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Nutritional quality of food purchases during the COVID-19 public health crisis: An analysis of geographic disparities in North Carolina

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ABSTRACT

Objective: To examine geographic disparities in the nutritional quality of food purchases during the COVID-19 public health crisis in North Carolina (NC).
Methods: Using shopper-level longitudinal transaction records between October 2019– and December 2020 from NC's largest grocery retailer, we fit mixed-effect models to examine disparities in the nutritional quality of food purchases among shoppers in counties with different levels of socioeconomic development and how such disparities changed after March 2020, accounting for other observed and contextual factors.
Results: Shoppers in counties with lower development levels purchased a larger share of calories from least healthy foods and a smaller share from healthier foods compared to shoppers in counties with higher development levels. These disparities were slightly attenuated for the least healthy foods and did not change for healthier foods after the onset of the COVID crisis.
Conclusion: Despite existing nutritional disparities among shoppers in counties with different levels of socioeconomic development, we did not observe a large-scale accentuation of inequities in dietary quality during the COVID-19 crisis. This pattern may have resulted from programmatic responses to mitigate the adverse effects of the COVID crisis on vulnerable populations. Future work should further explore the role of such responses.

1. Introduction

The COVID-19 pandemic caused lockdowns, business closures, and economic uncertainties around the world that greatly impacted consumer behaviors. A growing body of evidence has explored the effects of this public health crisis on dietary behaviors due to factors such as confinement, stress, loss of employment, restaurant closures, and supply-chain disruptions (Alabi and Ngwenyama, 2022; Mignogna et al., 2022). Studies from around the world document heterogeneous effects: while increased snacking, consumption of comfort foods, and decreased consumption of fresh produce were detrimental to diet quality, increased opportunities for home cooking and decreased fast-food consumption also led to diet quality improvements in certain instances (Bennett et al., 2021; Zupo et al., 2020; Mekanna et al., 2023).

In the US, the crisis created by COVID-19 also led to heterogeneous effects, with increases in the intake of both unhealthy and healthy foods (Bhutani et al., 2021; Chen et al., 2021). However, these dietary changes do not seem to have been evenly distributed across the population. Food insecurity, which is associated with lower diet quality (Hanson and Connor, 2014; Leung et al., 2014; Morales and Berkowitz, 2016), increased among certain population groups, including non-Hispanic Black households and households with children, especially those whose members lost employment (Coleman-Jensen et al., 2020; Dubowitz et al., 2021; Fan et al., 2022; Niles et al., 2020; Wolfson and Leung, 2020). Supply chain issues also disrupted food access in socially vulnerable areas (Cardarelli et al., 2021; Heuer et al., 2020). Cross-sectional evidence shows disparities in markers of deteriorating diet quality among those who experienced food insecurity (Bin Zarah et al., 2020; Byker Shanks et al., 2022; Jackson et al., 2022; Litton and Beavers, 2021; Wolfson et al., 2022), certain racial and ethnic minorities (Cohen et al., 2022), and those experiencing higher levels of stress (Khubchandani et al., 2020). Concerns about job security and greater health

Abbreviations: EBT, Electronic Benefit Transfer; FVLN, fruits, vegetables, legumes and nuts; NC, North Carolina; P-EBT, Pandemic Electronic Benefit Transfer; SNAP, Supplemental Nutrition Assistance Program; SSB, Sugar-sweetened beverage; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

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risks were also associated with a higher likelihood of engaging in food stockpiling (Amaral et al., 2022; Lin et al., 2021).

Few studies have used longitudinal data to assess disparities in dietary patterns during the COVID-19 crisis. Additionally, to our knowledge, no studies have assessed whether disparities in diet quality during this period varied based on geography. Geographic disparities in access to healthier foods and exposure to less healthy foods during regular times are well-documented in the US, such that the food environment negatively influences diet quality in areas with lower socioeconomic status and higher levels of racial segregation (Cooksey Stowers et al., 2020; Powell et al., 2007; Walker et al., 2010). The COVID-19 pandemic may have exacerbated these negative influences, especially given that areas with higher social vulnerability, poverty rates, and racialized economic segregation were more likely to experience higher COVID burdens (Jackson et al., 2021; Tan et al., 2020; Tipirneni et al., 2022). In turn, the severity of local COVID conditions was associated with a higher likelihood of individuals experiencing food insecurity (Park et al., 2022).

This study examined geographic disparities in the nutritional quality of food purchases in North Carolina (NC) during the first months of the COVID-19 public health crisis. In March 2020, the state closed schools, restaurants, bars, and issued a stay-at-home order (NC COVID-19, n.d). In April, as many states implemented lockdowns and unemployment soared throughout the country, the federal government issued economic impact payments to most households (Cox et al., 2022). NC's stay-at-home order ended on May 20th and a partial reopening process ensued (NC COVID-19, n.d.). Throughout the year, NC residents also benefitted from expanded eligibility requirements for the state's unemployment insurance program, benefit extensions after the exhaustion of the program's regular limit, and supplemental benefit amounts (NC Department of Commerce, n.d.). For those not eligible for the state's unemployment insurance, the federal government offered benefits through the Pandemic Unemployment Assistance program (US Department of Labor, n.d.). Additionally, in December 2020, the federal government issued a new round of economic impact payments (Cox et al., 2022).

Food-specific responses to the COVID-19 crisis were also implemented throughout the year. Starting in mid-March, the federal government approved emergency allotments and made adjustments to food assistance programs: the Supplemental Nutrition Assistance Program (SNAP) suspended work requirements and offered beneficiaries the maximum benefit amount allowed for their household size (Rosenbaum et al., n.d.); the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) allowed agencies to issue benefits remotely (United States Department of Agriculture, 2020a) and waived physical presence test requirements (United States Department of Agriculture, 2020b); and a new program, Pandemic EBT (P-EBT), provided financial assistance for grocery purchases while schools were closed to households whose children receive free or reduced-price meals at schools (NC Department of Health and Human Services, 2020). Community and charitable organizations also stepped up to fill gaps with direct food distributions (Hege et al., 2021).

In this context, we used purchase data from NC's largest grocery store chain to examine changes in county-level disparities in the purchases of food categories of public health relevance, adjusting for the use of benefits from nutrition assistance programs and other observed contextual factors.

2. Methods

2.1. Study design

Data for this retrospective longitudinal study consisted of transaction records from the largest grocery chain in NC, which has approximately 500 stores located across the state. Transactions were linked to frequent shopper numbers (IDs), which are available to all who shop at this retailer and used to access store discounts. The retailer had a total of 5.4 million frequent shopper IDs registered in NC between October 2019 and December 2020. As reference, NC's total population was 10.4 million in 2020 (U.S. Census Bureau, n.d.).

Our initial sample included all shopper IDs that made at least one purchase every month during the study period. Because of the frequency of such shoppers' purchases, we believe that they were more likely to be doing a larger share of their grocery shopping at the retailer in question than more casual shoppers. From this initial sample, we excluded outliers whose monthly expenditures were at the top 1 %, since these were potentially engaging in non-representative bulk buying (e.g., cashiers using their own shopper IDs to help customers without shopper IDs access discounts).

The dataset contained information about each shopper ID's transactions: products purchased, shopping episodes, purchase location (store), and use of SNAP or WIC for payment. No other individual-level information about shoppers was available. The University of North Carolina at Chapel Hill's Institutional Review Board did not consider this study of deidentified data to be human-subjects research.

2.2. Data analysis

We aggregated each frequent shopper ID's transactions monthly for the period of interest. Products purchased were first classified as food or nonfood items; food items were then linked to nutrition facts panel information using a previously established approach (Slining et al., 2013) and further classified into previously established policy-relevant categories (Grummon and Taillie, 2017). For this study, we grouped food items classified as sugar-sweetened beverages (SSBs), desserts, sweet snacks, candy, chocolate, gums, sweeteners, toppings, salty snacks, or processed meats and seafood as the least healthy foods category. In turn, we grouped fruits, vegetables, legumes, and nuts (FVLN) as the healthier foods category. Our outcomes were the share of total calories purchased from least healthy foods and from FVLN. To obtain these measures, we used products' calorie information from their linked nutrition facts panels, calculated the number of calories purchased by each shopper ID from foods in each category, and divided these by the total number of calories from all food products purchased (including foods that did not belong in either the least healthy foods or the FVLN categories).

We were interested in changes to purchase patterns between March and December 2020 compared to October 2019 to February 2020. To examine such changes, we modeled months in the dataset as indicator variables, using February 2020 as the referent month. These specifications allowed us to more accurately model the data given the relatively short span of the pre-COVID period, the lack of linearity observed in purchases over the time period, and our inability to control for seasonality between January and September 2020. As a sensitivity analysis, we estimated a model with linear trends including only the periods that overlapped pre-COVID and during COVID in our dataset (i.e., October-December 2019 and October-December 2020) to control for seasonality.

All geography-related variables were based on shopper IDs' monthly top store – i.e., the store where they spent the largest dollar amount for the month. To analyze whether the COVID-19 crisis exacerbated disparities in the nutritional quality of food purchases, we stratified the sample based on the NC Department of Commerce's County Development Tiers. This measure classifies counties into three tiers (where 1 = least developed and 3 = most developed) and is used to determine eligibility and allocate resources for state programs. Classifications consider counties' average unemployment rate, median household income, population growth, and property tax base per capita (North Carolina Department of Commerce, n.d., North Carolina Department of Commerce, n.d). We also interacted development tier indicators with a COVID-period indicator to examine whether changes in purchase patterns of our food categories differed among development tiers after the onset of COVID-19.

Because variability in the severity of COVID-19 across different areas

of NC may have differentially influenced residents' food purchasing behaviors, we adjusted our results for monthly COVID cases in the county where each shopper ID's top store was located. We obtained the number of cases from the COVID-19 Data Repository provided by Johns Hopkins University's Center for Systems Science and Engineering (Dong et al., 2020) and standardized cases per 10,000 inhabitants using county population estimates as of April 1st 2020 from NC's Office of State Budget and Management (Office of State Budget and Management, n.d.).

We also adjusted our results for other observed variables that may have influenced purchasing patterns. To account for the use of SNAP and/or WIC, we used time-varying indicator variables for shoppers who used such programs' EBT cards for grocery purchases during a given month, the month prior, or the month after (for a rolling 3-month period) in the data. We also interacted these variables with the COVID-period indicator to account for programmatic changes after March 2020. Additionally, we included median monthly expenditure per shopping episode on all items in our models to account for possible stockpiling behaviors.

Models included random intercepts for shopper ID to account for repeated measures. All analyses were conducted in Stata/SE version 17.

3. Results

The sample contained 1.24 million unique shopper IDs, representing around 23 % of all shopper IDs available from this retailer within NC. Table 1 reports sample characteristics. Shoppers in the sample made purchases in 496 stores located in 86 of NC's 100 counties between October 2019 and December 2020. Based on each ID's first appearance in the dataset, 21.3 % shopped primarily in a store located in lowest development counties, while 38.9 % shopped in a store located in highest development counties. Additionally, 18.8 % of shoppers were classified as SNAP users, and 4.3 % as WIC users.

Table 1
North Carolina transaction sample characteristics: unique shopper IDs, counties, stores, and mean transaction size per shopping episode (in US$ and calories) by county development tier between October 2019 and December 2020.

	n	%
Shopper IDs	**1,240,668**	**100**
SNAP users†	233,473	18.8
WIC users†	53,678	4.3
Development tier 1 (least)†	264,192	21
Development tier 2†	494,059	39.8
Development tier 3 (most)†	482,417	39
Counties	**86**	**100**
Development tier 1 (least)	33	38.4
Development tier 2	35	40.7
Development tier 3 (most)	18	20.9
Top stores	**496**	**100**
Development tier 1 (least)	116	23.4
Development tier 2	188	37.9
Development tier 3 (most)	192	38.7
	Mean	**SD**
Mean US$ amount spent per shopping episode˘		
Development tier 1 (least)	47.55	53.04
Development tier 2	48.83	53.82
Development tier 3 (most)	46.44	62.85
Mean kcal purchased per shopping episode˘		
Development tier 1 (least)	11,899.13	15,370.47
Development tier 2	11,798.31	14,903.00
Development tier 3 (most)	10,749.02	15,187.51

Note. County Development Tiers are defined by the North Carolina Department of Commerce considering counties' average unemployment rate, median household income, percentage growth in the population, and adjusted property tax base per capita.

† Based on each shopper's first appearance in the dataset.

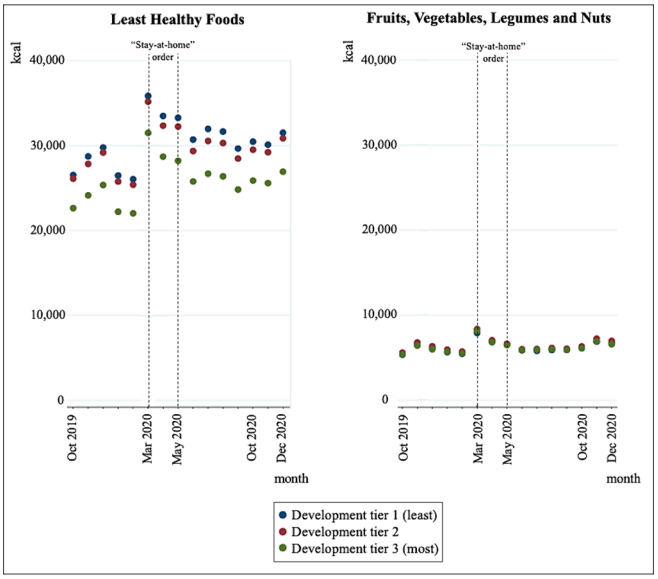
˘ Based on all items purchased per shopping trip across all shoppers and months.

Fig. 1 shows the unadjusted mean number of calories purchased, and Fig. 2, the unadjusted percentage of calories purchased in each county development tier. Figs. 1 and 2 reveal that, both pre-COVID and during COVID, the absolute number and the share of calories coming from least healthy foods was higher and the share of calories coming from FVLN was lower for shoppers in less-developed counties.

Table 2 shows our adjusted results. After an initial decrease in the share of calories coming from least healthy foods in March 2020, we observed an increase above February levels for several months. On the other hand, the share of calories coming from FVLN remained below February 2020 levels for most of the rest of the year.

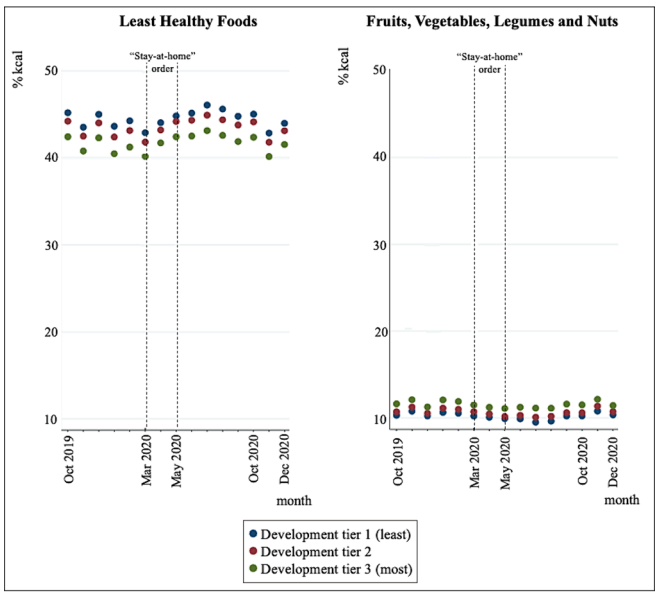
We observed significant disparities in the share of calories coming from least healthy foods among shoppers in different county development tiers before and during the COVID crisis. Before March 2020, purchases of least healthy foods were 0.85 percentage points lower among those in middle-development counties ($p < 0.01$), and 2.14 percentage points lower among those in the highest development counties ($p < 0.01$), compared to those in the lowest development counties. After March 2020, we observed a slight attenuation of these disparities, evidenced by the significant positive interactions between development tiers and COVID period (both $p < 0.01$).

We also observed significant disparities in the share of calories coming from FVLN among shoppers in counties in different development tiers. Purchases of FVLN were 0.26 percentage points higher among those in middle-development counties ($p < 0.01$), and 0.81 percentage points higher among those in the highest development counties ($p < 0.01$), compared to those in the lowest development counties. These disparities did not change significantly after the onset of the COVID-19 crisis, so we did not retain the interactions between development tiers and COVID period in the final model.



Note. County Development Tiers are defined by the NC Department of Commerce considering counties' average unemployment rate, median household income, population growth, and adjusted property tax base per capita

Fig. 1. Mean number of calories (kcal) purchased from least healthy foods and fruits, vegetables, legumes and nuts monthly in North Carolina (by county development tier) between October 2019 and December 2020. Note. County Development Tiers are defined by the NC Department of Commerce considering counties' average unemployment rate, median household income, population growth, and adjusted property tax base per capita.



Note. County Development Tiers are defined by the NC Department of Commerce considering counties' average unemployment rate, median household income, population growth, and adjusted property tax base per capita

Fig. 2. Mean percentage of calories (% kcal) purchased from least healthy foods and fruits, vegetables, legumes and nuts monthly in North Carolina (by county development tier) between October 2019-December 2020. Note. County Development Tiers are defined by the NC Department of Commerce considering counties' average unemployment rate, median household income, population growth, and adjusted property tax base per capita.

Among shoppers who used SNAP in any rolling 3-month period, we observed a reduction in the share of calories purchased from least healthy foods and an increase in the share of calories purchased from FVLN after March 2020, as evidenced by the significant interactions between SNAP use and COVID period (both $p < 0.01$). In turn, among shoppers who used WIC benefits in any rolling 3-month period, we observed an increase in the share of calories purchased from least healthy foods and a reduction in the share of calories purchased from FVLN after March 2020 (both $p < 0.01$).

Our results did not indicate an influence of the number of COVID cases at the county level on the share of calories purchased from our food categories. In turn, increases in shoppers' median monthly expenditure per shopping episode on all items were associated with small decreases in the share of calories purchased from least healthy foods and FVLN (both $p < 0.01$).

Our sensitivity analysis restricting observations to periods that overlapped pre-COVID and during COVID (Table S1) confirmed most of these findings. Disparities observed between shoppers in different county development tiers and shoppers who used food assistance programs followed the same pattern as in our main models, except for the interaction between the highest development tier and COVID period for FVLN, which was null in our main analysis but significant and slightly negative in our sensitivity analysis. Additionally, because this sensitivity analysis included trends, it offered the additional insight that, compared to 2019, the negative trend in calories purchased from least healthy foods became more pronounced in 2020, while the negative trend in calories purchased from FVLN was attenuated and exhibited minimal fluctuations in 2020. These findings suggest that, towards the end of 2020, as COVID-related restrictions loosened and the economy started to recover, diet quality may also have started to recover.

4. Discussion

In this longitudinal study, we examined disparities in purchases of healthier and less healthy food purchases before and after the onset of the COVID-19 crisis in NC. We found that the initial shock caused by COVID led to a decrease in the share of calories coming from both food categories, suggesting that foods that are neither in the least healthy nor in the healthiest categories likely saw the largest relative increases in purchases early on. However, after an initial period, the share of calories purchased from least healthy foods increased above February 2020 levels and remained above such levels for most of the rest of the year, while the share of calories purchased from healthier foods remained below February levels. This finding is consistent with several studies reporting an overall deterioration in diet quality during the pandemic (Bennett et al., 2021; Bhutani et al., 2021; Zupo et al., 2020).

Importantly, we observed disparities in the nutritional quality of food purchases among individuals in counties with different levels of socioeconomic development. Those shopping in less-developed counties purchased a larger share of calories from least healthy foods and a smaller share from healthier foods. These findings reflect well-established disparities in diet quality across areas with different socioeconomic status or racial profile in the US (Cooksey Stowers et al., 2020; Powell et al., 2007; Walker et al., 2010). However, we found that these disparities were slightly attenuated for least healthy foods after March 2020, and did not change significantly for healthier foods. These patterns may seem surprising given previous evidence of the geographically inequitable effects of COVID-19 (Jackson et al., 2021; Park et al., 2022; Tan et al., 2020; Tipirneni et al., 2022), but a few factors may help explain it. The federal government's economic impact payments may have played an important role, as the first two rounds of payments in 2020 are estimated to have lifted 11.7 million people above the poverty line (Cox et al., 2022). Social support services such as unemployment insurance may also have played an important role. Previous studies show that unemployment insurance reduced food insecurity among those who lost employment (Ogundari et al., 2022; Raifman et al., 2021), and a study in Los Angeles found that unemployment benefits were associated with improvements in diet quality during this period (Miller et al., 2021). And although subsequent to our study period, the 2021 Child Tax Credit also reduced material hardship, food insecurity, and improved diet quality (Adams et al., 2022; Parolin et al., 2021; Shafer et al., 2022).

We also observed a slight improvement in the nutritional quality of SNAP users' food purchases after March 2020, which aligns with previous evidence that programmatic responses played an important role in combatting food insecurity during COVID-19. In NC, there was a 28 % increase in SNAP dollars received by participants in 2020 compared to 2019 (Center on Budget and Policy Priorities, 2022), while, for reference, food-at-home prices increased 3.5 % in 2020 (United States Department of Agriculture, n.d.). Previous studies show that SNAP participation and supplements helped combat food insufficiency and buffered reductions in consumption of healthy foods (Bryant and Follett, 2022; Lee et al., 2023), and P-EBT is estimated to have reduced food insecurity among low-income households by as much as 30 % in the week following its disbursement (Bauer et al., 2020). In NC, households already enrolled in SNAP and eligible for the new P-EBT program received both benefits through their existing SNAP-EBT card (NC Department of Health and Human Services, 2020), so although we were not able to identify purchases using P-EBT in our data, at least a portion of those who we identified as SNAP users were likely also using P-EBT benefits.

On the other hand, our study suggests some deterioration in the nutritional quality of WIC users' food purchases after the initial onset of the COVID-19 crisis. Previous studies have shown that the flexibilities introduced to WIC in 2020 led to increased participation in the program (Vasan et al., 2021), and that beneficiaries perceived such flexibilities as having helped lower barriers to program participation (Barnes and Petry, 2021). However, our findings suggest that, within the first year of the pandemic, WIC's programmatic responses, while helpful, may not have been sufficient to address the multitude of challenges faced by WIC households. These findings are consistent with a study focused on WIC shoppers using data from the same retailer, which observed decreases in

Table 2
Percentage point variation in calories purchased monthly in North Carolina between October 2019 and December 2020 from least healthy foods and fruits, vegetables, legumes and nuts (FVLN), adjusted estimates from mixed-effects models with random intercepts.

	Least Healthy Foods			FVLN		
	β	SE	95 % CI	β	SE	95 % CI
Month						
Oct-19	1.06***	0.02	1.02,1.09	−0.27***	0.01	−0.29,−0.24
Nov-19	−0.59***	0.02	−0.63,−0.55	0.25***	0.01	0.22,0.27
Dec-19	0.91***	0.02	0.87,0.95	−0.48***	0.01	−0.50,−0.46
Jan-20	−0.74***	0.02	−0.78,−0.70	0.15***	0.01	0.13,0.17
Feb-20 (reference)	–	–	–	–	–	–
Mar-20	−1.27***	0.03	−1.32,−1.22	−0.38***	0.01	−0.41,−0.36
Apr-20	0.30***	0.03	0.25,0.35	−0.57***	0.01	−0.60,−0.55
May-20	1.03***	0.03	0.98,1.08	−0.74***	0.01	−0.76,−0.72
Jun-20	1.15***	0.03	1.10,1.20	−0.64***	0.01	−0.66,−0.62
Jul-20	1.83***	0.03	1.78,1.88	−0.85***	0.01	−0.87,−0.83
Aug-20	1.32***	0.03	1.25,1.37	−0.82***	0.01	−0.84,−0.79
Sep-20	0.64***	0.03	0.59,0.69	−0.35***	0.01	−0.38,−0.33
Oct-20	1.03***	0.03	0.98,1.08	−0.39***	0.01	−0.42,−0.37
Nov-20	−1.18***	0.03	−1.23,−1.12	0.27***	0.01	0.25,0.30
Dec-20	0.19***	0.03	0.14,0.24	−0.37***	0.01	−0.40,−0.35
Development tier						
1 (lowest, reference)	–	–	–	–	–	–
2	−0.85***	0.03	−0.90,−0.80	0.26***	0.01	0.23,0.29
3 (highest)	−2.14***	0.03	−2.19,−2.08	0.81***	0.01	0.78,0.84
Development tier*COVID period						
1*COVID (reference)	–	–	–	–	–	–
2*COVID	0.14***	0.02	0.10,0.19	–	–	–
3*COVID	0.29***	0.02	0.25,0.33	–	–	–
SNAP	0.65***	0.02	0.61,0.69	−1.64***	0.01	−1.66,−1.61
SNAP*COVID period	−0.30***	0.02	−0.34,−0.26	0.53***	0.01	0.50,0.55
WIC	−3.76***	0.04	−3.85,−3.68	−0.39***	0.02	−0.44,−0.35
WIC*COVID period	1.09***	0.04	1.01,1.18	−0.12***	0.02	−0.16,−0.07
COVID cases	<0.01***	<0.01	<0.01,<0.01	<0.01***	<0.01	<0.01,<0.01
Median monthly expenditure	−0.02***	<0.01	−0.02, −0.02	>−0.01***	<0.01	>−0.01, >−0.01

Note. County Development Tiers are defined by the North Carolina Department of Commerce considering counties' average unemployment rate, median household income, percentage growth in the population, and adjusted property tax base per capita.
Note. SNAP = Supplemental Nutrition Assistance Program; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
*** Statistically significant at the 99.9% confidence level.
* Statistically significant at the 95% confidence level.

the share of calories purchased from fruits and vegetables and increases in the share of calories from less healthy foods categories and SSBs in 2020 (Duffy, 2023).

This study's strengths include the use of a large sample of longitudinal food purchasing data from a widespread, affordable retailer in NC. However, this study also has limitations. People may shop at multiple retailers and our data did not include information on purchases from retailers that are common sources of unhealthy foods in socially disadvantaged areas, such as convenience stores and fast-food restaurants (Larson et al., 2009; Moore et al., 2009; Rummo et al., 2015). Therefore, we cannot rule out the possibility that nutritional disparities in households' total purchases across different retailers did become more pronounced. Within the retailer in question, we were only able to analyze data from shoppers who used frequent shopper cards, and given the lack of individual-level information about shoppers, we were unable to account for possible multiple shopper cards within the same household. We were also not able to control for the different ways in which the pandemic affected NC residents, such as loss of employment, ability to work from home, and access to other types of social benefits. Due to the limited number of pre-COVID time points in our data, we were also not able to account for seasonality during part of the study period. Additionally, we were not able to account for changes in the food supply during the period, which may have been differentially impacted by geography. Lastly, the distinction between food purchases and food consumption is important to bear in mind, as our data only allowed us to examine the former.

5. Conclusion

We did not observe a large-scale accentuation of nutritional inequities among NC residents in counties with lower levels of socioeconomic development. These patterns may have resulted from programmatic responses to mitigate the adverse effects of the COVID crisis on vulnerable populations at the federal and state levels. Future work should further explore the role of such responses.

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CRediT authorship contribution statement

Aline D'Angelo Campos: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Shu Wen Ng:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102812.

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