITC) paid by the state,[54] minimum wage, Medicaid expansion, and preemption laws related to labor. Details regarding the justification for each factor, how they were operationalized, and data sources can be found in Figure 2 (online only).

Healthy Food Retail Legislation was identified using similar data collection methods as those used by the CDC in creating their 2011 database on state initiatives supporting healthier food retail.[18] The database with 2008-2017 legislation collected for this study can be found in Figure 3 (online only).

## Statistical Methods

All outcomes were continuous and, except for percent calories from sugar and from saturated fat, were logged to control for undue influence of high outliers. Statistical analysis was completed using STATA version 15.[135] To calculate descriptive study characteristics, averages and proportions were calculated using survey weights. Nielsen provides household weights to account for survey design and generate nationally-representative estimates. These weights are recalculated each year to adjust for changes in their open cohort and US demographic trends.

To determine the best statistical model, a three-level multilevel model was tested first, as it was the most consistent with the hypothesis that state context is associated with the quality of foods purchased by households residing within the state. Multilevel models are important tools for disaggregating the contribution of individual-level and contextual influences on health behaviors.[136-138] The three levels were defined as level one (year), level two (household) and level three (state). However, after controlling for sample design, the proportion of variance explained at the state level was close to zero. Therefore, a two-level model was used (time within households). Further detail on the three-level model and analysis of the variance explained by household-level versus state-level factors, as well as relevant equations and STATA code, can be found in Figure 4 (online only).[139]

To control for unobserved, time-invariant differences between states and potential endogeneity of observed state policies, the longitudinal design of the panel data and state fixed effects were used as an identification strategy to detect policy effects (binary state indicators; n=49, 48 contiguous states and the District of Columbia). This strategy required variation in policy variables within states over time. Since sufficient variation was found and state fixed effects were jointly significant in all outcome models, the final model was a two-level model with state fixed effects. The final series of models use the nutritional outcomes as dependent variables, state policies as the key explanatory variables of interest, adjust for household income, education, race/ethnicity and composition, and control for year and state fixed effects. Therefore, effect estimates for the policy variables should be interpreted as the association between policies and each nutritional outcome controlling for household demographic characteristics and time-invariant state context. STATA's meglm command was used with a gamma distribution and log link to control for high outliers (note, this is distinct from a log-transformation of our outcome variables). The only exceptions were the percent calories from saturated fat and from sugar, where meglm was used with a gaussian distribution and identity link. All models use svyset to adjust for Nielsen's complex sampling design, which uses a stratified random sample with households as the primary sampling unit and Nielsen markets as sampling strata.[140-142] Results are presented with 95% confidence intervals and marked as statistically significant at p-values of 0.05, 0.01, and 0.001.

Several sensitivity analyses were conducted. Two subpopulation analyses were conducted to test the hypothesis that state context would be more meaningful for households with low income and households with low educational attainment. The analytic sample was limited to those households with an income at or below 200% the Federal Poverty Level, and separately for households with no higher than a high school education using the subpop option and repeated the analysis (n=142,025 and n=112,989, respectively). To statistically evaluate whether the model could be stratified by income (or education), a likelihood ratio test (LRT) was used. A LRT compares the log likelihoods from a restricted and unrestricted model. The restricted model used all household-year observations. The log likelihood for the unrestricted model was the sum of the log likelihood from the model using only households with low income (or education) and the log likelihood of the model with all other observations. Across all nutritional outcome models, the p-value was <0.0001, rejecting the null hypothesis that the coefficients of the two subsamples were the same and providing statistical justification to stratify the models by income (or education).

Lastly, a sensitivity analysis was conducted using the full sample, but replacing food group outcomes with calories from each group as a percent of total calories purchased, rather than as calories per person per day. Controlling for compositional effects accounts for households that may have purchased more or less PFPs. Whereas analysis of the absolute value of the association between policies and nutritional outcomes can be easily compared to serving sizes for each outcome, compositional analysis captures whether potential increases or decreases in outcomes are occurring relatively faster or slower than the change in total calories purchased from PFPs in response to policy change. Results from this sensitivity analysis should be interpreted as the association between policies and the percent of purchases dedicated to each group while controlling for household demographic characteristics and time-invariant state context.

## Results

A summary of nutritional outcomes, household-level characteristics and state-level variables is provided in Table 5. From 2008-2017, calories from all PFPs declined, partly due to the declines in SSBs and desserts and snacks. Sugar also decreased, both in grams and as a percent of total calories. In comparison, calories from fruits and NS vegetables remained low and the percent calories from saturated fat increased. The household demographic profile slightly changed, where the percent of households with low income increased but the percent of households with low educational attainment decreased. The percent of Non-Hispanic White households decreased while the percent of Hispanic and Asian households increased. Finally, there is substantial variation in state policy and spending patterns, with a trend towards increasing action at the state level over time. This variation was necessary for the identification strategy used to detect an association between these state policies and nutritional outcomes using a fixed effects model. State fixed effects are jointly significant at $p<0.0001$ for all nutritional outcomes, indicating that state context is associated with average nutritional outcomes for households within each state.

### Association of state policies and quality of PFPs using all households in sample

Two-level GLM models were used to examine the association between state level policies and nutritional outcomes. Results for models using a log link can be found in Table 6, where coefficients have been exponentiated and converted to percent changes for interpretability. Overall, few policies are associated with nutritional outcomes. The supplemental EITC paid by the state as a percent of the federal EITC is significant for several outcomes, where an increase of one percentage point is associated with an increase in purchases of NS vegetables and a decrease in purchases of fruit, SSBs, and sugar. Medicaid expansion and expenditures on financial assistance and housing were associated with a notable decline in SSBs, where expansion of Medicaid or an increase of $1,000 spent per capita was associated with a decline in daily calories from SSBs of 4.7% [95% CI: −6.9%, −2.4%] and 5.1% [95% CI: −8.3%, −1.8%] respectively.

Although not always statistically significant, almost all outcomes showed a decline when programs intended to raise income increase: an expansion of SNAP broad-based categorical eligibility (BBCE) criteria, minimum wage and expenditures on financial assistance and housing. This suggests that an expansion of these policies was associated with an overall decline in PFPs. These inverse associations were also statistically significant in the following cases: increasing one of the SNAP BBCE criteria was statistically associated with a decline in grams of sugar; a $1/hour increase in state minimum wage was statistically associated with a decline in total calories, calories from NS vegetables, grams of saturated fat and milligrams of sodium; an increase of $1,000 spent per capita on welfare and housing was associated with a decline in SSBs and grams of sugar.

Results for models using an identity link should be interpreted as a change in percentage points (Table 7). Similarly, few policies are associated with statistically significant changes in nutritional outcomes. No policies are associated with changes in the percent calories from saturated fat. The associations that exist between policies and the percent calories from sugar are small, and results for specific policies are consistent with models for total calories and grams of sugar. Increasing BBCE criteria to expand SNAP eligibility and increasing the EITC are not associated with a change in calories but are associated with a decrease in grams of sugar per person per day (Table 6) and are therefore also associated with a decrease in the percent calories from sugar (Table 7). In comparison, an increase in the minimum wage is associated with a decrease in total calories but not with a change in grams of sugar – therefore, it is associated with an increase in the percent of calories from sugar (0.13 percentage points for every dollar increase [0.05, 0.20]).

Results from sensitivity analyses were largely consistent. For the first sensitivity analysis, when the sample was limited to only households with low income or only households with low educational attainment, there were fewer significant associations between policies and nutritional outcomes. Therefore, presentation of results is limited to Tables 8-9 online only for households with low income and Tables 10-11 online only for households with low educational attainment. For the second sensitivity analysis, when food group outcomes were operationalized as the share of total calories rather than calories per person per day, there were slightly more significant associations (Table 12 online only). Most notably, an increase in expenditures on financial assistance is associated with a 4.2% increase in the share of calories from NS vegetables [1.9, 6.8], while this association is not significant using calories of NS vegetables per person per day.

## Discussion

This study used data with full coverage of the contiguous United States from 2008 to 2017 to examine whether state context is associated with the nutritional quality of food purchases. While the joint significance of the state fixed effects variables for all nutritional outcomes indicated the importance of state context, its effect was not captured by observed policy variables. Although some social policies, like minimum wage, were associated with several nutritional outcomes, policies directly relevant to food purchases (e.g., Healthy Food Retail legislation, increasing BBCE for SNAP) were not associated with most outcomes.

Contrary to the study hypothesis, state-level policies directly related to purchasing food were rarely significant, even when the sample was limited to households with low income or only households with low educational attainment. In addition, there were not many differences in significant policy effects when outcomes were operationalized as grams/calories per person per day or as the share of total calories purchased. This suggests that the absolute increase or decrease in nutritional outcomes is generally proportional to the change in overall calories purchased associated with a policy change.

This does not mean food assistance policies are not important for households directly impacted by them and are not important tools for reducing socioeconomic disparities in the nutritional quality of food purchases. Rather, this study focuses on the part of food assistance programming that is modifiable by states (e.g., increasing BBCE for SNAP and how well states facilitate access to WIC) and assess their relevance to the quality of PFPs. For example, participating in WIC is associated with healthier food purchases,[61] but no association was found between expanded access to WIC and the quality of purchases when the sample was limited to only households with low income. As another example, individual Healthy Food Retail policies may still be important for specific states. The effect of the Healthy Food Retail variable may have been diluted because the scope of legislation varied widely, but assumptions were not made about how to weight them relative to one another. In addition, policies like financing initiatives may be important in specific neighborhoods[143] or populations with low income[83] but may not be expansive enough to affect average purchases in a state. For example, Pennsylvania's 2004-2006 Fresh Food Financing Initiative has been one of the most successful state-level healthy food financing initiatives in terms of projects funded and residents impacted, yet is estimated to have only reached 400,000 people[143] in a state with 12,400,000 people.[144] There are also initiatives that operate at the state-level but are not codified as laws (e.g., the New Jersey Food Access Initiative[145]). Since the focus of the present study was on the state as a political actor, only legislative efforts tied to state government were included. Data collection methods used by the CDC in creating their 2011 database on state initiatives supporting healthier food retail were replicated.[18] The updated database will be a useful resource in and of itself (see Figure 3 online only).

In comparison with food policies, several social safety net policies were associated with nutritional outcomes, although they did not always improve the nutritional quality of PFPs. For example, minimum wage appears to be associated with a general reduction in purchases, even when the sample is limited to households with low income or only households with low educational attainment. These findings may reflect that states most likely to increase minimum wage are also those states with faster increases in the cost of living,[49, 73] driving down the purchase of PFPs. Although state fixed effects were included, this may not fully control for confounding if cost-of-living also changes over time. In addition, PFPs may decline if minimum wage increases reduce eligibility for social safety net programs such as SNAP,[146] thereby increasing income without increasing the affordability of food. In addition, while this study finds that an increase in minimum wage is not significantly associated with fruit PFPs and is negatively associated with NS vegetable PFPs, other research is mixed. One longitudinal study following workers with low incomes in Minneapolis found no significant change in self-reported consumption of fruits and vegetables after the city's first phase of raising the minimum wage, which may be because the initial wage increase from 2018 to 2019 was not large enough to produce changes in dietary intake.[147] Another study used cross-sectional data from the Behavioral Risk Factor and Surveillance System survey and, after controlling for the endogeneity of state policies, found a small but positive association between state-level minimum wage policy and the consumption of fruits and vegetables.[72] Comparing results across studies suggests that higher wages may lead to higher purchases of non-packaged fruits and vegetables, but further research is needed.

Similarly, an increase in SNAP BBCE criteria may be associated with a general reduction in purchases due to differences in the purchasing power of SNAP. Benefits are calculated using a national formula that does not adjust for local cost of living. Although SNAP BBCE expands who is eligible for benefits, this increased enrollment does not equalize SNAP's purchasing power. Areas of the country with the lowest purchasing power of SNAP tend to be areas where states have expanded SNAP BBCE.[148]

These results do not suggest that state context can be ignored. State fixed effect variables were jointly significant and not equal to each other. Before including state fixed effects, most state policies were statistically significant. In models with state fixed effects, most associations were attenuated and no longer significant. Given that within-state variation was present in all policies over time, these policies are likely endogenous. For example, households with a preference for healthier foods may self-select into states with more progressive food, health, and social policies. Similarly, different food retailers (e.g., Walmart vs Whole Foods) may disproportionately locate stores in states according to these household preferences and/or state policies. Since the nutritional quality of PFPs has been found to differ by store type,[149, 150] the relative proportion of store types across states may be important.[151] This suggests that state context must be accounted for as a confounder between state policy and diet-related outcomes.

This study also has several methodological implications for multilevel analysis. It is not surprising that household characteristics explained most of the variance in PFPs in the multilevel models, which included data for approximately 60,000 households per year compared to 49 states. In these three level models, adjusting for survey design and measurable household and state-level characteristics explained 60% to 100% of variation at the state level (Table 1 online only). Findings in this study illustrate the importance of examining both the change in the state residual and the proportion of total variance explained at the state level. Many multilevel variance components analysis in public health[14, 16, 152] simply add measurable characteristics to the model and interpret percent changes in the higher-level variance (in this study, state-level variance). However, large percent reductions in this variance may be misleading if the proportion of total variance explained by higher levels is low to begin with.[153] In addition, most of the state-level variation was reduced by introducing market fixed effects (to adjust for survey design strata). While some markets are nested within states, others cross state boundaries. This suggests that the quality of PFPs is influenced by higher level contextual factors but that these factors are not necessarily delineated by political boundaries.

The present study has several limitations. First, state-level policy variables are considered independently, when they act in complex and interacting ways.[16] However, low levels of collinearity were observed between policy variables. In addition, not all household-level variation can be accounted for. Accounting for measurable household characteristics (income, education, race/ethnicity and age composition) only explained 3% (fruits) to 16% (total calories) of household variance (Table 1 online only). The remaining residual variance attributed to the household level reflects a combination of measurement error and unmeasured factors such as health preferences, which may influence the likelihood of shopping at healthier retail outlets and food preferences. A limitation of the fixed effects analysis is limited variation in some policies, although there was no policy for which within-state variation was zero (Table 5). A limitation of the categorization of our outcome variables is that some healthy foods may be misclassified in food groups to avoid (e.g., unbuttered popcorn in "desserts and snacks" or low-sodium, healthy frozen entrees in "mixed dishes") and some less healthful foods may be misclassified into healthy food groups (e.g., pre-packaged salads kits in "NS vegetables" contain add-ons or dressings that may be high in added sugar or unhealthy fats, or canned fruit in "fruits" with added sugar). Finally, packaged foods are not a complete picture of the diet. State policies may be associated with overall dietary quality through impacts on other parts of the diet, such as improving the healthfulness of food away from home (e.g., menu labelling) or expanding access to fresh fruits and vegetables (e.g., farmers markets).[154]

This study also has several important strengths. Nielsen Homescan is a panel dataset with extensive geographic (contiguous US) and temporal coverage (ten years), and a large and diverse sample of households. In addition, the nutrition information linked to packaged foods were updated each year, providing an up-to-date understanding of the nutritional quality of packaged food purchases. Lastly, the CDC's State Initiatives Healthy Food Retail Legislation database[18] from 2011 has been updated. This allowed for evaluation of state policy directly related to food purchases. This state policy database compliments a concurrent review of federal policies aimed at improving the nutritional quality of food purchases[155] and will serve as a useful tool for the broader research community.

## Conclusions

Little evidence was found that state policy context in 2008-2017 was associated with the quality of PFPs. However, there is increasing variability in state policies directly related to food purchases (e.g., Healthy Retail legislation and preemption of nutrition laws) and indirectly related to food purchases (e.g., social safety net policies and preemption of labor laws which may affect PFPs through purchasing power). Therefore, future research should continue to monitor how state context affects the nutritional quality of PFPs. In addition, future research is needed to evaluate how specific policies in individual states or local jurisdictions affect purchases and measures of overall dietary quality, should sufficient data be available at the state and local level. As part of this continuing effort, part of the data collection process was an update of the 2011 CDC database on state initiatives supporting healthier food retail. This will be a useful resource for public health research focused on food retail.

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## Practice Implications

**What is the current knowledge on this topic?**

Although diet quality is influenced by individual and systemic factors and that state context is associated with mortality, no research has examined whether state policies are associated with differences in the nutritional quality of packaged food purchases (PFPs).

**How does this research add to knowledge on this topic?**

This is the first study to examine the association between state-level food and social safety net policies and the nutritional quality of PFPs, which make up the majority of the diet.

**How might this knowledge impact current dietetics practice?**

Keeping current with changing state social support policies can assist registered dietitians/nutritionists in identifying potential resources to meet client needs. This study updated CDC's 2011 Healthy Food Retail database, which is a resource they may find useful.

## Research Snapshot

**Research Question:**

Are state food and social safety net policies associated with the nutritional quality of household packaged food purchases?

**Key Findings:**

This study used data from a range of state policies and from the Nielsen Homescan Panel, an observational, open-cohort of households, from 2008-2017, and found some associations between social safety net policies and the nutritional quality of PFPs. However, very few associations were found between Healthy Food Retail policies at the state level and the quality of purchases. These results were consistent when the sample was limited to households with low income or low educational attainment.

| Nutritional outcomes | Rationale | Nielsen Packaged Food Purchase categories included in each food grouping, with examples of specific food items |
|---|---|---|
| % calories from sugar, % from saturated fat; Grams of sugar, grams of saturated fat, mg of sodium (*per capita per day)* | • Overconsumed in the US[37]<br>• Diets high in sugar are associated with cancer, metabolic syndrome and obesity[38, 39]<br>• Replacement of saturated fat with polyunsaturated fat reduces cardiovascular disease risk[40]<br>• Salt intake associated with cancer[38] and cardiovascular disease[41] | *n/a* |
| Total calories (*per capita per day*) | Provide context for calories for select food groups below | *n/a* |
| Calories from healthy food groups: fruit, non-starchy (NS) vegetables (*kcal per capita per day*) | • Underconsumed in the US[37]<br>• Important sources of vitamins and fiber<br>• High consumption associated with lower cardiovascular disease risk.[42] | • Fruits: fresh fruit (e.g., fruit salads, bag of apples); frozen fruit; canned fruit; dried fruit (e.g., cranberries, dates, prunes, raisins)<br>• Non-starchy vegetables: fresh vegetables (e.g., packaged carrots, cauliflower, lettuce, precut fresh salad mix, herbs); frozen vegetables (e.g., broccoli, carrots, mixed frozen vegetables in sauce); canned vegetables (e.g., pickles, canned green beans, tomato paste, sauerkraut). Excludes corn, potatoes, legumes |
| Calories from food groups to limit: processed meats, mixed dishes, sugar-sweetened beverages (SSBs), desserts and snacks (*kcal per capita per day*) | • Mixed dishes and desserts and snacks are large contributors of total energy, sugar, saturated fat and sodium in US diet[33]<br>• The consumption of processed meat is classified as "carcinogenic to humans" by the International Agency for Research on Cancer,[43] possibly due to nitrates, higher salt content, and other chemical preservatives[38, 44, 45]<br>• SSBs independently linked to chronic diseases[46] | • Processed meats: canned processed meats (e.g., corned beef, canned sausage, canned lunch meat); frozen breaded seafood; refrigerated processed meats (e.g., bacon, bratwurst, frankfurters, lunch meat, sausage, corn dogs, taco filling). Excludes: canned seafood and chicken, unbreaded frozen seafood, frozen meat, fresh eggs<br>• Mixed dishes: canned mixed dishes (e.g., canned pasta dishes, beans with meat); frozen entrees; frozen/ refrigerated breakfasts, pizzas, and appetizers; shelf-stable soups and stews (e.g., ramen noodles, chili, dry soup mixes, canned soup)<br>• SSBs: soda, sports drinks, energy drinks, caloric coffee/tea/water exceeding 7 kcal per 100 mL<br>• Desserts and snacks: grain-based desserts (e.g., baking mixes and fillings, packaged pastries, cookies); shelf-stable pudding and gelatin; salty snacks (e.g., crackers, rice cakes, pretzels, chips, popcorn, trail mixes); sweeteners (e.g., sugar, molasses, honey); toppings (e.g., whipping cream, frosting, syrup, fruit spreads); candy (e.g., candy, gum); baking chocolate |

**Figure 1 online only:**

The public health relevance of study nutritional outcomes, including examples of food items included in each food grouping

| Factor | Rationale | Data aggregation and codebook | Data source |
|---|---|---|---|
| May directly impact food purchases | | | |
| Supplemental Nutrition Assistance Program (SNAP) eligibility | While the federal income requirement for SNAP is a family income of less than or equal to 100% of the Federal Poverty Level, individual states can expand eligibility through broad-based categorical eligibility (BBCE) criteria,[21, 55, 56] including increasing the income level or eliminating the asset test, and use of these criteria is correlated with increased likelihood of participation in SNAP.[57] | 0 = no BBCE<br>1 = Either raises income eligibility above 130% gross income (federal limit) OR raises asset limits / eliminates the asset test<br>2 = Both raises income above 130% *and* raises asset limits | SNAP Policy Database.[58] Data for 2017 was collected based on data from October 2018.[59] In cases where the value for this variable changed from 2016-2018, the default was to apply data from 2018 unless legislation or news was found showing the change only applied to 2018. |
| Special Supplemental Nutrition Program for Women, Infants and Children (WIC) coverage | Participation in WIC[60] is associated with the healthfulness of overall packaged food purchases.[61] However, the coverage rate of eligible women, infants and children who participate in WIC varies widely by state. Reported WIC coverage rates at the state level will be used as a WIC policy variable, reflecting the resources states invest in enrolling families in social services that have a direct impact on nutrition and food choice. | Percent coverage is a continuous variable | Food and Nutrition Service through annual eligibility and program reach reports.[25, 62, 63] |
| Healthy Food Retail Legislation | States have introduced and enacted a variety of legislative measures to either establish task forces to make recommendations to improve healthy food retail, provide financial assistance and incentives to increase food retailers or improve the selection of foods in existing retailers in underserved areas, or enact market interventions to influence decisions at the point of purchase (e.g, taxes). Enacted bills will be included if they 1) build new or expand existing food retail outlets; 2) renovate or upgrade equipment at existing food retail outlets; 3) examine healthier food | The number of active pieces of legislation or task forces is summed by state-year and coded as a continuous variable. A complete list of Healthy Food Retail Policies can be found in **Figure 3 (online only)**. | Following the methodology used in a 2013 report[18] from the Centers for Disease Control and Prevention (CDC), legislation will be identified using the CDC's *Nutrition, Physical Activity and Obesity Legislation* database.[64] In addition, the Healthy Food Access Portal[65] and Rudd Center's *Legislation Database*[66] will be used to search |

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| | access through a task force or food council.[18] Legislation that does not affect packaged foods will be excluded (e.g., expanding access to farmer's markets). | | for state level policies. |
| Preemptive Legislation: Healthy Food Retail | Conversely, a growing number of states have passed legislation or ballot initiatives that serve to prohibit nutrition- and food-related legislation.[67-69] These laws prohibit local governments from passing the types of healthy food retail legislation enumerated above with consequences for PFPs. For example, SSB taxes may reduce SSB consumption,[70] prohibiting these taxes may result in differential consumption of unhealthy foods across states. | Coded as a dichotomous variable by state-year<br>1 = At least one active piece of preemptive legislation<br>0 = No preemption relevant to food retail | Article by Pomeranz, et al[68] |
| May indirectly impact food purchases | | | |
| Preemptive Legislation: Labor Laws | There are several ways localities can increase worker protections that contribute to a household's financial security. Local control of labor laws can be preempted by the state. Data was collected for six types of preemptive labor laws: minimum wage, fair scheduling, project labor agreements, prevailing wage, paid leave and gig economy. See data source for further details. | Coded as a dichotomous variable by state-year for each type of labor preemption. These were then summed across all six labor preemption laws, creating a continuous variable with a possible range of 0 - 6 | Economic Policy Institute[71] |
| Minimum Wage | The federal minimum wage is $7.25, but states can enact their own legislation to raise the minimum wage, which is associated with increased fruit and vegetable consumption[72] | Coded as a continuous variable in nominal dollars | US Department of Labor[73] |
| Expenditures on higher education | Educational attainment greater than high school is associated with healthier food purchases.[51] In addition, disparities in mortality by education are found to vary by state.[15] The reduction of education disparities and possible increase in household income is expected to increase the healthfulness of food purchases. | Continuous variable, per capita $1,000. Expenses "E30" (direct expenses that support activities at state institutions of higher education) and "E35" (other education expenses, including payments to individuals for tuition and financial aid) were collected as per capita | The Urban Institute's Tax Policy Center "State and Local Finance Initiative" database,[53] which uses data from the US Census Bureau Annual Survey of State and Local Government Finances, US Bureau of Economic Analysis, and US Bureau of Labor Statistics |

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| | | dollar amounts, summed and divided by $1,000 for interpretability. | |
| Expenditures on welfare and housing | Household income is associated with the nutritional quality of store purchases.[51, 74] Expenditures on financial assistance programs are combined with housing assistance because affordable housing is an increasing problem in the US, more affordable housing is expected to increase financial resources available to households | Continuous variable per capita $1,000. Expenses "E74" (housing and community expenses) and "E90" (public welfare expenses including cash assistance, Temporary Assistance for Needy Families, emergency relief programs, etc) were collected as per capita dollar amounts, summed, and divided by $1,000 for interpretability. | The Urban Institute's Tax Policy Center "State and Local Finance Initiative" database,[53] which uses data from the US Census Bureau Annual Survey of State and Local Government Finances, US Bureau of Economic Analysis, and US Bureau of Labor Statistics |
| Percent of the federal Earned Income Tax Credit (EITC) offered by the state | The federal EITC increases income for low-income households and has been shown to reduce poverty[75] and help low-income earners work more hours.[76] As of 2019, 29 states offer their own EITC to supplement an earner's federal EITC. | Continuous variable expressed as a percent from 0 – 100% of the federal EITC | University of Kentucky's Center for Poverty Research[54] |
| Medicaid Expansion | In addition to housing, medical expenses are another major competing cost for households that limit their food budget. The expansion of health insurance is expected to increase financial resources available to households. | Dichotomous variable 1 = Expanded Medicaid 0 = Did not expand Medicaid | For a history of Medicaid expansion, data will be sourced from news articles[77] and relevant non-profits.[78] |

**Figure 2 online only:**

Dependent policy variables used to characterize state context with explanation of potential impact on food purchases, variable categorization in statistical model, and data source

| State | Years | Bill/Law Number[a] | Type of program | Notes |
|---|---|---|---|---|
| AL | 2015-2017 | Act 2015-240, SB260; SJR 105[79] | Advisory Committee & Program/Initiative | Alabama Healthy Food Financing Act passed in 2015; a Study Commission was created through Senate Joint Resolution 105 in 2016 |
| CA | 2006-2012 | AB 2384 (Chapter 236, Statutes of 2006) and AB 2726 (Chapter 466, Statutes of 2008)[80] | Program / Initiative | Healthy Food Purchase Pilot Program; Pilot included working with small grocers to increase the consumption of fruits and vegetables and to offer financial incentives to food stamp recipients. 2008 bill extended effective date for pilot program to Jan 1, 2012 |
| CA | 2011-2017 | AB 581 (Chapter 505, Statutes of 2011)[80] | Program / Initiative | Healthy Food Financing Initiative and HFFI Council; In effect until July 1, 2017 |
| CO | 2010-2017 | CO HB 1191[81] | Program / Initiative | Eliminate Candy and Soda Sales Tax Exemption: Narrowed the existing state sales and use tax exemptions for food so that candy and soft drinks are no longer exempt from the state sales tax and use taxes. (tried to repeal this in 2015, but SB 274 failed) |
| CO | 2010-2017 | CO SB 106[82] | Food Council | Food Systems Advisory Council: Creates a statewide food systems advisory council, with members from nutrition and health; agricultural production; food wholesalers and food retailers; anti-hunger and food assistance programs; economic development; and local government. Purpose: to identify studies and best practices of the food system; to develop local food policies that contribute to building robust, resilient, and long-term local food economies; and to develop policy recommendations regarding hunger and food access. |
| CT | 2008-2017 | Connecticut General Statutes, Sec. 22-456[83] | Food Council | Connecticut Food Policy Council |
| DC | 2000-2017 | Chapter 38 of Title 47 of the District of Columbia Official Code; B11 amendment; B44 amendment[84] | Program / Initiative | Supermarket Tax Exemption Act of 2000; Amended at various points, including the "Neighborhood Supermarket Tax Relief Clarification Act of 2010" |
| DC | 2011-2017 | Law# L18-0353[85] | Program / Initiative | Food, Environmental, and Economic Development in the District of Columbia Act of 2010: Program to attract and renovate grocery stores, corner stores and other small food retailers in low-income areas |
| DC | 2015-2017 | DC Law 20-191[86] | Food Council | Establish a Food Policy Council and Director within the Office of Planning. Adopted Nov 2014 |
| DC | 2010-2017 | Resolution Number 18-424[87] | Program / Initiative | Approves the proposed Bellevue Small Area Action Plan. Seeks to enhance the overall commercial environment of the Bellevue neighborhood through the various strategies including encouraging local businesses to participate in a cooperative buying agreement with the Ward 8 farmers market for distribution of fresh, healthy food options. |
| DC | 2014-2017 | Resolution Number 627[88] | Program / Initiative | Prohibits the owner or operator of a grocery store from imposing a restrictive land covenant to a buyer of its |

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| | | | | property, which would prohibit the use of the new facility for the same purpose. The prohibition is designed to prevent the creation of food deserts in the District. |
| FL | 2016-2017 | FL Chapter No. 2016-221[89] | Program / Initiative | Healthy Food Financing Initiative Program, signed April 2016 |
| IL | 2009 | Senate Joint Resolution 72[90] | Task Force / Advisory Committee | Task Force created to consider an Illinois Fresh Food Fund and recommend measures, including potential legislation, yielding a result that successfully stimulates supermarket development across Illinois. |
| IL | 2012-2018 | SB 1221[91] | Appropriations | Appropriations $10,000,000, part of the Illinois Jobs Now! program; Grants/loans to supermarkets to be administered by the Dept of Commerce and Economic Opportunity. These appropriations were made in 2010 and were the state's contribution to the Illinois Fresh Food Fund, which combined state and federal funds to increase access to healthy foods. Funds were actually distributed between 2012-2018[92] |
| IL | 2010-2017 | Public Act No. 1119[93] | Task Force / Advisory Committee | Authorizes the creation of the Commission to End Hunger for the purpose of developing an action plan and ensuring cross-collaboration among government entities and community partners toward the goal of ending hunger in the state. Directs the Commission to identify funding sources that can be used to improve nutrition and end hunger, to identify barriers to access, and to promote public-private partnerships. Provides for the membership of the commission. |
| IL | 2010-2017 | Public Act 34, Section 910[94] | Appropriations | Sales tax expansion: candy and soft drinks are not considered food to be taxed at 1% and are therefore subject to a higher sales tax of 6.25% |
| IN | 2016 | SB 15[95] | Task Force / Advisory Committee | Fresh food initiative. Urges the legislative council to assign to an appropriate study committee the topics related to the establishment of a food desert grant and loan program |
| KS | 2010-2011 | Executive Order 10-11[96] | Task Force / Advisory Committee | Kansas Food Security Task Force |
| KY | 2012 | HB 550[97] | Task Force / Advisory Committee | Kentucky Healthy Nutrition Pilot Project. Directs the Legislative Research Commission to complete a comprehensive review of available studies or programs, undertaken either prior to or during the period of the study, that focus on the nutritional habits of Kentucky citizens and the health outcomes of those habits. The staff shall submit a written report detailing its study findings for referral to the appropriate interim joint committee on or before November 30, 2012 |
| LA | 2008 | SR 112[98] | Task Force / Advisory Committee | Healthy Food Retail Study Group to investigate the lack of access to fresh healthy foods in certain rural and urban communities and to develop recommendations for the creation of a statewide financing program to provide grants and loans to bring fresh food retailers into areas in need of improved access to healthy food |
| LA | 2009 | SB 299, Act# 252[99] | Program / Initiative | Healthy Food Retail Act: grants and loans for new construction and renovations for healthy food retail, but it was never funded so only counted for the year the bill passed |
| LA | 2011-2012 | HB 840[100] | Food Council | Establishes the LA Sustainable Local Food Policy Council |
| LA | 2016 | HCR 205[101] | Task Force / Advisory Committee | Creates a task force to study and identify food desserts in the state and submit findings by June 2016 |
| MA | 2010-2017 | Chapter 277 of the Acts of 2010[102] | Food Council | Massachusetts Food Policy Council |

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| MA | 2014 | Chapter 286 of the Acts of 2014[103] | Program / Initiative | Establishes Massachusetts Food Trust Program (although appropriations weren't made until 2017 and released in 2018) |
| MD | 2010-2017 | HB 1135, Chapter 724[104] | Program / Initiative | Property Tax Credit - Grocery Stores - Low-Income Areas. Effective June 01, 2010, and every year after |
| MD | 2015-2017 | HB451, Chapter 228[105] | Task Force / Advisory Committee | Forms an interagency food desert advisory committee to provide loans and financial assistance to small businesses and food-related enterprises that provide fresh fruit and vegetables to residents in food deserts. Altering the purposes of the Neighborhood Business Development Program to include helping to create specified small businesses and other food-related enterprises in food deserts; requiring the Business Development Program in the Neighborhood Business Development Program to provide financial assistance to projects in food deserts; authorizing specified entities to apply for financial assistance for a project in a food desert under specified circumstances; etc. Effective Oct 2014 |
| MI | 2009-2017 | SB 294; Public Act 231[106] | Program / Initiative | Amends 2005 PA 210 to provide tax incentives for grocery stores and other qualifying food retail establishments to locate in underserved areas. Effective date July 17, 2008. Further amended by SB 1597, Public Act 500, which went into effect Jan 13, 2009 |
| MI | 2012-2017 | H4759; Public Act 81[107] | Program / Initiative | Modifies definitions of qualifying facility for purposes of the commercial rehabilitation tax to include a building or a group of contiguous buildings, a portion of a building or contiguous buildings previously used for commercial or industrial purposes, obsolete industrial property, and vacant property. A "qualified retail food establishment" means property that will be used primarily as a retail supermarket, grocery store, produce market, or delicatessen that offers unprocessed USDA-inspected meat and poultry products or meat products that carry the USDA organic seal, fresh fruits and vegetables, and dairy products for sale to the public. An "underserved area" has a supermarket customer base with more than 50% living in a low-income census tract, or that has demonstrated significant access limitations due to travel distance. |
| MI | 2013 | H5500[108] | Appropriations | One time funding for the Healthy Food Program ($1,500,000), passed in 2011 |
| MN | 2016-2017 | Chapter 189 H.F. No.2749[109] | Advisory Committee & Program/Initiative | Good Food Access Program. Establishes program and outlines duties of Advisory Committee; funds are appropriated starting 2017 |
| MN | 2013-2017 | MN HB 1249; companion: MN SB 1205[110] | Program / Initiative | Sales tax expansion: Expands the types of snack foods eligible for sales tax to include snack items (previously only candy and soda were subject to a sales tax) |
| MS | 2014 | HB 1328[111] | Program/Initiative | Small Business and Grocer Investment Act; legislation passed, but funding never appropriated. Expired in 2016 and was reenacted by HB 1132 in 2019 |
| MS | 2011 | HB 1170[112] | Task Force / Advisory Committee | Creation Of an Advisory Committee To Study Areas Of This State That Are Underserved In The Retail Of Availability Of Healthy Foods. Report due by Dec 2011 |
| MT | 2011 | HJR 8[113] | Task Force / Advisory Committee | Interim study on reducing childhood hunger in Montana and ways to improve access to nutritious food |
| NC | 2016-2017 | HB 250[114] | Appropriations | While the Healthy Food Small Retailer / Corner Store Act was never passed by the Senate after being passed by the House, the 2016 appropriations bill included funding for a statewide Healthy Corner Store Initiative |
| NC | 2009-2015 | SB491 | Food Council[115] | North Carolina Sustainable Local Food Advisory Council, originally established 2009-2012 and extended through 2015 |

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|---|---|---|---|---|
| NM | 2008 | HJM 10[116] | Task Force / Advisory Committee | Food Gap Task Force appointed to generate a report for the governor, which was delivered Dec 2008 |
| NV | 2005 - 2009 | SB 229, Chapter 198[117] | Program / Initiative | Incentivizes businesses to locate or expand in underserved areas, with a specific tax incentive for grocery stores in southern NV |
| NV | 2008-2017 | SB 352, Chapter 407[118] | Advisory Committee & Program/Initiative | Southern Nevada Enterprise Community Infrastructure Improvement Act - creation of advisory board and extends the temporary tax incentive for locating or expanding businesses that are or will become grocery stores within the Southern Nevada Enterprise Community. Although the tax incentive was through 2009, the advisory board still exists. |
| NY | 2009-2012, 2016 | S59-B, Chapter 59[119] | Program / Initiative | The 2009-2010 budget for transportation, economic development, and environmental conservation (article VII legislation) establishes the New York Healthy Food & Healthy Communities (HFHC) Fund, with an initial investment of $30 million; the 2016 budget included some funding as part of the Downtown Revitalization Initiative to focus on healthy food retail development |
| NY | 2007-2017 | Executive order[120] | Food Council | Executive order, renewed by Gov Cuomo in 2011. Note that A02983 was proposed in the house to establish the council through legislation, but it did not move through. Renamed the New York State Council on Hunger and Food Policy in 2016. |
| OH | 2016-2017 | FY 2016-2017 Budget[121] | Appropriations | $2 million in seed capital provided for the Healthy Food for Ohio program |
| OK | 2010-2017 | HB3015[122] | Program / Initiative | Amends the Oklahoma Agricultural Linked Deposit Act to include healthy corner stores as eligible for loans through the program if they are located in underserved areas |
| OK | 2017 | SB 506[123] | Program / Initiative | Healthy Food Financing Act: financing for grocery stores and small food retailers (new and existing) in underserved communities. Administered by OK Dept of Ag, Food and Forestry |
| PA | 2004-2010 | HB 2579[124] | Program / Initiative | Pennsylvania Fresh Food Financing Initiative (FFFI) |
| PA | 2008-2016 | HB 2233, Act 115[125] | Program / Initiative | Elm Street Program Act - allows grants to be used for projects such as grocery stores in qualifying neighborhoods. HB 2233 extends grant period 5 years past original sunset date of 2011 |
| PA | 2016-2017 | Executive Order 2015-12 by Governor Tom Wolf[126] | Food Council | Governor's Food Security Partnership established to develop and implement strategies to improve the nutrition of Pennsylvanians and involve the Cabinet Secretaries of the Departments of Aging, Agriculture, Community and Economic Development, Education, Health and Human Services |
| SC | 2016-2017 | 2016-2017 State budget[127] | Program / Initiative | SC Healthy Food Financing Initiative funded in the state's budget, which was ratified June 2016 |
| SD | 2013-2017 | HB 1154[128] | Program / Initiative | Revises the definition of food to exclude candy, soft drinks and vending machine goods; therefore they are still subject to sales tax even though sales tax is being reduced to zero on all other foods |
| TX | 2009-2010 | SB 343[129] | Task Force / Advisory Committee | Advisory committee to study the retail availability of healthy foods in certain underserved areas of Texas. Passed June 2009, directed to submit report by Sept 1, 2010 |
| TX | 2014-2017 | HB 2840[130] | Program / Initiative | Permits a land bank to sell property to a developer for construction of a grocery store that offers fresh produce and other food items. Takes effect Sept 2013 |
| TX | 2014-2017 | SB 1511[131] | Program / Initiative | Repeals sales tax exemption on snack foods |

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|---|---|---|---|---|
| UT | 2017 | HB 121[132] | Food Council | Creates and appropriates funds to the Local Food Advisory Council. The council shall study and make recommendations on how to best promote vibrant, locally owned farms; promote resilient ecosystems; promote strong communities and healthy eating; enhance thriving local food economies; assess impacts of population growth and urbanization and the decline in productive ranch and farmland; assessment of laws and regulations that deter or hinder the direct sales of locally grown and produced food; and necessary steps to develop and implement a robust, integrated local food system and provide greater food security for residents. These provisions are repealed on November 30, 2022. |
| VA | 2014-2017 | Executive Order 34[133] | Task Force / Advisory Committee | Create the Commonwealth Council on Bridging the Nutritional Divide, chaired by First Lady Dorothy McAuliffe |
| VT | 2009-2017 | Sec 35 10 Vermont Statutes Annotated Chapter 15 330[134] | Food Council | Vermont Farm to Plate Network created as part of the Farm to Plate Investment Program |

**Figure 3 online only:**

State-level Healthy Food Retail Policies and Legislation, 2008-2017

a: AB = Assembly Bill; HB = House Bill; HCR = House Concurrent Resolution; HF = House File Number; HJM = House Joint Memorial; FY = Fiscal Year; SB = Senate Bill; SJR = Senate Joint Resolution; SR = Senate Resolution.

*Deriving the Multilevel Model – Analysis of components of variance*

To determine the best statistical model, we started with a three-level multilevel model, as it was the most consistent with our hypothesis that state context is associated with the quality of packaged foods purchased by households residing within the state. We used time as level one, households as level two, and states as level three. To define the third level, this study used the contiguous 48 states and the District of Columbia for a total of 49 state-level units. A significant state variance would indicate that differences between states are relevant to the nutritional quality of household purchases. We monitored changes in the state-level variance, its statistical significance and the proportion of total variance explained at the state level (i.e., the interclass correlation, or ICC) after adjusting for complex survey design and fully specifying the model with household-level characteristics and state-level policies.

STATA's mixed command was used to conduct three-level multilevel regression. However, mixed is not compatible with STATA's svyset command. Therefore, to account for Nielsen's survey design, markets were included as fixed effects and annual household weights were rescaled to generate weights at level one (year), level two (household) and level three (state) following Heeringa et al.[139] Code available upon request.

The conceptual three-level random intercept model is provided by equation 1, where *HH_X* refers to the vector of household-level covariates (income, education, race/ethnicity, household composition and year), *State_X* refers to the vector of state-level covariates (SNAP eligibility, WIC coverage, healthy food retail policies, preemption targeting food retail, preemption targeting labor, Medicaid expansion, proportion of EITC paid by the state, expenditures on higher education, expenditures on housing and welfare, and minimum wage), *i.market* refers to sampling strata fixed effects, *t* refers to time (level 1), *h* refers to individual households (level 2), *s* refers to US state of residence (level 3) and *e* is the residual:

$$\text{Equation 1: } Y_{ths} = \beta_{0hs} + \beta_{1th} HH\_X_{ths} + \beta_{2ts} State\_X_{ts} + i.market_{ths} + e_{ths}$$

We conducted two subpopulation analyses because we expected state context to be more meaningful for low-income and low-education households. First, we limited the analytic sample to those households with an income at or below 200% the Federal Poverty Level and repeated all steps (n=142,025). Next, we limited the analytic sample to those households with no higher than a high school education and repeated all steps (n=112,989). For models limited only to low-income or low-education households, rescaled weights were recalculated to be appropriate for the new subpopulation.

Although the state-level variance remained statistically significant, the percent of total variance explained at the state level was very small (see **Table 1 online only**). In empty models, this percent ranged from 0.6% (fruits, vegetables) to 2.7% (processed meats). Most of the state-level variance was reduced after controlling for Nielsen's survey design, after which the state-level intraclass correlation (ICC) was less than 0.5% across all outcomes. Further reductions in the state-level variance occurred after controlling for household and state-level variables, further reducing the percent of total variance explained at the state level close to zero (Table 1 online only). When the sample was limited to only low-income or only low-education households, results were similar (see **Tables 2 and 3 online only**). Although using markets instead of states increased the percent of total variance explained at the third level (see **Table 4 online only**), using markets would have precluded analysis of state-level policies. Therefore, we opted to use two-level models, with time as level one and household as level two.

*Final Model*

We evaluated the significance of state-level policies for all outcomes (*State_X*). Since we were not interested in partitioning variance as we were when determining model fit, we used STATA's `meglm` command with a gamma distribution and log link rather than log-transform our outcomes. The only exceptions were the percent calories from saturated fat and from sugar, where we used `meglm` with a gaussian distribution and identity link. Survey design was accounted for using STATA's `svyset` command, which is compatible with `meglm`. We included all state policies and adjusted for household-level covariates (*HH_X*: income, race/ethnicity, education, age composition, year). To control for unobserved, time-invariant differences between states and potential endogeneity of observed state policies, we included state fixed effects (*i.state*; n=49, 48 contiguous states and the District of Columbia). We found state fixed effects to be jointly significant in all outcome models. Our final model is provided by equation 2.

$$\text{Equation 2: } Y_{th} = \beta_{0h} + \beta_{1th} HH\_X_{th} + \beta_{2t} State\_X_t + i.state_{th} + e_{th}$$

**Figure 4 online only –.**

Derivation of statistical model

**Table 1 online only:**

Changes in State-level Variance and Intraclass Correlation (ICC) While Building a Multilevel Statistical Model for Each Nutritional Outcome, Using Household (HH) Panel Data from 2008-2017[a]

| | Total Calories[b] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model 1: Intercept-only models** | | | | | | | | | | | |
| Level 2 variance (HH) | 0.2563 | 1.2678 | 0.8713 | 1.1739 | 0.7405 | 1.9421 | 0.4575 | 0.3269 | 0.3288 | 0.3097 | 0.0037 |
| Level 1 variance (time) | 0.0960 | 0.7985 | 0.4245 | 0.6468 | 0.3910 | 1.1108 | 0.1862 | 0.1171 | 0.1248 | 0.1653 | 0.0014 |
| HH ICC[c] | 72.8% | 61.4% | 67.2% | 64.5% | 65.4% | 63.6% | 71.1% | 73.6% | 72.5% | 65.2% | 73.2% |
| Level 3 variance (state) | 0.0031 | 0.0128 | 0.0073 | 0.0484 | 0.0083 | 0.0281 | 0.0066 | 0.0066 | 0.0039 | 0.0054 | 0.0000 |
| Level 2 variance (HH) | 0.2534 | 1.2609 | 0.8660 | 1.1344 | 0.7329 | 1.9202 | 0.3216 | 0.3228 | 0.3239 | 0.3049 | 0.0037 |
| Level 1 variance (time) | 0.0949 | 0.7938 | 0.4208 | 0.6419 | 0.3878 | 1.1046 | 0.1158 | 0.1201 | 0.1235 | 0.1639 | 0.0014 |
| HH ICC[d] | 73.0% | 61.6% | 67.5% | 64.8% | 65.6% | 63.8% | 73.9% | 73.3% | 72.6% | 65.4% | 73.3% |
| State ICC[e] | 0.9% | 0.6% | 0.6% | 2.7% | 0.7% | 0.9% | 1.5% | 1.5% | 0.9% | 1.1% | 0.8% |
| LRT statistic[f] | 1551 | −482 | 271 | 3463 | 758 | −176 | 2097 | 1903 | 1672 | 1710 | −669 |
| p-value | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Model 2: Accounting for survey design with weights and market fixed effects** | | | | | | | | | | | |
| Level 3 variance (state) | 0.0006 | 0.0051 | 0.0000 | 0.0062 | 0.0014 | 0.0122 | 0.0015 | 0.0016 | 0.0015 | 0.0007 | 0.0000 |
| Level 2 variance (HH) | 0.2719 | 1.3233 | 0.9609 | 1.1461 | 0.7703 | 1.8399 | 0.4634 | 0.3363 | 0.3364 | 0.3271 | 0.0040 |
| Level 1 variance (time) | 0.1024 | 0.8424 | 0.4505 | 0.6279 | 0.3902 | 0.9730 | 0.1977 | 0.1231 | 0.1306 | 0.1676 | 0.0014 |
| HH ICC | 72.7% | 61.2% | 68.1% | 64.7% | 66.4% | 65.6% | 70.2% | 73.3% | 72.1% | 66.2% | 74.2% |
| State ICC | 0.2% | 0.2% | 0.0% | 0.3% | 0.1% | 0.4% | 0.2% | 0.4% | 0.3% | 0.1% | 0.4% |
| % reduction of state-level variance from Model 1 | −79.2% | −60.4% | −100.0% | −87.2% | −83.3% | −56.5% | −77.2% | −75.3% | −61.4% | −86.8% | −51.2% |
| **Model 3: With household characteristics** | | | | | | | | | | | |
| Level 3 variance (state) | 0.0005 | 0.0040 | 0.0000 | 0.0048 | 0.0005 | 0.0091 | 0.0012 | 0.0009 | 0.0014 | 0.0005 | 0.0000 |
| Level 2 variance (HH) | 0.2296 | 1.2829 | 0.8824 | 1.1105 | 0.7385 | 1.7360 | 0.4217 | 0.2923 | 0.3039 | 0.2823 | 0.0038 |
| Level 1 variance (time) | 0.0770 | 0.8233 | 0.4280 | 0.6091 | 0.3684 | 0.9355 | 0.1731 | 0.0988 | 0.1032 | 0.1410 | 0.0013 |
| HH ICC | 74.9% | 61.0% | 67.3% | 64.7% | 66.7% | 65.1% | 71.0% | 74.8% | 74.7% | 66.7% | 73.9% |
| State ICC | 0.2% | 0.2% | 0.0% | 0.3% | 0.0% | 0.3% | 0.2% | 0.2% | 0.3% | 0.1% | 0.2% |
| % reduction of state-level variance from Model 1 | −84% | −68% | −100% | −90% | −93% | −67% | −81% | −86% | −65% | −90% | −68% |

| | Total Calories[b] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % of household-level variation explained by household characteristics[g] | 16% | 3% | 8% | 3% | 4% | 6% | 9% | 13% | 10% | 14% | 4% |
| **Model 4: With state characteristics** | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0051 | 0.0015 | 0.0039 | 0.0000 | 0.0105 | 0.0009 | 0.0005 | 0.0009 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2296 | 1.2828 | 0.8821 | 1.1105 | 0.7386 | 1.7358 | 0.4217 | 0.2923 | 0.3039 | 0.2824 | 0.0038 |
| Level 1 variance (time) | 0.0770 | 0.8232 | 0.4278 | 0.6091 | 0.3684 | 0.9347 | 0.1731 | 0.0988 | 0.1032 | 0.1410 | 0.0013 |
| HH ICC | 74.9% | 61.0% | 67.4% | 64.7% | 66.7% | 65.1% | 70.9% | 74.8% | 74.7% | 66.7% | 73.9% |
| State ICC | 0.0% | 0.2% | 0.1% | 0.2% | 0.0% | 0.4% | 0.1% | 0.1% | 0.2% | 0.0% | 0.2% |
| % reduction of state-level variance from Model 1 | −100% | −60% | −79% | −92% | −100% | −63% | −87% | −93% | −77% | −100% | −73% |

[a] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[b] Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day. Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year.

[c] The household-level intraclass correlation (ICC) is the proportion of the variance attributable to the household residual, or differences between households.

[d] In three level models, the ICC of the second level captures the residual of the second and third levels, so the household-level ICC is the proportion of the variance explained by the household and state levels

[e] The state-level ICC is the proportion of the variance attributable to the state residual, or differences between states.

[f] The Likelihood Ratio Test (LRT) evaluates whether the three-level model is a statistically significant improvement in model fit compared to a two-level model. The table provides the chi-squared test statistic along with the associated p-value. A p-value of 0 indicates it is less than 0.0001 and therefore that the three-level model is a better fit for a given nutritional outcome. A p-value of 1 indicates that the two-level model is a better fit for a given outcome.

[g] The percent of household-level variation explained by the household measures we include in our model is calculated by taking the difference between the Level 2 variances in Models 2 and 3 and dividing the difference by the Level 2 variance in Model 2.

**Table 2 online only:**

Changes in State-level Variance and Intraclass Correlation (ICC) While Building a Multilevel Statistical Model for Each Nutritional Outcome, Using Household (HH) Panel Data for Households with Low Income,[a] 2008-2017[b]

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model 1: Intercept-only models** | | | | | | | | | | | | |
| Level 2 variance (HH) | 0.2726 | 1.3657 | 0.9606 | 1.1613 | 0.7576 | 1.9656 | 0.4710 | 0.3413 | 0.3388 | 0.3256 | 0.0006 | 0.0042 |
| Level 1 variance (time) | 0.1002 | 0.9173 | 0.4871 | 0.6489 | 0.4105 | 1.0079 | 0.1978 | 0.1187 | 0.1294 | 0.1689 | 0.0003 | 0.0015 |
| HH ICC[d] | 73.1% | 59.8% | 66.4% | 64.2% | 64.9% | 66.1% | 70.4% | 74.2% | 72.4% | 65.8% | 66.7% | 73.5% |
| Level 3 variance (state) | 0.0029 | 0.0139 | 0.0089 | 0.0468 | 0.0062 | 0.0281 | 0.0072 | 0.0054 | 0.0036 | 0.0050 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2708 | 1.3591 | 0.9553 | 1.1283 | 0.7567 | 1.9438 | 0.4631 | 0.3375 | 0.3357 | 0.3223 | 0.0006 | 0.0041 |
| Level 1 variance (time) | 0.0990 | 0.9128 | 0.4824 | 0.6444 | 0.4075 | 1.0042 | 0.1963 | 0.1173 | 0.1281 | 0.1675 | 0.0003 | 0.0015 |
| HH ICC[e] | 73.4% | 60.1% | 66.7% | 64.6% | 65.2% | 66.3% | 70.6% | 74.5% | 72.6% | 66.1% | 67.2% | 73.6% |
| State ICC[f] | 0.8% | 0.6% | 0.6% | 2.6% | 0.5% | 0.9% | 1.1% | 1.2% | 0.8% | 1.0% | 2.2% | 0.7% |
| LRT statistic[g] | 422.6 | −26.06 | 357.75 | 952.3 | −29.47 | −67.25 | 468.27 | 525.63 | 348.25 | 371.04 | 612.15 | −213.33 |
| p-value | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Model 2: Accounting for survey design with weights and market fixed effects** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0021 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0005 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2836 | 1.4341 | 1.0457 | 1.1260 | 0.7664 | 1.7952 | 0.4660 | 0.3523 | 0.3427 | 0.3450 | 0.0005 | 0.0044 |
| Level 1 variance (time) | 0.1048 | 0.9431 | 0.4971 | 0.6037 | 0.4039 | 0.8644 | 0.1978 | 0.1213 | 0.1323 | 0.1693 | 0.0003 | 0.0015 |
| HH ICC | 73.0% | 60.3% | 67.8% | 65.1% | 65.5% | 67.5% | 70.2% | 74.4% | 72.1% | 67.1% | 66.9% | 74.8% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% |
| % reduction of state-level variance from Model 1 | −100.0% | −100.0% | −100.0% | −95.5% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −90.6% | −100.0% | −100.0% |
| **Model 3: With household characteristics** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0023 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2221 | 1.3888 | 0.9594 | 1.1014 | 0.7320 | 1.7344 | 0.4048 | 0.2859 | 0.2944 | 0.2873 | 0.0005 | 0.0043 |
| Level 1 variance (time) | 0.0799 | 0.9247 | 0.4769 | 0.5835 | 0.3845 | 0.8400 | 0.1730 | 0.0974 | 0.1058 | 0.1439 | 0.0002 | 0.0015 |
| HH ICC | 73.5% | 60.0% | 66.8% | 65.4% | 65.6% | 67.4% | 70.1% | 74.6% | 73.6% | 66.6% | 67.4% | 74.6% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % reduction of state-level variance from Model 1 | −100% | −100% | −100% | −95% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% |
| **Model 4: With state characteristics** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2221 | 1.3887 | 0.9596 | 1.1019 | 0.7321 | 1.7352 | 0.4048 | 0.2858 | 0.2943 | 0.2872 | 0.0005 | 0.0043 |
| Level 1 variance (time) | 0.0799 | 0.9245 | 0.4767 | 0.5834 | 0.3845 | 0.8393 | 0.1730 | 0.0974 | 0.1058 | 0.1439 | 0.0002 | 0.0015 |
| HH ICC | 73.5% | 60.0% | 66.8% | 65.4% | 65.6% | 67.4% | 70.1% | 74.6% | 73.6% | 66.6% | 67.4% | 74.6% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| % reduction of state-level variance from Model 1 | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% |

[a]Households with low income are those with incomes below 200% of the federal poverty level

[b]Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c]Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day. Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year.

[d]The household-level intraclass correlation (ICC) is the proportion of the variance attributable to the household residual, or differences between households.

[e]In three level models, the ICC of the second level captures the residual of the second and third levels, so the household-level ICC is the proportion of the variance explained by the household and state levels

[f]The state-level ICC is the proportion of the variance attributable to the state residual, or differences between states.

[g]The Likelihood Ratio Test (LRT) evaluates whether the three-level model is a statistically significant improvement in model fit compared to a two-level model. The table provides the chi-squared test statistic along with the associated p-value. A p-value of 0 indicates it is less than 0.0001 and therefore that the three-level model is a better fit for a given nutritional outcome. A p-value of 1 indicates that the two-level model is a better fit for a given outcome.

**Table 3 online only:**

Changes in State-level Variance and Intraclass Correlation (ICC) While Building a Multilevel Statistical Model for Each Nutritional Outcome, Using Household (HH) Panel Data for Households with Low Educational Attainment,[a] 2008-2017[b]

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model 1: Intercept-only models** | | | | | | | | | | | | |
| Level 2 variance (HH) | 0.2440 | 1.4604 | 0.9408 | 1.0864 | 0.7208 | 1.9454 | 0.4347 | 0.3096 | 0.3158 | 0.2937 | 0.0005 | 0.0042 |
| Level 1 variance (time) | 0.0939 | 0.8705 | 0.4388 | 0.5686 | 0.3619 | 0.9970 | 0.1752 | 0.1117 | 0.1205 | 0.1571 | 0.0003 | 0.0014 |
| HH ICC[d] | 72.2% | 62.7% | 68.2% | 65.6% | 66.6% | 66.1% | 71.3% | 73.5% | 72.4% | 65.1% | 67.4% | 74.8% |
| Level 3 variance (state) | 0.0021 | 0.0144 | 0.0081 | 0.0435 | 0.0060 | 0.0264 | 0.0070 | 0.0041 | 0.0035 | 0.0048 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2418 | 1.4531 | 0.9309 | 1.0440 | 0.7157 | 1.9224 | 0.4273 | 0.3059 | 0.3118 | 0.2897 | 0.0005 | 0.0041 |
| Level 1 variance (time) | 0.0934 | 0.8663 | 0.4373 | 0.5668 | 0.3602 | 0.9919 | 0.1740 | 0.1111 | 0.1198 | 0.1565 | 0.0003 | 0.0014 |
| HH ICC[e] | 72.3% | 62.9% | 68.2% | 65.7% | 66.7% | 66.3% | 71.4% | 73.6% | 72.5% | 65.3% | 67.8% | 74.9% |
| State ICC[f] | 0.6% | 0.6% | 0.6% | 2.6% | 0.6% | 0.9% | 1.1% | 1.0% | 0.8% | 1.1% | 2.0% | 0.8% |
| LRT statstic[g] | 91.28 | 50.56 | −18.37 | 672.96 | 49.86 | 188.24 | 414.24 | 107.39 | 176.43 | 156.54 | 404.95 | −93.85 |
| p-value | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Model 2: Accounting for survey design with weights and market fixed effects** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2663 | 1.5242 | 1.0421 | 1.0891 | 0.7624 | 1.8412 | 0.4580 | 0.3349 | 0.3330 | 0.3188 | 0.0005 | 0.0044 |
| Level 1 variance (time) | 0.1004 | 0.8966 | 0.4585 | 0.5616 | 0.3813 | 0.9007 | 0.1889 | 0.1194 | 0.1281 | 0.1666 | 0.0003 | 0.0014 |
| HH ICC | 72.6% | 63.0% | 69.4% | 66.0% | 66.7% | 67.2% | 70.8% | 73.7% | 72.2% | 65.7% | 67.6% | 75.4% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| % reduction of state-level variance from Model 1 | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% | −100.0% |
| **Model 3: With household characteristics** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0017 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0009 | 0.0000 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2267 | 1.4502 | 0.9459 | 1.1023 | 0.7501 | 1.8300 | 0.4194 | 0.2881 | 0.3097 | 0.2839 | 0.0005 | 0.0043 |
| Level 1 variance (time) | 0.0733 | 0.8753 | 0.4348 | 0.5366 | 0.3608 | 0.8654 | 0.1621 | 0.0930 | 0.0998 | 0.1382 | 0.0002 | 0.0014 |
| HH ICC | 75.6% | 62.4% | 68.5% | 67.3% | 67.5% | 67.9% | 72.1% | 75.6% | 75.7% | 67.3% | 68.9% | 75.3% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.0% | 0.0% |

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Mixed Dishes | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % reduction of state-level variance from Model 1 | −100% | −100% | −100% | −96% | −100% | −100% | −100% | −100% | −75% | −100% | −100% | −100% |
| **Model 4: With state characteristics** | | | | | | | | | | | | |
| Level 3 variance (state) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2265 | 1.4500 | 0.9459 | 1.1024 | 0.7500 | 1.8303 | 0.4192 | 0.2879 | 0.3099 | 0.2835 | 0.0005 | 0.0043 |
| Level 1 variance (time) | 0.0732 | 0.8749 | 0.4346 | 0.5365 | 0.3606 | 0.8647 | 0.1621 | 0.0930 | 0.0997 | 0.1382 | 0.0002 | 0.0014 |
| HH ICC | 75.6% | 62.4% | 68.5% | 67.3% | 67.5% | 67.9% | 72.1% | 75.6% | 75.7% | 67.2% | 68.9% | 75.3% |
| State ICC | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| % reduction of state-level variance from Model 1 | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% | −100% |

[a]Households with low education are those with a high school degree or less

[b]Authors’ calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c]Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day. Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year.

[d]The household-level intraclass correlation (ICC) is the proportion of the variance attributable to the household residual, or differences between households.

[e]In three level models, the ICC of the second level captures the residual of the second and third levels, so the household-level ICC is the proportion of the variance explained by the household and state levels

[f]The state-level ICC is the proportion of the variance attributable to the state residual, or differences between states.

[g]The Likelihood Ratio Test (LRT) evaluates whether the three-level model is a statistically significant improvement in model fit compared to a two-level model. The table provides the chi-squared test statistic along with the associated p-value. A p-value of 0 indicates it is less than 0.0001 and therefore that the three-level model is a better fit for a given nutritional outcome. A p-value of 1 indicates that the two-level model is a better fit for a given outcome.

**Table 4 online only:**

Changes in Market-level[a] Variance and Intraclass Correlation (ICC) While Building a Multilevel Statistical Model for Each Nutritional Outcome, Using Household (HH) Panel Data, 2008-2017[b]

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model 1: Intercept-only models** | | | | | | | | | | | |
| Level 2 variance (HH) | 0.2563 | 1.2678 | 0.8713 | 1.1739 | 1.9421 | 0.4575 | 0.3269 | 0.3288 | 0.3097 | 0.0006 | 0.0037 |
| Level 1 variance (time) | 0.0960 | 0.7985 | 0.4245 | 0.6468 | 1.1108 | 0.1862 | 0.1171 | 0.1248 | 0.1653 | 0.0003 | 0.0014 |
| HH ICC[d] | 72.8% | 61.4% | 67.2% | 64.5% | 63.6% | 71.1% | 73.6% | 72.5% | 65.2% | 65.4% | 73.2% |
| Level 3 variance (market) | 0.0054 | 0.0163 | 0.0102 | 0.0551 | 0.0367 | 0.0151 | 0.0091 | 0.0079 | 0.0083 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2507 | 1.2548 | 0.8620 | 1.1203 | 1.9144 | 0.4408 | 0.3177 | 0.3206 | 0.3019 | 0.0006 | 0.0037 |
| Level 1 variance (time) | 0.0947 | 0.7929 | 0.4204 | 0.6416 | 1.1036 | 0.1844 | 0.1156 | 0.1233 | 0.1637 | 0.0003 | 0.0014 |
| HH ICC[e] | 73.0% | 61.6% | 67.5% | 64.7% | 63.9% | 71.2% | 73.9% | 72.7% | 65.5% | 65.9% | 73.4% |
| Market ICC[f] | 1.5% | 0.8% | 0.8% | 3.0% | 1.2% | 2.4% | 2.1% | 1.7% | 1.7% | 1.3% | 1.0% |
| LRT statistic[g] | 2506.37 | 120.69 | 270.76 | 4371.57 | 250.37 | 3143.1 | 3171.64 | 2541.36 | 2727.28 | 1688.55 | −996.56 |
| p-value | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Model 2: Accounting for survey design with weights** | | | | | | | | | | | |
| Level 3 variance (market) | 0.0068 | 0.0197 | 0.0142 | 0.0540 | 0.0369 | 0.0173 | 0.0105 | 0.0095 | 0.0098 | 0.0000 | 0.0001 |
| Level 2 variance (HH) | 0.2705 | 1.3224 | 0.9575 | 1.1381 | 1.8361 | 0.4586 | 0.3346 | 0.3343 | 0.3245 | 0.0005 | 0.0039 |
| Level 1 variance (time) | 0.1017 | 0.8362 | 0.4471 | 0.6217 | 0.9696 | 0.1952 | 0.1221 | 0.1298 | 0.1657 | 0.0003 | 0.0014 |
| HH ICC | 73.2% | 61.6% | 68.5% | 65.7% | 65.9% | 70.9% | 73.9% | 72.6% | 66.9% | 67.0% | 74.4% |
| Market ICC | 1.8% | 0.9% | 1.0% | 3.0% | 1.3% | 2.6% | 2.3% | 2.0% | 2.0% | 1.5% | 1.0% |
| % reduction of market-level variance from Model 1 | 27.0% | 20.3% | 40.0% | −1.9% | 0.8% | 15.1% | 16.2% | 21.1% | 18.8% | 10.5% | 10.2% |
| **Model 3: With household characteristics** | | | | | | | | | | | |
| Level 3 variance (market) | 0.0033 | 0.0159 | 0.0100 | 0.0451 | 0.0248 | 0.0095 | 0.0055 | 0.0048 | 0.0098 | 0.0000 | 0.0000 |
| Level 2 variance (HH) | 0.2284 | 1.2802 | 0.8772 | 1.1028 | 1.7330 | 0.4171 | 0.2908 | 0.3021 | 0.3245 | 0.0005 | 0.0038 |
| Level 1 variance (time) | 0.0765 | 0.8174 | 0.4249 | 0.6032 | 0.9327 | 0.1707 | 0.0980 | 0.1027 | 0.1657 | 0.0002 | 0.0013 |
| HH ICC | 75.2% | 61.3% | 67.6% | 65.6% | 65.3% | 71.4% | 75.1% | 74.9% | 66.9% | 67.9% | 74.1% |
| Market ICC | 1.1% | 0.8% | 0.8% | 2.6% | 0.9% | 1.6% | 1.4% | 1.2% | 2.0% | 1.1% | 0.8% |

| | Total Calories[c] | Fruits | Vegetables | Processed Meats | Sugar-Sweetened Beverages | Desserts and Snacks | Saturated Fat g | Sugar g | Sodium mg | Percent Saturated Fat | Percent Sugar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % reduction of market-level variance from Model 1 | −39% | −3% | −2% | −18% | −32% | −37% | −39% | −39% | 19% | −28% | −14% |

[a] Nielsen Homescan samples households within 76 market areas.

[b] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c] Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day. Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year. Note that 3-level random effects models were not able to converge when using calories from mixed dishes as an outcome.

[d] The household-level intraclass correlation (ICC) is the proportion of the variance attributable to the household residual, or differences between households.

[e] In three level models, the ICC of the second level captures the residual of the second and third levels, so the household-level ICC is the proportion of the variance explained by the household and market levels

[f] The state-level ICC is the proportion of the variance attributable to the market residual, or differences between markets.

[g] The Likelihood Ratio Test (LRT) evaluates whether the three-level model is a statistically significant improvement in model fit compared to a two-level model. The table provides the chi-squared test statistic along with the associated p-value. A p-value of 0 indicates it is less than 0.0001 and therefore that the three-level model is a better fit for a given nutritional outcome. A p-value of 1 indicates that the two-level model is a better fit for a given outcome.

**Table 5:**

Statistics describing model inputs, including average packaged food purchases and sociodemographic characteristics of households as well as contextual state policy variables for select years, 2008 and 2017[a]

| **Nutritional Outcomes, mean(SE)[b]** | | | **Household Characteristics, mean(SE)** | | | **State Characteristics** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2008** | **2017** | | **2008** | **2017** | | **2008** | **2017** | **Within-state variation[c] mean (SD)** |
| | | | Households excluded[d] | 446 | 236 | **Factors that may directly affect food purchases** | | | |
| Total calories[e] | 1,374 (5.8) | 1,220 (4.6) | Sample size[f] | 61,091 | 62,581 | SNAP[h] eligibility[i] | 35 states offered no BBCE; 10 raised income and asset limits | 11 states offered no BBCE; 30 raised income and asset limits | 1.1 (0.5) |
| **Healthy Food Groups** | | | **Income**[g] | | | | | | |
| Fruit, kcal | 21 (0.2) | 22 (0.2) | Average ratio to FPL[j] | 3.63 (0.02) | 3.33 (0.01) | WIC[k] coverage | Mean: 61%; Min: 46%; Max: 82% | Mean: 48%; Min: 36%; Max: 64% | 55.4% (5.6%) |
| NS[l] Vegetables, kcal | 16 (0.1) | 18 (0.1) | <185% FPL | 24.9% (0.3%) | 27.7% (0.3%) | Healthy Food Retail Policy | 41 states had 0 policies; maximum # in one state = 2 | 26 states had 0 policies; maximum # in one state = 5 | 0.49 (0.45) |
| **Food Groups to Limit** | | | 185-400% FPL | 35.8% (0.3%) | 37.4% (0.3%) | | | | |
| Processed meat, kcal | 53 (0.4) | 53 (0.4) | >400% FPL | 39.2% (0.3%) | 34.9% (0.3%) | Preemption: Food Purchasing | 0 states | 5 states | 0.04 (0.14) |
| Mixed dishes, kcal | 96 (0.6) | 88 (0.6) | **Education** | | | **Factors that may indirectly affect food purchases** | | | |
| SSBs,[m] kcal | 72 (0.7) | 52 (0.5) | High school or less | 30.6% (0.3%) | 26.4% (0.3%) | Preemption: Labor Laws | 37 states had 0 policies; maximum # in one state = 3 | 8 states had 0 policies; maximum # in one state = 6 | 0.97 (1.07) |
| Desserts and Snacks, kcal | 351 (1.7) | 313 (1.4) | Some college | 32.2% (0.3%) | 31.9% (0.3%) | | | | |
| **Nutrients of Concern** | | | College graduate | 25.1% (0.3%) | 27.0% (0.2%) | Medicaid Expansion | 0 states | 31 states | 0.23 (0.38) |
| Saturated fat, g | 17 (0.1) | 18 (0.1) | Post college graduate | 12.2% (0.2%) | 14.7% (0.2%) | State EITC[n] | Mean: 7%; Min: 0%; Max: 40% | Mean: 10%; Min: 0%; Max: 85% | 8.3% (5.5%) |
| Sugar, g | 90 (0.4) | 73 (0.3) | **Race/Ethnicity** | | | Expenditures on higher education ($1,000 per capita) | Mean: 1.036; Min: 0.253; Max: 1.528 | Mean: 1.141; Min: 0.179; Max: 2.019 | 1.1 (0.07) |
| Sodium, mg | 2,665 (14.4) | 2,321 (11.5) | Hispanic | 11.7% (0.3%) | 13.8% (0.2%) | | | | |
| Saturated fat, % of kcals | 11% (0.0%) | 13% (0.0%) | NH[o] White | 71.4% (0.3%) | 67.2% (0.3%) | Expenditures on welfare and housing ($1,000 per capita) | Mean: 1.758; Min: 0.886; Max: 5.855 | Mean: 2.259; Min: 1.277; Max: 6.751 | 2.0 (0.23) |

| Nutritional Outcomes, mean(SE)[b] | | | Household Characteristics, mean(SE) | | | State Characteristics | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2008** | **2017** | | **2008** | **2017** | | **2008** | **2017** | **Within-state variation[c] mean (SD)** |
| Sugar, % of kcals | 26% (0.1%) | 24% (0.0%) | NH Black | 11.5% (0.2%) | 11.8% (0.2%) | | | | |
| | | | NH Asian | 2.8% (0.1%) | 4.1% (0.1%) | Minimum Wage | Mean: $6.57; Min: $5.85; Max: $8.07 | Mean: $8.25; Min: $7.25; Max: $11.5 | $7.53 ($0.60) |
| | | | NH Other[p] | 2.5% (0.1%) | 3.1% (0.1%) | | | | |

[a] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[b] Estimates are generated using survey-weighted averages and are nationally-representative. Therefore, a standard error (SE) is presented rather than a standard deviation (SD).

[c] The within-state standard deviation of the mean value for a policy indicates whether there is variation over time. A value of 0 would indicate that a policy has no variation over time, which would make the policy collinear with the state-level fixed effects. Variation within states over time was a necessary component of the fixed effects model's identification strategy to detect a policy effect. Values were calculated using xtsum in STATA using 49 states over 10 years.

[d] Households were excluded if they did not purchase a minimum dollar amount of packaged foods in a three-month period and if they had incorrect geographic information.

[e] Nutritional outcomes in units of calories or grams are expressed in units per person per day. Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year. These nutrients and food groups are derived from packaged food purchases (PFPs) only, and do not include nutrients and foods from food eaten away from home or from unpackaged foods from the store (e.g., loose onions or meat from the butcher). SSBs = Sugar-sweetened beverages.

[f] Final sample size does not include excluded households

[g] Household income is presented after adjusting income for the local cost of living and then indexing income to the Federal Poverty Level based on the year and number of individuals in the household.

[h] SNAP: Supplemental Nutrition Assistance Program

[i] Policy variables are operationalized as follows: SNAP eligibility refers to a state's ability to expand coverage through Broad Based Categorical Eligibility (BBCE), either through raising the income or asset limit (variable = 0 for no BBCE, 1 or 2). WIC coverage refers to the percent of eligible women, infants and children receiving benefits (variable = continuous). Healthy Food Retail Policy refer to state-level legislative measures to improve access to healthy foods (variable = count). A complete list of policies can be found in Figure 3 online only. Preemption laws may prohibit healthy food retail legislation or preempt labor laws that would increase worker rights/income (binary variable, 1 = presence of at least one such law). Medicaid expansion (binary variable = 1 if state expanded Medicaid). State EITC refers to supplementary earned income tax credit given by the state (variable = continuous, expressed as a percent of the federal EITC). Expenditures are expressed in per capita $1,000, real 2017 dollars (not nominal dollars) (variable = continuous). Minimum wage refers to a state's minimum wage in nominal dollars (variable = continuous).

[j] FPL: Federal Poverty Level

[k] WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[l] NS: non-starchy

[m] SSBs: sugar-sweetened beverages

[n] EITC: Earned Income Tax Credit

[o] NH: non-Hispanic

[p] "Other" race includes instances where the head of household identifies with multiple races or with another racial/ethnic group, such as Native American or Native Hawai'ian.

## Table 6:

Percent change[a] in nutritional outcomes of U.S. household packaged food purchases (PFPs)[b] associated with changes in state policies, 2008-2017

| | **Total Calories**[c] | **Fruits** | **NS**[d] **Vegetables** | **Processed Meats** | **Mixed Dishes** | **SSBs**[e] | **Desserts and Snacks** | **Saturated fat, g** | **Sugar, g** | **Sodium, mg** |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [f] | | | | | | | | | | |
| Healthy Food Retail Policy β *(95% confidence interval)* | 0.4 *(−0.1, 0.8)* | 0.4 *(−0.6, 1.5)* | 0.5 *(−0.4, 1.3)* | 0.4 *(−0.4, 1.2)* | −0.4 *(−1.1, 0.3)* | 0.8 *(−0.2, 1.9)* | 0.7* *(0.1, 1.3)* | 0.3 (−0.2, 0.8) | 0.3 (−0.2, 0.9) | 0.3 (−0.3, 0.8) |
| SNAP[g] eligibility | −0.4 *(−0.9, 0.1)* | −1.0 *(−2.1, 0.2)* | −0.3 *(−1.2, 0.6)* | −0.9 *(−1.8, 0.1)* | −0.7 *(−1.5, 0.1)* | −0.5 *(−1.6, 0.7)* | −0.4 *(−1.0, 0.3)* | −0.3 (−0.8, 0.2) | −0.6* (−1.2, −0.1) | −0.4 (−1.0, 0.2) |
| WIC[h] coverage | 0.0 *(−0.1, 0.1)* | −0.1 *(−0.3, 0.1)* | −0.2* *(−0.4, 0.0)* | 0.2* *(0.0, 0.3)* | −0.1 *(−0.2, 0.0)* | 0.0 *(−0.2, 0.2)* | 0.0 *(−0.1, 0.1)* | 0.0 (−0.1, 0.0) | 0.0 (−0.1, 0.1) | 0.0 (−0.1, 0.1) |
| Medicaid Expansion | −0.7 *(−1.6, 0.3)* | −1.3 *(−3.5, 0.8)* | 0.1 *(−1.6, 1.9)* | −0.2 *(−1.9, 1.6)* | −1.5 *(−3.0, 0.1)* | −4.7*** *(−6.9, −2.4)* | −0.3 *(−1.4, 0.9)* | −0.6 (−1.6, 0.4) | −1.0 (−2.1, 0.0) | −1.4* (−2.5, −0.3) |
| Minimum Wage | −0.9** *(−1.5, −0.3)* | 1.0 *(−0.3, 2.4)* | −2.2*** *(−3.3, −1.0)* | −0.6 *(−1.7, 0.5)* | −0.2 *(−1.2, 0.7)* | −0.9 *(−2.4, 0.5)* | −0.6 *(−1.3, 0.2)* | −0.9** (−1.5, −0.3) | −0.4 (−1.1, 0.2) | −0.9* (−1.6, −0.2) |
| Proportion of EITC[i] | 0.0 *(0.0, 0.0)* | −0.1* *(−0.1, 0.0)* | 0.1* *(0.0, 0.1)* | 0.0 *(0.0, 0.1)* | 0.0 *(0.0, 0.1)* | −0.1* *(−0.1, 0.0)* | 0.0 *(0.0, 0.0)* | 0.0 (0.0, 0.0) | −2.9* (−0.1, 0.0) | −0.0 (0.0, 0.0) |
| Expenditures on higher education ($1,000/capita) | 1.6 *(−2.5, 5.8)* | −2.4 *(−11.5, 7.7)* | 5.6 *(−2.3, 14.2)* | 4.1 *(−3.5, 12.2)* | 0.3 *(−6.3, 7.3)* | 1.5 *(−8.0, 12.0)* | 3.3 *(−2.0, 8.9)* | 2.4 (−2.0, 7.0) | 2.2 (−2.4, 7.0) | 0.2 (−4.9, 5.4) |
| Expenditures on welfare and housing ($1,000/ capita) | −1.3 *(−2.7, 0.0)* | −2.6 *(−5.6, 0.5)* | 2.4 *(−0.3, 5.1)* | −2.5 *(−5.0, 0.1)* | −1.7 *(−4.0, 0.6)* | −5.1** *(−8.3, −1.8)* | −1.0 *(−2.7, 0.8)* | −0.6 (−2.0, 0.9) | −1.7* (−3.2, −0.2) | −0.4 (−2.1, 1.4) |
| ***Policies expected to be associated with less healthful PFPs*** [j] | | | | | | | | | | |
| Preemption: Food Retail | 0.6 *(−1.0, 2.3)* | 1.3 *(−2.9, 5.8)* | −1.1 *(−4.1, 2.0)* | −0.5 *(−3.5, 2.5)* | 1.0 *(−1.7, 3.8)* | 0.7 *(−3.2, 4.9)* | 1.0 *(−1.0, 3.1)* | −0.2 (−1.9, 1.6) | 1.2 (−0.7, 3.2) | 1.8 (−0.2, 3.8) |
| Preemption: Labor Laws | −0.2 *(−0.4, 0.1)* | −0.4 *(−1.0, 0.3)* | 1.2*** *(0.7, 1.8)* | −0.4 *(−1.0, 0.1)* | 0.3 *(−0.2, 0.7)* | 1.1** *(0.4, 1.8)* | 0.0 *(−0.4, 0.3)* | −0.1 (−0.4, 0.2) | 0.1 (−0.2, 0.4) | −0.2 (−0.6, 0.1) |

[a]Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using a log link. Estimates were exponentiated for interpretability. Therefore, beta-coefficients should be interpreted as the percent change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on policy variable coding). Outcomes were calculated as calories/grams/milligrams per person per day. For example: A $1,000 per capita increase in a state's expenditures on welfare and housing was associated with a 5.1% decrease in calories purchased per person per day from sugar-sweetened beverages (SSBs). Estimates are presented with 95% confidence intervals (which were also exponentiated and converted to percent change).

[b] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c] Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day.

[d] NS: Non-starchy

[e] SSBs: Sugar-sweetened beverages

[f] A healthier purchasing pattern was expected to be higher in fruit and vegetable PFPs but lower in food groups to limit and nutrients of concern. Therefore, these policies were expected to be positively associated with fruits and vegetables and negatively associated with all other outcomes.

[g] SNAP: Supplemental Nutrition Assistance Program

[h] WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[i] EITC: Earned Income Tax Credit

[j] These policies were expected to be negatively associated with fruits and vegetables and positively associated with all other outcomes reflecting foods and nutrients to limit.

[*] $p < 0.05$

[**] $p < 0.01$

[***] $p < 0.001$

## Table 7:

Change in the percent of calories from saturated fat and sugar[a] in U.S. household packaged food purchases (PFPs)[b] associated with changes in state policies, 2008-2017

| | **% calories from saturated fat** | **% calories from sugar** |
|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [c] | | |
| Healthy Food Retail Policy β *(95% confidence interval)* | 0.00% (−0.03%, 0.02%) | −0.01% (−0.07%, 0.05%) |
| SNAP[d] eligibility | 0.01% (−0.01%, 0.04%) | −0.07% * (−0.13%, 0.00%) |
| WIC[e] coverage | 0.00% (0.00%, 0.00%) | 0.01% (0.00%, 0.02%) |
| Medicaid Expansion | 0.03% (−0.02%, 0.08%) | −0.07% (−0.20%, 0.05%) |
| Minimum Wage | −0.03% (−0.06%, 0.00%) | 0.13% ** (0.05%, 0.20%) |
| Proportion of EITC[f] | 0.00% (−0.07%, 0.18%) | −0.01% *** (−0.83%, −0.28%) |
| Expenditures on higher education (per capita) | 0.18% (−0.04%, 0.39%) | 0.04% (−0.48%, 0.57%) |
| Expenditures on welfare and housing (per capita) | 0.07% (−0.01%, 0.14%) | −0.05% (−0.22%, 0.12%) |
| ***Policies expected to be associated with less healthful PFPs*** [g] | | |
| Preemption: Food Purchasing | −0.06% (−0.14%, 0.02%) | 0.15% (−0.09%, 0.39%) |
| Preemption: Labor Laws | 0.01% (−0.01%, 0.02%) | 0.05% ** (0.02%, 0.09%) |

[a] Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using an identity link. Beta-coefficients should be interpreted as changes in percentage points of the outcome for an increase of one unit of each variable (see Figure 2 online only for details on policy variable coding). Outcomes were calculated as a percent of total calories from PFPs. For example: A state expanding SNAP BBCE is associated with a 0.07 percentage point decrease in PFP calories from sugar.

[b] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c] A healthier purchasing pattern was expected to be lower in sugar and saturated fat. Therefore, these policies were expected to be negatively associated with these outcomes.

[d] SNAP: Supplemental Nutrition Assistance Program

[e] WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[f] EITC: Earned Income Tax Credit

[g] These policies were expected to be positively associated with nutritional outcomes to limit – in this case, a high percentage of calories from sugar or saturated fat.

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

**Table 8 online only:**

Percent change[a] in nutritional outcomes of packaged food purchases (PFPs)[b] associated with changes in state policies among low-income households,[c] 2008-2017

| | Total Calories[d] | Fruits | NS[e] Vegetables | Processed Meats | Mixed Dishes | SSBs[f] | Desserts and Snacks | Saturated fat g | Sugar g | Sodium mg |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [g] | | | | | | | | | | |
| Healthy Food Retail Policy | 0.1 | 0.9 | 0.8 | 0.6 | −1.1 | −0.5 | −0.1 | 0.0 | −0.1 | 0.0 |
| SNAP[h] eligibility | 0.0 | −1.7 | −0.3 | −0.9 | 0.0 | −1.1 | 0.5 | −0.1 | 0.0 | 0.0 |
| WIC[i] coverage | 0.0 | 0.0 | −0.2 | 0.0 | 0.0 | 0.0 | 0.1 | −0.1 | 0.0 | 0.0 |
| Medicaid Expansion | 0.2 | 0.9 | 1.2 | 1.3 | −1.1 | −4.0 | −0.1 | 0.5 | −0.4 | −1.2 |
| Minimum Wage | −1.3* | 0.4 | −1.5 | −2.1* | −0.7 | −1.8 | −1.0 | −1.3* | −0.7 | −0.9 |
| Proportion of EITC[j] | 0.0 | −0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Expenditures on higher education ($1,000 per capita) | 7.0 | 2.9 | 13.6 | −1.7 | 3.3 | −5.5 | 6.9 | 9.2* | 5.2 | 3.8 |
| Expenditures on welfare and housing ($1,000 per capita) | −1.3 | −6.2 | −0.4 | −1.2 | −2.5 | −8.3 | −0.4 | −0.2 | −2.4 | −0.5 |
| ***Policies expected to be associated with less healthful PFPs*** [k] | | | | | | | | | | |
| Preemption: Food Purchasing | −0.1 | 0.9 | −4.7 | 1.2 | 3.2 | −4.0 | 0.8 | −0.8 | 0.2 | 1.7 |
| Preemption: Labor Laws | −0.3 | −0.8 | 1.4* | 0.2 | −0.1 | 0.0 | −0.2 | −0.2 | 0.0 | −0.5 |

[a]Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using a log link. Estimates were exponentiated for interpretability. Therefore, beta-coefficients should be interpreted as the percent change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on coding). Outcomes were calculated as calories/grams/milligrams per person per day. For example: A $1 per hour increase in a state's minimum wage is associated with a 1.3% decrease in total calories purchased per person per day.

[b]Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c]The study sample was limited to households with an income less than 200% of the federal poverty level, hypothesizing that social policies would have a more meaningful effect on households more likely to benefit from these programs. To test whether the model could be stratified by income, a likelihood ratio test was used. The restricted model log likelihood was derived using all household-year observations (e.g., the model used for primary analysis, see Table 6). The unrestricted log likelihood was the sum of the log likelihood from the model using only households with low income and the log likelihood of the model with all other observations. Across all nutritional outcome models, the p-value was <0.0001, rejecting the null hypothesis that the coefficients of the two subsamples were the same and providing statistical justification to stratify the models by income.

[d]Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day.

[e]NS: Non-starchy

[f] SSBs: Sugar-sweetened beverages.

[g] A healthier purchasing pattern was expected to be higher in fruit and vegetable PFPs but lower in food groups and nutrients to limit. Therefore, these policies were expected to be positively associated with fruits and vegetables and negatively associated with all other outcomes.

[h] SNAP: Supplemental Nutrition Assistance Program

[i] WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[j] EITC: Earned Income Tax Credit

[k] These policies were expected to be negatively associated with fruits and vegetables and positively associated with all other outcomes reflecting foods and nutrients to limit.

[*] $p < 0.05$

**Table 9 online only:**

Change in the percent of calories from saturated fat and sugar[a] in U.S. household packaged food purchases (PFPs)[b] associated with changes in state policies among low-income households,[c] 2008-2017

| | % calories from saturated fat[d] | % calories from sugar |
|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [e] | | |
| Healthy Food Retail Policy | 0.00% | −0.07% |
| SNAP[f] eligibility | −0.02% | −0.01% |
| WIC[g] coverage | −0.01% | 0.01% |
| Medicaid Expansion | 0.05% | −0.15% |
| Minimum Wage | −0.04% | 0.13% |
| Proportion of EITC[h] | 0.00% | 0.00% |
| Expenditures on higher education ($1,000 per capita) | 0.28% | −0.49% |
| Expenditures on welfare and housing ($1,000 per capita) | 0.17% * | −0.14% |
| ***Policies expected to be associated with less healthful PFPs*** [i] | | |
| Preemption: Food Purchasing | −0.06% | 0.02% |
| Preemption: Labor Laws | 0.00% | 0.06% |

[a]Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using an identity link. Therefore, beta-coefficients should be interpreted as the change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on coding). Outcomes were calculated as calories/grams/milligrams per person per day. For example: A $1,000 per capita increase in a state's expenditures on welfare and housing programs is associated with a 0.17 percentage point increase in the PFP calories from saturated fat.

[b]Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c]The study sample was limited to households with an income less than 200% of the federal poverty level, hypothesizing that social policies would have a more meaningful effect on households more likely to benefit from these programs. To test whether the model could be stratified by income, a likelihood ratio test was used. The restricted model log likelihood was derived using all household-year observations (e.g., the model used for primary analysis, see Table 6). The unrestricted log likelihood was the sum of the log likelihood from the model using only households with low income and the log likelihood of the model with all other observations. Across all nutritional outcome models, the p-value was <0.0001, rejecting the null hypothesis that the coefficients of the two subsamples were the same and providing statistical justification to stratify the models by income.

[d]Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year.

[e]A healthier purchasing pattern was expected to be lower in sugar and saturated fat. Therefore, these policies were expected to be negatively associated with these outcomes.

[f]SNAP: Supplemental Nutrition Assistance Program

[g]WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[h]EITC: Earned Income Tax Credit

[i]These policies were expected to be positively associated with nutritional outcomes to limit – in this case, a high percentage of calories from sugar or saturated fat.

*$p < 0.05$

### Table 10 online only:

Percent change[a] in nutritional outcomes of packaged food purchases (PFPs)[b] associated with changes in state policies among households with low education,[c] 2008-2017

| | Total Calories[d] | Fruits | NS[e] Vegetables | Processed Meats | Mixed Dishes | SSBs[f] | Desserts and Snacks | Saturated fat g | Sugar g | Sodium mg |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [g] | | | | | | | | | | |
| Healthy Food Retail Policy | 0.2 | 0.2 | 0.5 | 0.2 | −0.7 | 0.3 | 0.0 | 0.0 | 0.3 | 0.1 |
| SNAP[h] eligibility | −0.9 | −2.3* | −0.3 | −1.2 | −0.7 | −0.9 | −0.6 | −0.9 | −1.1* | −1.0 |
| WIC[i] coverage | 0.1 | −0.2 | −0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 |
| Medicaid Expansion | 0.2 | −2.0 | −0.2 | −0.1 | −1.6 | −1.7 | −0.4 | 0.3 | 0.3 | −1.3 |
| Minimum Wage | −1.6* | 1.4 | −2.7* | −0.9 | 0.6 | −2.4 | −1.3 | −1.6* | −1.0 | −1.9* |
| Proportion of EITC[j] | 0.0 | −0.1 | 0.0 | 0.0 | −0.1 | −0.1 | 0.0 | 0.0 | −0.1 | 0.0 |
| Expenditures on higher education ($1,000 per capita) | 0.6 | 22.9* | −0.1 | −6.6 | −3.7 | −5.7 | −1.4 | 2.1 | 1.6 | −1.3 |
| Expenditures on welfare and housing ($1,000 per capita) | −0.2 | −4.1 | −1.1 | −1.1 | −1.1 | −2.6 | 0.8 | 0.4 | −0.7 | 0.5 |
| ***Policies expected to be associated with less healthful PFPs*** [k] | | | | | | | | | | |
| Preemption: Food Purchasing | −0.9 | 0.8 | −4.0 | 0.3 | 2.2 | 3.3 | −1.5 | −0.9 | 0.4 | 1.9 |
| Preemption: Labor Laws | 0.1 | −0.1 | 1.2* | −0.1 | 0.1 | 1.3* | 0.3 | 0.3 | 0.5 | −0.3 |

[a] Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using a log link. Estimates were exponentiated for interpretability. Therefore, beta-coefficients should be interpreted as the percent change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on coding). Outcomes were calculated as calories/grams/milligrams per person per day. For example: A $1,000 per capita increase in a state's expenditures on higher education is associated with a 22.9% increase in calories from packaged fruit purchased per person per day.

[b] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c] The study sample was limited to households with a high school education or less, hypothesizing that social policies would have a more meaningful effect on households more likely to benefit from these programs. To test whether the model could be stratified by income, a likelihood ratio test was used. The restricted model log likelihood was derived using all household-year observations (e.g., the model used for primary analysis, see Table 6). The unrestricted log likelihood was the sum of the log likelihood from the model using only households with low education and the log likelihood of the model with all other observations. Across all nutritional outcome models, the p-value was $<0.0001$, rejecting the null hypothesis that the coefficients of the two subsamples were the same and providing statistical justification to stratify the models by education.

[d] Total calories and all food groups are modelled in units of calories purchased per capita per day. Nutrients measured in grams or milligrams are also modelled in units per capita per day.

[e]NS: Non-starchy

[f]SSBs: Sugar-sweetened beverages

[g]A healthier purchasing pattern was expected to be higher in fruit and vegetable PFPs but lower in food groups and nutrients to limit. Therefore, these policies were expected to be positively associated with fruits and vegetables and negatively associated with all other outcomes.

[h]SNAP: Supplemental Nutrition Assistance Program

[i]WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[j]EITC: Earned Income Tax Credit

[k]These policies were expected to be negatively associated with fruits and vegetables and positively associated with all other outcomes reflecting foods and nutrients to limit.

*$p < 0.05$

**Table 11 online only:**

Change in the percent of calories from saturated fat and sugar[a] in U.S. household packaged food purchases (PFPs)[b] associated with changes in state policies among households with low education,[c] 2008-2017

| | % calories from saturated fat[d] | % calories from sugar |
|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [e] | | |
| Healthy Food Retail Policy | −0.01% | −0.01% |
| SNAP[f] eligibility | −0.01% | −0.10% |
| WIC[g] coverage | −0.01% | 0.01% |
| Medicaid Expansion | 0.03% | 0.06% |
| Minimum Wage | −0.04% | 0.15% * |
| Proportion of EITC[h] | 0.00% | −0.01% * |
| Expenditures on higher education ($1,000 per capita) | 0.32% | −0.13% |
| Expenditures on welfare and housing ($1,000 per capita) | 0.08% | −0.08% |
| ***Policies expected to be associated with less healthful PFPs*** [i] | | |
| Preemption: Food Purchasing | 0.03% | 0.28% |
| Preemption: Labor Laws | 0.01% | 0.07% |

[a]Sample is limited to households with a high school education or less. Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using an identity link. Therefore, beta-coefficients should be interpreted as the change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on coding). Outcomes were calculated as percent of total calories. For example: An increase of the state supplemental EITC equal to 1% of the federal EITC is associated with a 0.01 percentage point decrease in the PFP calories from sugar.

[b]Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c]The study sample was limited to households with a high school education or less, hypothesizing that social policies would have a more meaningful effect on households more likely to benefit from these programs. To test whether the model could be stratified by income, a likelihood ratio test was used. The restricted model log likelihood was derived using all household-year observations (e.g., the model used for primary analysis, see Table 6). The unrestricted log likelihood was the sum of the log likelihood from the model using only households with low education and the log likelihood of the model with all other observations. Across all nutritional outcome models, the p-value was <0.0001, rejecting the null hypothesis that the coefficients of the two subsamples were the same and providing statistical justification to stratify the models by education.

[d]Percentages are calculated by converting grams of saturated fat (or sugar) purchased in a year to calories from saturated fat (or sugar) and dividing by total calories for the same year.

[e]A healthier purchasing pattern was expected to be lower in sugar and saturated fat. Therefore, these policies were expected to be negatively associated with these outcomes.

[f]SNAP: Supplemental Nutrition Assistance Program

[g]WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[h]EITC: Earned Income Tax Credit

[i]These policies were expected to be positively associated with nutritional outcomes to limit – in this case, a high percentage of calories from sugar or saturated fat.

*$p < 0.05$

## Table 12:

Percent change[a] in the share of calories from each food group of U.S. household packaged food purchases (PFPs)[b] associated with changes in state policies, 2008-2017

| | **Fruits**[c] | **NS**[d] **Vegetables** | **Processed Meats** | **Mixed Dishes** | **SSBs**[e] | **Desserts and Snacks** |
|---|---|---|---|---|---|---|
| ***Policies expected to be associated with healthier PFPs*** [f] | | | | | | |
| Healthy Food Retail Policy β (*95% confidence interval*) | 0.1 *(−0.9, 1.0)* | 0.3 *(−0.5, 1.1)* | 0.1 *(−0.5, 0.8)* | −0.7* *(−1.3, −0.1)* | 0.4 *(−.0.5, 1.4)* | 0.4* *(0.0, 0.7)* |
| SNAP[g] eligibility | −0.3 *(−1.4, 0.8)* | 0.2 *(−0.6, 1.0)* | −0.2 *(−1.0, 0.6)* | −0.2 *(−0.09, 0.5)* | 0.0 *(−1.2, 1.0)* | 0.0 *(−0.4, 0.4)* |
| WIC[h] coverage | −0.1 *(−0.3, 0.1)* | −0.2* *(−0.3, 0.0)* | 0.2** *(0.0, 0.3)* | −0.1 *(−0.2, 0.0)* | 0.0 *(−0.2, 0.2)* | 0.0 *(0.0, 0.1)* |
| Medicaid Expansion | −0.3 *(−2.4, 1.7)* | 0.7 *(−0.8, 2.3)* | 0..3 *(−1.1, 1.8)* | −0.7 *(−1.9, 0.6)* | −3.7** *(−5.7, −1.6)* | 0.6 *(−0.2, 1.3)* |
| Minimum Wage | 1.8** *(0.6, 3.2)* | −1.4** *(−2.4, −0.4)* | 0.0 *(−0.9, 1.0)* | 0.5 *(−0.3, 1.3)* | −0.3 *(−1.6, 1.0)* | 0.2 *(−0.3, 0.7)* |
| Proportion of EITC[i] | −0.1** *(−0.1, 0.0)* | 0.1** *(0.0, 0.1)* | 0.0 *(0.0, 0.1)* | 0.0 *(0.0, 0.1)* | −0.1* *(−0.1, 0.0)* | 0.0 *(0.0, 0.0)* |
| Expenditures on higher education ($1,000/ capita) | −5.4 *(−13.5, 3.7)* | 4.8 *(−2.1, 12.4)* | 2.7 *(−3.5, 9.3)* | −0.6 *(−6.1, 5.1)* | 0.3 *(−8.2, 9.6)* | 1.5 *(−1.6, 4.8)* |
| Expenditures on welfare and housing ($1,000/capita) | −1.0 *(−3.8, 1.9)* | 4.2*** *(1.9, 6.8)* | −0.5 *(−2.7, 1.6)* | −0.6 *(−2.5, 1.4)* | −3.9* *(−6.7, −0.8)* | 0.6 *(−0.6, 1.8)* |
| ***Policies expected to be associated with less healthful PFPs*** [j] | | | | | | |
| Preemption: Food Retail | 1.0 *(−2.9, 5.0)* | −1.0 *(−3.7, 1.8)* | −0.4 *(−2.8, 2.1)* | 1.0 *(−1.3, 3.2)* | 0.2 *(−3.3, 3.9)* | 0.6 *(−0.7, 1.8)* |
| Preemption: Labor Laws | −0.2 *(−0.8, 0.4)* | 1.4*** *(0.9, 1.9)* | −0.4 *(−0.8, 0.1)* | 0.5* *(0.1, 0.9)* | 1.2*** *(0.6, 1.8)* | 0.1 *(−0.1, 0.3)* |

[a] Multilevel models control for household-level characteristics, year and include state fixed effects. All GLM models were generated using a log link. Estimates were exponentiated for interpretability. Therefore, beta-coefficients should be interpreted as the percent change in the outcome for an increase of one unit of each variable (see Figure 2 online only for details on policy variable coding). Outcomes were calculated as a percent of total calories. For example: A $1 increase in a state's minimum wage is associated with a 1.8% increase in fruit purchases as a share of total calories purchased. Estimates are presented with 95% confidence intervals (which were also exponentiated and converted to percent change).

[b] Authors' calculations based in part on data reported by Nielsen through its Homescan Services for all food categories, including beverages and alcohol for the 2008-2017 periods across the U.S. market. The Nielsen Company, 2019. The conclusions drawn from the Nielsen data do not reflect the views of Nielsen. Nielsen is not responsible for and had no role in, and was not involved in, analyzing and preparing the results reported herein.

[c] All food groups are modelled in units of calories purchased per capita per day.

[d] NS: Non-starchy

[e] SSBs: Sugar-sweetened beverages.

[f] A healthier purchasing pattern was expected to be higher in fruit and vegetable PFPs but lower in food groups to limit and nutrients of concern. Therefore, these policies were expected to be positively associated with fruits and vegetables and negatively associated with all other outcomes.

[g]SNAP: Supplemental Nutrition Assistance Program

[h]WIC: Special Supplemental Nutrition Assistance Program for Women, Infants, and Children

[i]EITC: Earned Income Tax Credit

[j]These policies were expected to be negatively associated with fruits and vegetables and positively associated with all other outcomes reflecting foods and nutrients to limit.

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$