Cross-sector analysis of socioeconomic, racial/ethnic, and urban/rural disparities in food policy enactment in the United States

ABSTRACT

We examined racial/ethnic, socioeconomic, and urban/rural disparities in food policy enactment across different sectors, as well as retail food access, throughout the United States. Policy and retail food store data were obtained from 443 communities as part of the Bridging the Gap Community Obesity Measures Project. Our results indicated that median household income was inversely associated with healthier retail food zoning policies in Hispanic communities, where competitive food policies for schools were also healthier and mean fruit/vegetable access in stores was higher. In contrast, income was positively associated with healthier retail food zoning in rural communities, where competitive food policies were weaker. Black communities had low scores across all policy domains. Overall, Hispanic communities had the strongest food policies across sectors. Barriers to policy adoption in both rural and Black communities must be explored further.

KEYWORDS: policy; disparities; race/ethnicity; nutrition; socioeconomic status

INTRODUCTION

Racial/ethnic, socioeconomic, and geographic disparities in childhood obesity have persisted in the United States (U.S.) for decades (Wang and Beydoun, 2007). The prevalence of childhood obesity rose substantially in all socio-demographic groups from 1980 to 2000 (Ogden et al., 2002) but has consistently been highest in racial/ethnic minority, low-income, and rural populations (Wang and Beydoun, 2007; Johnson and Johnson, 2015). Though overall prevalence has stabilized since 2000 (Ogden et al., 2016), some studies reported that disparities in childhood obesity have worsened in recent years (Datar and Chung, 2015; Frederick et al., 2014). Disparities in obesity-related diseases such as diabetes have also grown in recent years (Geiss et al., 2014).

These trends have taken place even as federal, state, and local policymakers in the U.S. have implemented several initiatives to target environmental determinants of obesity (Institute of Medicine, 2012). Schools, for example, were an early target of policy change due to the widespread prevalence of high-calorie 'competitive foods' – i.e., foods and beverages that are sold in school outside of federal school meal programs (Larson and Story, 2010). Other initiatives have been promoted to target environmental determinants outside of school, such as zoning codes (Holzman, 2010), menu labels (Swartz et al., 2011), and sweetened beverage taxes (Powell et al., 2013).

There is growing evidence that policies, particularly in schools (Chriqui et al., 2014), may improve the food environment, diet, or obesity in the general population, but evidence is more limited in disadvantaged communities. Several studies reported no evidence that individual policy initiatives in specific sectors improved diet or reduced obesity in disadvantaged

communities. Studies in New York City (Elbel et al., 2015), Philadelphia (Cummins et al., 2014), Pittsburgh (Dubowitz et al., 2015), and Los Angeles (Sturm and Hattori, 2015), for example, each reported that policies to improve the neighborhood food environment had little, if any, impact on diet or obesity in disadvantaged communities. Another study reported that California's competitive food law changes were associated with declines in obesity prevalence in high-income areas but not low-income areas (Sanchez-Vaznaugh et al., 2015). It is impossible to generalize why policies have been ineffective in disadvantaged communities because the studies differed in many ways (e.g., location, study design, policy of interest, outcomes of interest.) However, the consistently null results raise questions as to why these patterns are occurring.

One potential explanation, which several authors suggested, is that isolated policies have not been complemented by changes in other sectors. Obesity experts generally agree that so single policy or program is sufficient to reduce obesity (Hawkes et al., 2015; Institute of Medicine, 2012). Isolated changes in one sector (e.g., schools) may be ineffective if not reinforced by complementary changes in other sectors (e.g., neighborhood food environment) . The World Cancer Research Fund International's NOURISHING framework identified a wide range of policies in different domains that are needed to reduce obesity (Hawkes et al., 2013). Public health experts have also advocated for a "Health in All Policies" approach in which various agencies and sectors must collaborate to address social and economic factors that cause health inequity (Rudolph et al., 2013).

In practice, coordinated change is complicated because different policies are designed and implemented by different agencies (e.g., education, housing) at different governing levels, and they face different political and logistical constraints. On a global level, obesity experts have

characterized policy change as "patchy" because cross-sector change is rare (Roberto et al., 2015). European health researchers have also discussed the challenges of implementing a "Health in All Policies" approach (Koivusalo, 2010).

To achieve the goal of cross-sector policy change, public health researchers and practitioners must understand the extent to which such changes are currently taking place, and whether different types of communities face different barriers to change. If disadvantaged communities are less likely to enact changes across sectors, then isolated policies described earlier may be particularly ineffective in disadvantaged communities.

To our knowledge, no study has examined disparities in policy implementation across multiple sectors. Several studies have reported disparities in implementation, but only in specific sectors (Jilcott Pitts et al., 2015; Nanney et al., 2013; Taber et al., 2011; Taber et al., 2015). Thus, this study was designed to determine if enactment of food-related policy across sectors varied by racial/ethnic composition, SES, and urbanicity. We examined multiple sectors individually and in combination. We also compared patterns of disparity in policy enactment to patterns of disparity in other environmental food measures (e.g., fruit/vegetable access).

METHODS

This repeated cross-sectional study utilized three years of data on competitive food policies, permitted use food zoning policies, and retail food stores, collected as part of the Bridging the Gap Community Obesity Measures Project (BTG-COMP). The study was a community-level analysis that did not include any human subject data. All data were objectively measured by BTG-COMP research staff. Specific measures are described in more detail below.

Data source – BTG-COMP

BTG-COMP investigators and research staff collected policy and environmental data from a national sample of communities across 46 states over a 3-year period, 2010-2012. For the purpose of this study, analyses were restricted to 443 communities in which complete data on food policy and food store measures were obtained (from an original sample of 471 communities). Data collection was conducted in conjunction with Monitoring the Future (MTF), an annual, nationally representative study of 8th, 10th, and 12th grade students. A multi-stage sampling procedure was used to select schools at each grade level; for each school, a catchment area was defined as the area from which the school drew the majority of its student population. This study utilized the second-year half sample of traditional public schools (i.e., neighborhood schools) participating in MTF. Each policy measure that was used in this study represents either the respective school district or catchment area (hereafter referred to as "community") of a MTF school. Further details on the MTF sampling procedure are provided elsewhere (Johnston et al., 2014).

Policy data

This study focused on 3 indices of school or community food policies – the competitive food policy index (CFPI), the healthy food zoning index (HFZI), and the modified retail food zoning index (MRFZI). These measures were purposely selected to represent different initiatives that have been promoted to target different environmental determinants of obesity in different sectors. Each index was measured on a 0-100 scale, with higher scores indicative of healthier policies. The measures were developed using data collected as part of BTG-COMP.

The CFPI was a measure of the strength of district-level competitive food and beverage provisions included in the congressionally-mandated school district wellness policies. Strength was determined by assessing the proportion of competitive food and beverage-related items (out of 57) that were definitively required in a given district's policy. The measure built on the original strength score developed by Schwartz et al., who had assessed strength of a series of location restrictions and nutrient standards across locations of sale (Schwartz et al., 2009). Our measure assessed the strength of 12 overarching provisions as well as 15 nutrient-specific standards for each of 3 locations of sale where most competitive food items are purchased at the secondary school level (i.e., vending machines, school stores, and a la carte lines) (Chriqui et al., 2013; Terry-McElrath et al., 2012). Supplementary Table 1 lists the items that were included, and which focused on items sold or made available outside of the cafeteria (e.g., freely accessible water). Policy data were compiled from hard copies of written policies obtained from internet searches and direct communication with public school districts where the study communities were located. Policies were double-coded and analyzed by 2 trained researchers using an adapted version of a coding scheme developed by Schwartz et al. (Schwartz et al., 2009), as described elsewhere (Chriqui et al., 2013).

The HFZI was a measure of the number of "healthy food outlets" (HFOs) that were permitted in the community based on municipal, township, and county-level zoning policies in jurisdictions that overlapped the community, including permitted, conditional, and accessory uses. Policies were collected and coded by trained policy analysts, who obtained the policies from government agencies either online or by mail from various offices (e.g., planning and zoning department). HFOs included supermarkets, farmers markets, fruit/vegetable stands, and

fruit/vegetable carts. Because this study focused on policies aimed at childhood obesity, the number of permitted HFO types in each jurisdiction was weighted according to the proportion of the overall community population age 0-17 years located in that jurisdiction, and then summed to the community level. The weighted count was divided by 4, the maximum value, and multiplied by 100 to create a 0-100 scale.

The MRFZI represented the percentage of all food outlet permitted use zoning that was for HFOs, analogous to the modified retail food environment index (National Center for Chronic Disease Prevention and Health Promotion, 2011). The numerator for the MRFZI was the number of HFOs that were permitted by zoning; the denominator was the sum of HFOs and non-HFOs that were permitted through zoning. Non-HFOs included fast food restaurants, convenience stores, grocery stores, mobile food vendors, and general retail stores. Like the HFZI, the MRFZI was weighted according to the proportion of the overall community population age 0-17 years located in that jurisdiction, and then summed to the community level.

Environmental data

Within each community, retail food store locations were initially obtained through Dun & Bradstreet and InfoUSA business listings, which were combined and deduplicated before telephone screening for eligibility. The remaining outlets were classified into three store type strata: supermarkets, grocery stores, and limited-service stores (convenience stores, specialty stores, liquor stores, pharmacies, dollar/discount stores, general merchandise stores, and produce markets.) A stratified random sample of stores was selected for observation in each community. Utilizing a half-open interval sampling approach, additional stores not in the initial frame were

sampled in the field by trained coders to compensate for business list errors and undercoverage that were observed in pilot validation studies (Han et al., 2012; Powell et al., 2011). In each community, an estimate of the total number of food stores was used to determine the number of additional stores to sample in each strata during field data collection; coders identified additional stores during routine data collection based on the supermarket, grocery, and limited service store type definitions. Stores sampled in the field that did not meet study criteria were excluded.

Food stores were measured through direct observation by trained field staff, using the BTG-COMP Food Store Observation Form, the development and testing of which has been described elsewhere (Rimkus et al., 2013). For our purpose, the food store measures of interest were: 1) the count of fresh fruits and vegetables sold; 2) the count of total fruits and vegetables sold (fresh, frozen, canned); and 3) the relative availability of "healthy" versus "unhealthy" items, using the same measure of relative healthy food access previously used by Zenk et al (Zenk et al., 2014). Relative healthy food access was calculated as a ratio of healthier formulations of products sold in stores versus matched, less healthy items. The less healthy food items included whole milk, full-fat cheese, high-sugar cereal, white bread, potato chips, fruit drink (less than 50% juice), and regular soda. Healthy alternative items were based on recommendations from the dietary guidelines (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2010) and included low-fat milk (skim or 1%), low-fat cheese (labeled as low fat, reduced fat, or made with 1%, or 2% milk), low-sugar cereal (less than 6 grams of sugar per serving), 100% whole wheat bread, baked or low-fat potato chips (less than 4 grams of fat /1 oz serving), 100% orange juice, and diet soda.

Demographic Measures

Measures of community racial/ethnic composition and median household income were obtained from the American Community Survey, an ongoing survey conducted by the US Census Bureau. Five-year estimates at the block group level, based on 2007-2011 data, were aggregated to the catchment level. Catchment area measures of race/ethnicity, as described in MTF (Johnston et al., 2014), were used for all analyses except competitive food policy analyses, for which we used district-level estimates of racial/ethnic composition obtained from the National Center for Education Statistics Common Core of Data. In competitive food analyses, we explored using the proportion of students who were eligible for free/reduced-price lunches as a measure of SES, in lieu of median household income, but found that results were substantively similar. Measures of urbanicity were based on locale codes obtained from the National Center for Education Statistics Common Core of Data, which were collapsed from twelve urban-centric locale codes to 3 categories as follows: cities were urban; suburbs and distant and fringe towns were suburban; and remote towns and rural areas were rural.

Statistical analyses

The analysis was designed to estimate disparities in policy and environmental measures between communities with different socio-demographic characteristics. All analyses adjusted for year of data collection and were weighted to account for the complex sampling design of BTG-COMP.

All analyses utilized general linear regression models, though exact model specification depended on the distribution of the outcome. Analyses of policy index measures used a gamma

distribution and log link, whereas analyses of food store access used a Gaussian distribution and identity link. To make results more consistent and interpretable, we used the 'margin' command in Stata, Version 13, to estimate the average marginal effect (AME). The AME represents the average difference in the dependent variable associated with socio-demographic variables of interest – i.e., racial/ethnic composition; urbanicity (urban, suburban, rural); and median household income.

Additionally, we tested for interactions between different socio-demographic predictors. In several models, we found statistically significant interactions between median household income and other predictors ($p<0.05$), and therefore all analyses of median household income were repeated after stratifying by predominant race/ethnicity and urbanicity. Predominant race/ethnicity was based on whether the community was at least 66.7% non-Hispanic White, 50% non-Hispanic Black, 50% Hispanic, or "other" (i.e., racially/ethnically mixed) if it met none of the first three criteria (O'Malley et al., 2007). In stratified analyses, communities were grouped into 6 categories – 1) urban and non-Hispanic White, 2) suburban and non-Hispanic White, 3) rural and non-Hispanic White, 4) non-Hispanic Black, 5) Hispanic, and 6) Other racial/ethnic composition. The last 3 categories were not divided by urbanicity due to their small sample sizes (n=17, 26, and 101, respectively). Nearly all Hispanic and non-Hispanic Black communities were located in urban or suburban areas.

After estimating disparities in individual policy measures, we analyzed whether communities with different socio-demographic characteristics were more likely to focus on particular sectors (i.e., competitive food policies versus permitted use zoning). Communities were cross-classified according to whether their CFPI and MRFZI scores were above the sample

median. This created four potential categories: 1) low CFPI score and low MRFZI score; 2) high CFPI score and low MRFZI score; 3) low CFPI score and high MRFZI score; 4) high CFPI score and high MRFZI score. A multinomial logistic regression model was used to determine if different types of communities were more likely to fall into a particular category, using "low CFPI and low MRFZI" as the base category.

RESULTS

Table 1 presents mean policy index scores overall and by socio-demographic characteristics. Mean CFPI, HFZI, and MRFZI scores were only 20.0, 34.5, and 21.8 (out of a theoretical maximum of 100), respectively. Distributions of each score included several zeros and were positively skewed – e.g., 14.0% of districts had CFPI scores equal to zero and only 7.1% had CFPI scores greater than 50. The maximum CFPI, HFZI, and MRFZI scores were 79.6, 100, and 66.3, respectively. Each index tended to be higher in predominantly Hispanic or urban areas. Differences by income measures were less consistent; the CFPI was generally equal across quintiles of median household income, whereas the HFZI and MRFZI tended to be higher in areas with greater income.

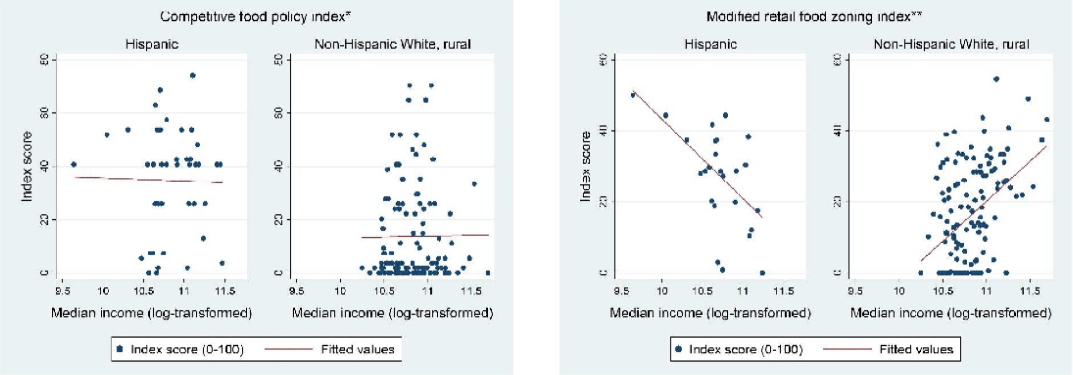
These results are echoed in Table 2, which shows adjusted differences in index scores associated with socio-demographic characteristics. Estimates in Table 2 represent the absolute difference in policy index scores associated with a 1-unit change in continuous measures (e.g., log-adjusted median household income) or relative to the reference category for categorical measures (e.g., suburban or rural areas compared to urban areas). The top half of Table 2 represents results from the total sample, and the bottom half represents the results for median

household income, stratified by racial/ethnic composition and urbanicity.

Each policy index measure varied by one or more socio-demographic characteristics, but the magnitude and direction of associations varied considerably across measures. In the total sample, CFPI scores did not vary by median income, whereas HFZI and MRFZI scores were positively associated with median income. The associations between zoning scores and income differed substantially by sub-group, however. The positive association between zoning scores and income was particularly pronounced in White, rural communities, whereas MRFZI scores and income were inversely associated in Hispanic communities. Communities with a higher proportion of Hispanics also tended to have higher CFPI scores, regardless of median household income. Suburban and rural areas tended to have lower scores across all policy domains, relative to urban communities, adjusted for median household income and race/ethnicity.

Figure 1 illustrates the striking difference in the association between household income and different policy index measures across different communities. The left side illustrates how Hispanic communities, on average, had healthier competitive food policies than non-Hispanic White rural communities, regardless of median income. The right side illustrates how income was inversely associated with MRFZI in Hispanic areas – i.e., low-income Hispanic areas had a higher proportion of HFOs permitted, among all food outlets, relative to high-income Hispanic areas – whereas income was positively associated with MRFZI in non-Hispanic White, rural areas. Collectively, the results in Table 2 and Figure 1 suggest that Hispanic communities had the healthiest policies across sectors, particularly in low-income areas, whereas low-income rural areas had the least healthy policies across sectors.

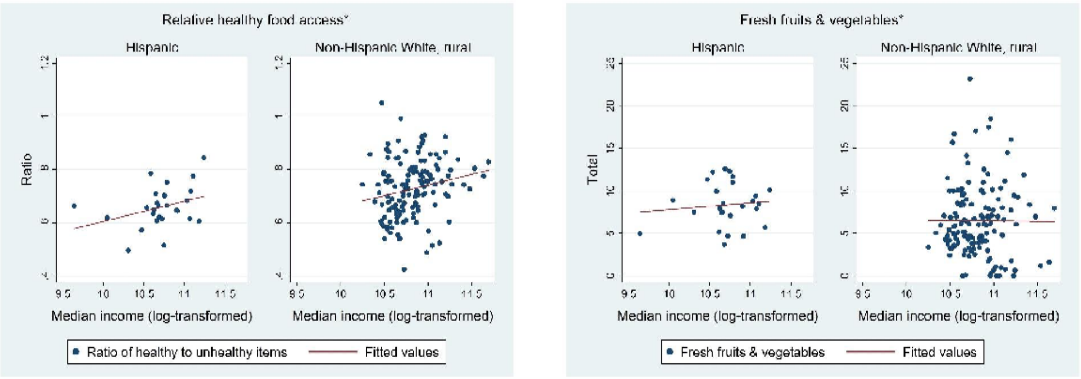
Figure 1. Unadjusted associations between median household income and food policy index measures, by demographic sub-group



* Hispanic: n=43; non-Hispanic White, rural: n=127
** Hispanic: n=26; non-Hispanic White, rural: n=149

Table 3 displays associations between community socio-demographic measures and the food store environment. Higher-income areas tended to have a higher ratio of healthy to unhealthy items in stores across all demographic sub-groups. As shown in the Supplementary Figure, the correlation was more decidedly linear than the correlation between income and policy measures in Figure 1. Results for fruits and vegetables were more mixed. Again, higher-income areas tended to have more fresh fruits and vegetables, but this association was less pronounced in rural areas. The proportion of Hispanics was positively associated with fresh fruit/vegetable access in food stores, controlling for median household income and urbanicity.

Supplementary Figure. Unadjusted associations between median household income and retail food access, by demographic sub-group



* Hispanic: n=26; non-Hispanic White, rural: n=149

Due to space constraints, results of the multinomial regression model are not presented in tables. (Specific results are available upon request). Briefly, suburban and rural areas were less likely to have above-median scores for both the CFPI and MRFZI, relative to urban areas (p=.003 and .01, respectively). Conversely, communities with more Hispanic residents were more likely to have above-median scores for both the CFPI and MRFZI (p=.02). Nearly two-thirds of predominantly Hispanic communities had above-median scores in both domains (63.8%), whereas only 10.9% of non-Hispanic White, rural communities and 28.4% of non-Hispanic Black communities did so.

DISCUSSION

Global public health experts have encouraged leaders to adopt a broader framework of policy domains that can reduce the persistently high prevalence of childhood obesity (Institute of

Medicine, 2012; Roberto et al., 2015). A multi-pronged approach is likely necessary to reduce both the overall prevalence and socio-demographic disparities in childhood obesity. To our knowledge, this was the first study to estimate the degree to which policy changes have taken place across multiple sectors in the general U.S. population, and whether cross-sector change is more or less common in sub-groups that suffer from higher obesity prevalence.

The most encouraging signs of progress were observed in predominantly Hispanic communities. Such areas tended to have stronger competitive food policies overall, more fruit/vegetable access overall, and healthier food permitted use zoning in low-income areas. The inverse association between income and healthy food permitted use zoning was particularly encouraging given that low-income communities tend to face many structural barriers to healthy food (Lovasi et al., 2009). Hispanic communities were also more likely to have above-median scores in multiple sectors – i.e., competitive food policy index and modified retail food zoning index. Collectively, the retail food environment and policies in Hispanic communities were designed to support healthy eating more than in other communities. With that said, low-income Hispanic communities still had low relative healthy food access and low prevalence of healthy food zoning. Factors such as these may partially explain why obesity disparities persist in Hispanic communities. Research must continue to examine whether modest encouraging signs that have taken place ultimately translate into healthier trends in obesity and related diseases among Hispanics. Future studies might also explore local or cultural factors that accounted for Hispanic communities having healthier policies and higher fruit/vegetable access than other communities.

In contrast, there was no sector in which non-Hispanic Black communities tended to have

higher scores than non-Hispanic White communities, nor was there any food store measure that was healthier in non-Hispanic Black communities. It is important to consider whether the causal mechanisms that underlie disparities in policy enactment may differ from mechanisms that underlie other disparities, including food store measures. Our results suggest that the latter may be largely attributable to income, which was highly correlated with food store measures, as previously reported (Zenk et al., 2014). Conversely, non-Hispanic Black communities tended to have low policy scores regardless of median household income, particularly relative to Hispanic communities. Disparities in policy enactment may be due to structural factors beyond household income or other individual characteristics (Krieger, 2012). We can only speculate about the mechanisms here; regardless, however, these results are troubling given that racial disparities in childhood obesity between non-Hispanic Blacks and Whites have grown for decades, particularly among girls, and shown no signs of receding (Ogden et al., 2016).

This study also raised important questions of whether low-income rural areas are an overlooked population. Rural areas consistently have higher obesity prevalence than urban areas (Johnson and Johnson, 2015), but they have not received as much attention from researchers or policymakers. The lack of attention was reflected in our results, as rural areas tended to have lower policy scores for both competitive foods and healthy permitted use zoning. Rural communities, like all areas, had a strong, positive association between income and relative healthy food access, but unlike Hispanic communities (which tended to be in urban or suburban areas), income was also positively associated with healthy permitted use zoning. In short, zoning codes in rural areas were not helping to address economic disparities that existed there. Residents in rural areas are likely to face different barriers to healthy food access compared to their urban

and suburban counterparts. Johnson et al. identified many policy research needs for rural areas, including economic development and barriers to food assistance programs (Johnson et al., 2014). A systematic review of nutrition policy and environmental strategies in rural areas noted several factors that need to be considered in such communities, such as long distances to food stores, local cultures and food preferences, and the need for strong local partnerships (Calancie et al., 2015). Future research should explore whether these factors are barriers to policy enactment, as well as explore rural residents' perceptions of needs, barriers, and solutions.

From a socioeconomic standpoint, school-based policies have been implemented more equally than zoning policies. This pattern could be interpreted in different ways. It is encouraging that low-income districts, particularly in Hispanic communities, are implementing changes to require healthier competitive foods in schools. However, there is relatively little evidence that unhealthy competitive foods in schools are a source of disparities in obesity. A recent study reported that high-income schools were, in fact, more likely to sell unhealthy foods and beverages than low-income schools (Taber et al., 2015). As discussed earlier, one study found that changes in California competitive food laws were inversely associated with obesity primarily in high-income areas (Sanchez-Vaznaugh et al., 2015). Recent federal changes to competitive food nutrition standards reflect a general consensus that schools are an important target for obesity prevention. However, competitive food policies may have a limited impact on socioeconomic disparities unless they are complemented with healthy zoning policies that, based on our results, were less common in low-income areas.

This study was the first to comprehensively analyze racial/ethnic, socioeconomic, and urban/rural disparities in food-related policies across multiple sectors in a national sample.

Nonetheless, several limitations should be considered. Foremost, our analyses did not include measures of dietary consumption or weight status, so it is unknown whether policy disparities translated into disparities in health outcomes. In the scope of this study, we could only analyze selected policy domains; future studies should explore domains such as beverage taxes or restricted use zoning. The sample sizes for Hispanic and non-Hispanic Black communities were very small, which precluded us from stratifying by urbanicity, reduced the statistical power for analyses of these groups, and inevitably gave more statistical leverage to communities with unusually high scores. Hispanic communities also tend to cluster in specific states such as California and Texas, and therefore results in this sub-group may have been influenced by state factors. The measure of relative healthy food access was also limited to a small number of products that had a "healthy" and "unhealthy" version, and even "healthy" items such as diet soda are not the optimal products that policies strive to promote. Finally, the sample was designed to represent communities where public school students in 8^{th}, 10^{th}, and 12^{th} grade resided, and therefore results cannot be generalized to other communities.

CONCLUSION

The results of this study echo previous reports that described a patchwork of policies that have been implemented to reduce obesity (Roberto et al., 2015). Cross-sector change has been widely advocated as a strategy for reducing obesity and health inequity, yet it has not occurred in many of the most disadvantaged communities in the U.S. The most promising signs of progress in the U.S. have occurred in Hispanic communities, where stronger policies have been implemented in multiple sectors. The least promising data were observed in non-Hispanic Black

communities and rural communities that tend to have the highest prevalence of childhood obesity. Other countries have reported similar challenges with cross-sector policy implementation and urged leaders to explore different strategies (Koivusalo, 2010). Researchers, advocates, and policymakers in the U.S. need to likewise examine barriers to cross-sector policy adoption in disadvantaged communities to determine the optimal way to promote community-wide change.

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