

Original Research

Special Supplemental Nutrition Program for Women, Infants, and Children Participant Grocery Store Purchases during the COVID-19 Pandemic in North Carolina



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A B S T R A C T

Background: Families participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) experienced barriers to accessing healthy food during the COVID-19 pandemic, but we do not yet understand how WIC participant food purchases shifted during the pandemic.

Objectives: We aimed to describe the association between the initial shock of the pandemic in March 2020 and WIC shoppers' food purchases and changes in purchases before and during the pandemic at a top grocery chain and examine differences in these relationships by duration of WIC use.

Methods: We used longitudinal food transaction data from WIC shoppers ($n = 2,989,116$ shopper-month observations from 175,081 unique WIC shoppers) from 496 stores in a top grocery store chain in North Carolina between October 2019 and May 2021. We used an interrupted time series design to describe the following: 1) the relationship between the initial shock of the pandemic and WIC shopper food purchases and 2) differences in purchases before and during the pandemic. To assess differences in purchases between shoppers consistently using WIC electronic benefit transfer (EBT) cards and shoppers starting or stopping WIC EBT use during the pandemic, we used models stratified by WIC group. Primary outcomes were share (%) of total calories purchased from fruits, vegetables, nuts, and legumes (FV), processed foods, and sugar-sweetened beverages (SSBs).

Results: We observed small decreases in the share of total calories from FV (-0.4%) and small increases in the share of calories from processed food (1.1%) and SSBs (0.5%) purchased at this retailer when comparing the pre and post March 2020 periods. Compared with shoppers that started or stopped using WIC benefits during the pandemic, shoppers that used WIC benefits consistently had slightly higher FV and lower processed food and SSB purchases at this retailer.

Conclusions: Future studies should examine whether additional supports for nutrient-dense food choices may be needed for families with low incomes in public health emergencies.

Keywords: WIC, public health emergency, emergency food system, federal nutrition assistance, food transaction data

Introduction

Dietary intake in early childhood is an important predictor of diet-related chronic disease risk later in childhood and throughout

life [1,2]. Additionally, adequate dietary intake during pregnancy is vital for the health of both the pregnant person and child. Income-related diet disparities start early in life, with young children living in households with low incomes often being less likely

Abbreviations: CVB, cash value benefit; EBT, electronic benefit transfer; FV, fruits, vegetables, nuts, and legumes; SNAP, Supplemental Nutrition Assistance Program; SSB, sugar-sweetened beverage; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

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to consume fruits and vegetables and more likely to consume energy-dense, nutrient-poor foods like sugar-sweetened beverages (SSBs) [3,4]. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal nutrition assistance program that addresses diet-related disparities by providing access to nutritious foods, nutrition education, and healthcare referrals [5].

Public health emergencies, such as the COVID-19 pandemic, often exacerbate existing health disparities [6]. During the COVID-19 pandemic, families with low incomes, such as WIC participants, were more likely to experience food insecurity [7, 8]. The pandemic also caused unprecedented disruptions in food acquisition behaviors because of factors like stay-at-home orders, fear of contracting the virus, and widespread food shortages [9–14]. Prior studies focusing on WIC participants during the pandemic have focused on perceptions of and WIC benefit redemption associated with pandemic-related policy changes to the WIC program [15–20], as well as associations of these policy changes with enrollment [21,22] and self-reported food consumption [23]. Some studies have used qualitative methods to describe WIC participants' experiences with purchasing food during the pandemic, such as how participants navigated food shortages or rising food costs [18,24].

A key gap in the literature is understanding whether and how WIC participants' purchases of food groups of public health concern shifted in response to the societal disruptions caused by the COVID-19 pandemic using longitudinal, point-of-sale food transaction data. These descriptive data, in addition to existing research in this area, can inform the design of future emergency food response policies such as increasing benefits for nutrient-dense foods and messaging about strategies for stockpiling nutrient-dense foods. A related question is whether there were differences in food purchases among individuals continuously using WIC electronic benefit transfer (EBT) throughout the pandemic (a proxy for WIC enrollment status) compared with those only using WIC before or after the pandemic. Understanding if there were differences in purchases across these groups of WIC shoppers can help decision makers begin to understand potential implications on diet of policies that facilitate or create barriers to nutrition assistance program participation during public health emergencies.

Given these key gaps in the existing literature, our primary objective was to describe WIC shopper food purchases of food groups of public health importance before and during the COVID-19 pandemic using longitudinal food transaction data from 496 stores in a top grocery store chain in North Carolina. A secondary objective was to understand if those associations differed among 3 subgroups of WIC shoppers: 1) people who used WIC EBT both before and during the pandemic, 2) people who started using WIC EBT during the pandemic, and 3) people who stopped using WIC EBT during the pandemic.

Methods

Food transaction data and food groups

We used loyalty-card food transaction data [25,26] from October 2019 to May of 2021 from 496 stores belonging to 1 of the top 2 food retailers in North Carolina [27] located in 86 of North Carolina's 100 counties. Most WIC benefits are redeemed

at large grocery stores, and this retailer is the preferred retailer by WIC participants in North Carolina due to clear shelf labeling [17; unpublished analysis of Nielsen Homescan Consumer Panel Data]. These data include every food and nonfood item purchased at this retailer in each shopping episode including barcode or item number, item size, item description, price, unit of measure, quantity sold, tender types used, store location, date of sale, and loyalty-card ID for the transaction. Using each product's barcode, our research team linked all products to nutrition label and product data from the Mintel Global New Product Database, Label Insight, or USDA's Food and Nutrient Database for Dietary Studies [28–30]. This data does not include food purchases made without loyalty cards, though the majority of grocery store transactions involve the use of a loyalty card (90%–95% based on some estimates) [31,32].

Our analysis focused on several food categories of public health interest [33–35]: 1) all fruits, vegetables, nuts, and legumes (FV) with and without added salt, fat, or sugar; 2) FV without added salt, fat, or sugar; 3) nonessential processed packaged foods (i.e., salty snacks, candy, and desserts), and 4) SSBs. We were interested in FV because they are high cost, nutrient-dense food categories of public health concern that were particularly influenced by rising costs due to inflation. Additionally, the WIC cash value benefit (CVB), which can be used only for FV, was the only food component of the WIC food package that increased during the pandemic (in June 2021), so we wanted to understand whether and how WIC shoppers' purchases of FV shifted before this increase. We differentiated between FV with and without added sugar, fat, and salt because only the latter is eligible for purchase with WIC CVB in North Carolina. We were also interested in processed foods and SSBs because these are low-cost, ultraprocessed, shelf-stable foods that families may have stockpiled in response to public health guidance to have ≥ 2 wk' worth of food on hand and/or due to fewer economic resources to buy food. Foods were categorized into these groups based on their ingredients. These food groups and example products are described in [Supplemental Table 1](#).

WIC shopper categorization

WIC shoppers were identified by the payment type used in a transaction, so if a loyalty-card shopper paid with a WIC EBT card at least once in the study period, they were considered a WIC shopper. We included only WIC shoppers who had ≥ 2 data points in the pre-COVID-19 period (October 2019–February 2020) and ≥ 2 data points in the postpandemic period (March 2020–May 2021). We also excluded observations from loyalty cards that were in the top 1% of expenditures in a given month because these are likely "store cards" used by cashiers on many shoppers (i.e., when someone does not have their own loyalty card). These exclusions led to a sample including 86% of all observations from loyalty-card IDs that ever used WIC during the study period ($n = 2,989,116$ shopper-month observations from 175,081 unique shoppers). To understand the purchasing patterns of shoppers consistently using WIC benefits throughout the pandemic, we focused our primary analyses on loyalty-card IDs of those who used WIC at least one ≥ 1 time in the prepandemic period and at least one ≥ 1 time in the postpandemic period. We are calling this group "consistent WIC shoppers" ($n = 1,450,038$ shopper-month observations from 83,080 unique shoppers).

We also compared purchases of 2 additional groups of WIC shoppers to consistent WIC shoppers in secondary analyses: 1) “previous WIC shoppers,” shoppers who used WIC ≥ 1 time in the prepandemic period and did not use WIC in the postpandemic period ($n = 389,180$ shopper-month observations from 24,225 unique shoppers); and 2) “new WIC shoppers,” shoppers who did not use WIC in the prepandemic period but did use WIC ≥ 1 time in the postpandemic period ($n = 1,149,898$ shopper-month observations from 67,776 unique shoppers). The goals of these analyses were to 1) account for increases in WIC enrollment during the pandemic [36] and potential unmeasured differences in characteristics between shoppers participating in WIC before and after the pandemic, and 2) examine differences in the nutritional quality of food purchases of people newly using WIC benefits or stopping WIC benefit use compared with those using WIC benefits throughout the pandemic to begin to understand the implications of policies that either facilitate or create barriers to WIC enrollment and benefit redemption during public health emergencies. We did not include non-WIC shoppers in our analyses as a comparison group because our goal was to describe patterns in WIC shoppers (a population of public health importance), food purchases during this time period, and how food purchases among WIC shoppers at this retailer may have changed relative to their purchases before the pandemic. Our objective was not to control for or remove the effects of secular trends using a non-WIC shopper comparison group or to examine differences between WIC shoppers’ purchases and the purchases of the general population during this time.

Exposure

Our primary exposure of interest was the initial shock and shifts in food acquisition behaviors introduced by the COVID-19 pandemic and associated stay-at-home orders and lockdowns. In North Carolina, the setting for this study, a state of emergency was announced on March 10, 2020 and the official stay-at-home order went into effect on March 27, 2020 [37]. Therefore, we decided to specify our prepandemic period as October 2019 (first month of data available) to February 2020 and our postpandemic period as March 2020 to May 2021. Our study period excludes the WIC CVB increase that occurred in June 2021 in North Carolina as it was not the purpose of these analyses to evaluate that policy change, rather to describe WIC shopper purchases of key food groups of public health interest before and during the pandemic at this retailer. The WIC food package flexibilities implemented during this study period did not affect our food groups of interest, and it is not our goal to evaluate the effects of these flexibilities.

Outcomes

Our primary outcomes were the monthly share (%) of total food and beverage calories purchased from: 1) all FV, 2) FV without added salt, sugar, and fat, 3) processed foods, and 4) SSBs at this retailer. Secondary outcomes were calories purchased per day from these 4 food groups at this retailer. We selected the share outcomes as our primary outcomes because we expected that absolute calories from all food groups would increase during this time given the decrease in food purchases away from home, and the share outcomes allow us to understand if the proportion of total purchases from different food groups,

an indicator of overall purchase quality, shifted during the pandemic. We also included the outcomes in terms of calories per day because these absolute measures demonstrate the immediate effects and shock of the pandemic on grocery store purchases.

Covariates

As with all deidentified food transaction data, we do not have shopper-level demographic data available. We used a directed acyclic graph to determine which of the available shopper-level covariates to include in our models. Our final models included mean minimum temperature, mean maximum temperature, indicator variables for the top store, and the volume purchased of products in the food group being modeled with missing nutritional information. We included indicator variables for each shopper’s monthly top store, or the store where they spent the most money each month, to control for store environment characteristics such as in-store marketing and promotions that may have influenced shopper purchases. To account for the seasonality of purchases of foods in our food groups of interest such as fruits, vegetables, and SSBs and to differentiate the effects of seasonality from the shock of the pandemic, we adjusted for the mean maximum and minimum temperatures in Raleigh, North Carolina each month using temperature data from the National Oceanic and Atmospheric Administration [38,39]. We could not use indicator variables for month to control for seasonality as we did not have 2 time periods for all months in our study period (e.g., only July 2020 is included in our dataset not July 2020 and July 2019 or July 2021).

Statistical analyses

We compared mean food purchases at this retailer from each food group in the prepandemic period and in the postpandemic period using unadjusted linear regression models with SEs clustered at the loyalty-card ID level. We then used an interrupted time series design with our adjusted models to describe the association between the shock of the pandemic and WIC shopper purchases at this retailer. We used a linear time trend, an indicator variable for pre/post March 2020, and their interaction to estimate the shift in the intercept (i.e., immediate effect) in March 2020 and the change in slope between the prepandemic and post/during-pandemic period. We used fixed effects models to examine changes within shoppers over time and control for time-invariant shopper characteristics that we are unable to observe due to the deidentified nature of these data, such as race, ethnicity, and education. All adjusted models used cluster robust SEs to account for repeated observations within shoppers, and we used the Holm–Bonferroni method [40] to adjust P values for multiple comparisons. To assess differences in the immediate effects in March 2020 and pre- and post/during-pandemic slopes across the 3 WIC groups, we used models stratified by WIC group. We then compared point estimates of immediate effects and slopes and overlap of 95% confidence intervals of those estimates across the WIC groups to assess whether there were differences across group because we did not have statistical tests comparing the 3 groups due to the stratified models. All analyses were conducted using Stata version 17. This study was reviewed and deemed nonhuman subjects research by the University of North Carolina at Chapel Hill Institutional Review Board.

Sensitivity analyses

We conducted a sensitivity analysis using the same analytic approach but using volume (share and absolute ounces) from each food group as the outcome (rather than calories) given that certain food groups are inherently more calorically dense than others (e.g., fruits and vegetables compared with processed foods). Given that many WIC participants also participate in the Supplemental Nutrition Assistance Program (SNAP), and the many changes to SNAP benefits during the pandemic and during our study period, we also added an interaction term for SNAP EBT use to assess modification by SNAP participation. We examined the significance of the interaction term as well as stratum-specific estimates in our assessment of modification by SNAP use.

Results

Unadjusted mean food group purchases in pre- and postpandemic periods

When comparing the prepandemic period (October 2019–February 2020) to the postpandemic period (March 2020–May 2021) among consistent WIC shoppers, the unadjusted monthly mean share of total calories purchased at this retailer from all FV decreased (−0.4%) (Table 1). In contrast, the unadjusted share of calories from processed foods and SSBs increased (1.1% and 0.5%, respectively). There were increases in calories purchased at this retailer per day from all food groups comparing the pre- to postpandemic period (Table 1).

Changes in WIC shopper food purchases from adjusted models

FV.

Among consistent WIC shoppers, there was a small, immediate decrease in March 2020 in the share of total food and beverage calories purchased from all FV at this retailer (−0.3%, $P < 0.001$) (Table 2). In the postpandemic period, the slopes or trends over time in the share of calories from FV shifted from negative to positive (Figure 1), perhaps suggesting purchases were returning to prepandemic levels after the March 2020 immediate decrease; however, the overall change in slope from the pre- to postpandemic period was very small (0.06%, $P < 0.001$). In terms of calories purchased per day, there was an immediate

increase of 35.9 calories from FV in March 2020 ($P < 0.001$). The trends over time in FV calories purchased per day were negative, small in magnitude, and similar in the pre- and postpandemic period (Table 2 and Figure 2). The results for FV without added salt, sugar, and fat were similar to those for all FV (Supplemental Tables 2 and 3).

Processed foods.

Among consistent WIC shoppers, there was an immediate increase in March 2020 in the share of total calories from processed foods at this retailer (0.8%, $P < 0.001$). The trends over time in share of total purchases from processed foods shifted from positive in the prepandemic period to negative in the postpandemic period (overall change of −0.1%, $P < 0.001$) (Table 2 and Figure 1). There was also an immediate increase in calories purchased per day from processed foods in March 2020 (151.4 calories, $P < 0.001$), and the trends in processed food calories per day shifted from positive to negative in the postpandemic periods (overall change of −14.8 calories per day, $P < 0.001$) (Table 2 and Figure 2).

SSBs.

Among consistent WIC shoppers, there was a small, immediate decrease in March 2020 in the share of total calories purchased at this retailer from SSBs (−0.2%, $P < 0.001$) (Table 2). For both share of total calories from SSBs and calories per day from SSBs, the overall changes in the slope from the pre- to postpandemic period were small (0.2%, $P < 0.001$ and 1.2, $P < 0.001$, respectively), but there was a sign change from negative slopes in the prepandemic period to positive slopes in the postpandemic period (Table 2 and Figures 1 and 2). In contrast to the immediate decrease in share of calories from SSBs, there was an immediate increase in the calories purchased per day at this retailer from SSBs in March 2020 (42.4 calories, $P < 0.001$) (Table 2).

Comparison with new and previous WIC shoppers

Consistent WIC shoppers regularly had the highest share of calories and calories purchased per day from FV and the lowest share of calories from processed foods and SSBs (Figure 1), compared with new and previous WIC shoppers. Comparing the pre- to postpandemic period, the new WIC group experienced the largest increase in share of calories and calories purchased per

TABLE 1

Unadjusted mean percentage of total food and beverage calories purchased and calories purchased per day from each food group pre and post March 2020 and the difference in the mean between the pre- and postpandemic period among consistent WIC shoppers ($n = 1,450,038$ shopper-month observations, 382,508 in prepandemic period and 1,067,530 in postpandemic period)

Food group	Prepandemic period (Oct 2019 to Feb 2020)	Postpandemic period (Mar 2020 to May 2021)	Difference between pre- and postpandemic periods
	Mean calories purchased per day (SD)		
Total	2411.6 (2118.0)	2820.8 (2413.9)	409.2 ¹
All FV	195.4 (197.9)	218.7 (218.3)	23.4 ¹
Processed food	652.2 (692.2)	774.8 (771.9)	122.7 ¹
SSBs	229.9 (299.0)	283.6 (363.6)	53.8 ¹
	Mean percentage of total food and beverage calories purchased (SD)		
All FV	9.4 (10.3)	9.0 (9.9)	−0.4 ¹
Processed food	25.4 (16.7)	26.4 (16.3)	1.1 ¹
SSBs	10.3(13.1)	10.7 (12.9)	0.5 ¹

Abbreviations: FV, fruits, vegetables, nuts, and legumes; SSB, sugar-sweetened beverage.

¹ Statistically significant after Holm–Bonferroni adjustment for multiple comparisons

TABLE 2

Estimates and 95% confidence intervals from adjusted fixed effects models of the immediate effect (change in intercept), the slope in the pre-pandemic period, the slope in the postpandemic period, and the overall change in slope from the pre to postpandemic periods for all food groups in terms of the share of total calories purchased and calories purchased per day from the food group among consistent WIC shoppers ($n = 1,450,038$ shopper-month observations)

Food group	Immediate effect	Slope prepandemic	Slope postpandemic	Change in slope
Share of total calories purchased (%)				
All FV	-0.3 ¹ (-0.4, -0.2)	-0.04 ¹ (-0.06, -0.01)	0.02 ¹ (0.02, 0.03)	0.06 ¹ (0.04, 0.08)
Processed Foods	0.8 ¹ (0.6, 0.9)	0.1 ¹ (0.08, 0.2)	-0.03 ¹ (-0.04, -0.02)	-0.1 ¹ (-0.2, -0.1)
SSBs	-0.2 ¹ (-0.3, -0.1)	-0.1 ¹ (-0.1, -0.07)	0.07 ¹ (0.06, 0.07)	0.2 ¹ (0.1, 0.2)
Calories purchased per day				
All FV	35.9 ¹ (34.5, 37.3)	-1.5 ¹ (-1.9, -1.2)	-1.3 ¹ (-1.4, -1.2)	0.2 (-0.2, 0.6)
Processed Foods	151.4 ¹ (146.7, 156.1)	7.9 ¹ (6.8, 9.0)	-6.9 ¹ (-7.2, -6.5)	-14.8 ¹ (-16.0, -13.5)
SSBs	42.4 ¹ (40.3, 44.5)	-1.0 ¹ (-1.5, -0.5)	0.2 ¹ (0.01, 0.4)	1.2 ¹ (0.6, 1.7)

95% confidence intervals are not adjusted for multiple comparisons

Abbreviations: FV, fruits, vegetables, nuts, and legumes; SSB, sugar-sweetened beverage.

¹ Statistically significant after Holm–Bonferroni adjustment for multiple comparisons

day at this retailer from FV (Figures 1 and 2; Supplemental Tables 2 and 3). The previous WIC group experienced the largest increases in the share of calories from SSBs and processed foods. The new WIC group experienced immediate decreases in the share of calories from processed foods in March 2020 compared with increases among consistent and previous WIC shoppers (Figure 1 and Supplemental Table 4). The new WIC group also did not experience an immediate change in March 2020 of share of purchases from FV whereas the consistent and previous WIC groups experienced small decreases (Figure 1 and Supplemental Table 4). Comparisons of the immediate effects and slopes in the pre- and postpandemic periods in terms of calories per day for each food group across the 3 WIC groups can be found in Supplemental Table 5.

Sensitivity analyses

Using volume (ounces) as an outcome as opposed to calories, the results were consistent when comparing mean share of total volume or mean ounces purchased per day at this retailer in the pre- and postpandemic periods (Supplemental Tables 6 and 7). In terms of the estimates of the immediate effects and slopes, for the absolute (ounces per day) outcomes, the magnitude of the effects was different (which is expected given the different units), but the direction of changes was consistent across calories and ounces. For the relative outcomes, there were small, but immediate increases in the share of volume from FV and SSBs as opposed to decreases observed in share of calories (Supplemental Table 8). We did not find evidence of modification by SNAP use.

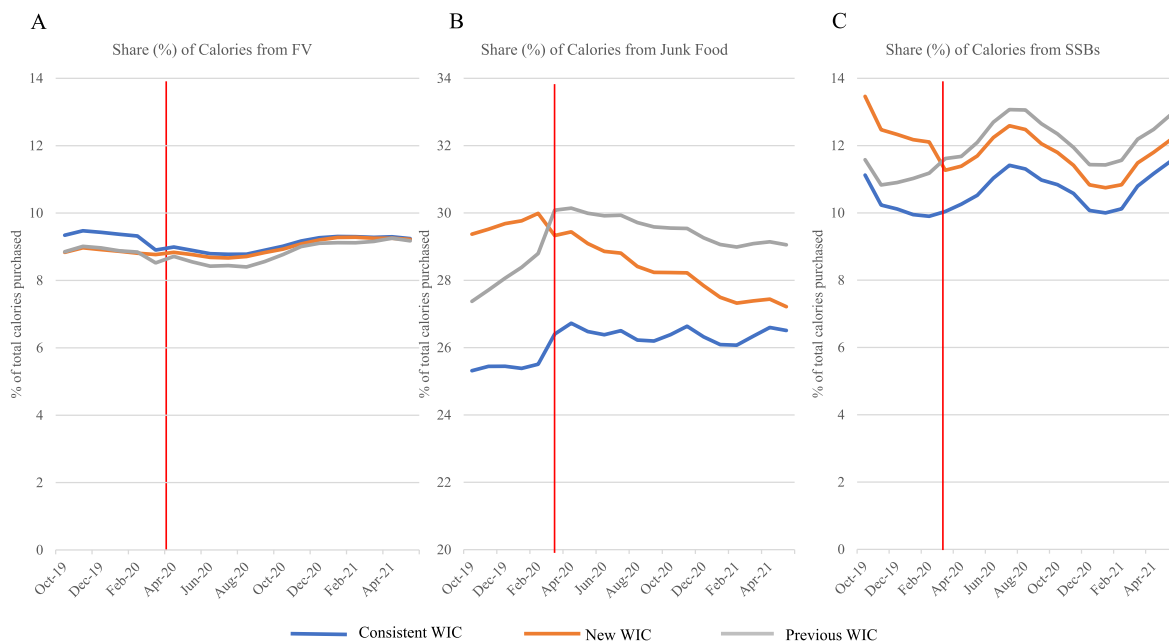


FIGURE 1. (A) Share of total calories from fruits, vegetables, nuts, and legumes (FV). (B) Share of total calories from processed foods. (C) Share of total calories from sugar-sweetened beverages (SSBs). Red line denotes March 2020. WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

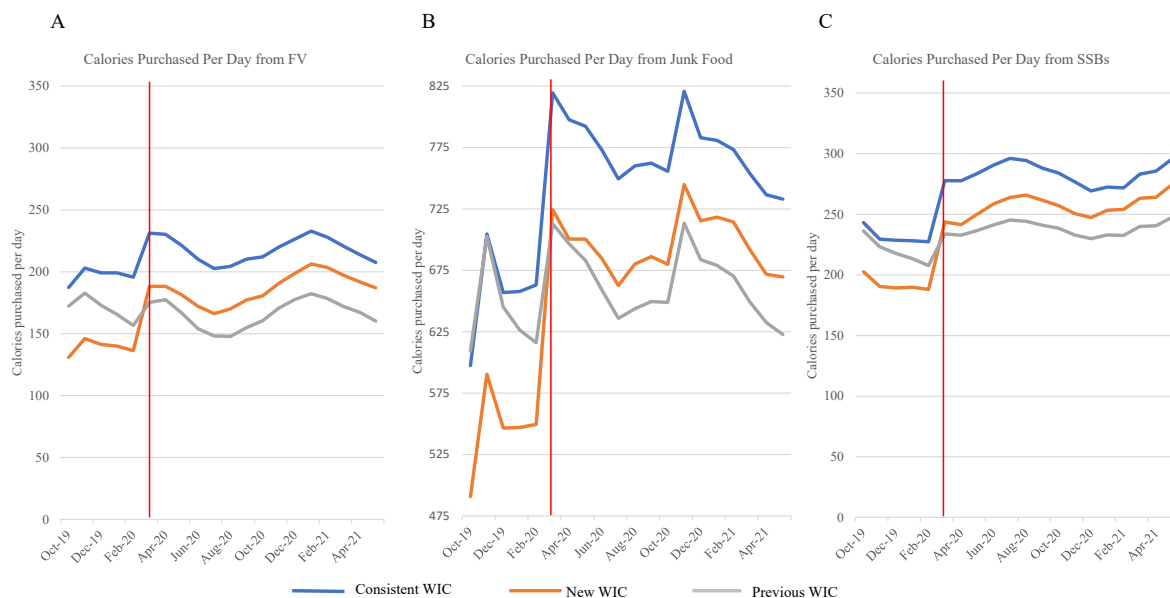


FIGURE 2. (A) Calories purchased per day from fruits, vegetables, nuts, and legumes (FV). (B) Calories purchased per day from processed foods. (C) Calories purchased per day from sugar-sweetened beverages (SSBs). Red line denotes March 2020. WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

Discussion

This study adds to the growing literature documenting shifts in food behaviors during the COVID-19 pandemic by describing purchases of food groups of public health interest among an understudied group, WIC participants, using longitudinal food transaction data from one of the top 2 food retailers in North Carolina [27]. Among consistent WIC shoppers, there were small decreases in the share (%) of total calories purchased at this retailer from FV and small increases in the share of total calories from processed food and SSBs when comparing means in the pre- and postpandemic periods. We also observed immediate increases in absolute food purchases (i.e., calories per shopper per day) from all food groups among WIC shoppers between February and March 2020. We hypothesize these increases were largely due to a larger share of overall food purchases coming from grocery stores as opposed to venues like restaurants and schools that were closed during the early stages of the pandemic as well as directives from the federal government to stockpile ~2 wk' worth of food [13,14].

Upon examining the trends in purchases in the 14 mo following the initial shock, it appears that WIC shoppers' purchases in the food groups examined at this retailer were largely trending toward where they were prepandemic. These trends back to prepandemic levels are consistent with what has been observed using nationally representative retail scanner data among all shoppers [13]. Describing food purchasing patterns of WIC shoppers into 2021 is an important contribution as few studies have examined food-related behaviors beyond the early phases of the pandemic and whether or not the immediate effects of the pandemic on food-related behaviors were sustained, and no studies have examined WIC shoppers' food purchases using point-of-sale food transaction data during this time period [13,14].

There were few changes of potential public health significance in WIC shoppers' FV purchases over this period. For example, the observed decrease of 0.4% of calories purchased at this retailer from FV from the pre- to postpandemic period when

an mean WIC household was buying between 2400 and 2800 calories/d from this retailer is a difference of ~10 calories of FV per household per day. However, it is worth noting that the share (%) of calories purchased from FV remains far below the share of calories from SSBs and processed foods, which is not unique to WIC shoppers but is nonetheless a public health concern. The largest increases in share (%) of total calories and calories per day were observed in the processed food category; however, this food group also contributes almost one-third of all calories purchased in our sample, so this would be expected. Similar increases in purchases of shelf-stable, low-cost, comfort foods during this period have been reported by other studies using survey and self-report methods [9,14,41,42]. It is also worth stating that we likely observed small changes in the share (%) of calories from each food group because, compared with an outcome like absolute calories per shopper per day, the percentage of total calories purchased is an outcome that has less quantitative 'room' to shift over time, so we would expect smaller changes in this type of outcome and we see similar effect sizes in studies using nationally representative retail scanner data [13]. For example, an absolute increase in SSB purchases from 400 to 500 calories per shopper per day (+100 calorie change) would translate to a change from ~17%–20% of total calories purchased (+3% change).

Existing literature on shifts in food-related behaviors during the pandemic has largely relied on convenience samples and self-report and survey methods. Two studies have used nationally representative samples to examine food purchasing patterns during the pandemic, and, despite different populations of interest, our results are largely consistent with these studies. One study using retail scanner data found similar large immediate effects on absolute purchases and small changes in the relative composition (%) of food sales [13]. The other study used self-reported purchase data from the US Census Bureau and found similar increases in the share of total expenditures on processed foods but found increases in share of total food

expenditures coming from FV, which may in part be attributable to inflation and price increases in this product category [14]. The current study builds on this literature by specifically focusing on a population of public health interest, households with low incomes participating in WIC.

Recent reviews have found both mixed results in terms of changes in fresh produce and comfort food (e.g., processed foods) consumption and purchases [43] and that intakes during the lockdown period compared with shortly after were higher in discretionary foods, desserts, juice, and other beverages, and lower in fruits, vegetables, and dairy [9]. One review also found that individuals with lower incomes had worse outcomes related to shifts in dietary behaviors during the pandemic [9]. Though these reviews include studies from international contexts in addition to the United States, they are relatively consistent with what we found in this study. Similarly, studies conducted in the United States using convenience samples and self-report have generally concluded that there were decreases in vegetables purchased during this period [11], and individuals with low incomes or those experiencing food insecurity, in particular, reported purchasing lower cost foods and purchasing more packaged, shelf-stable foods [18,41,42]. The current study, which also focuses on individuals with low incomes, adds to this literature by examining objective, longitudinal food retailer transaction data from nearly 500 grocery stores and found similar decreases in purchases of nutrient-dense foods and increases in the purchase of shelf-stable, packaged foods.

We also found that people who consistently used WIC benefits before and during the pandemic regularly had the highest share of calories purchased at this retailer from FV and the lowest share of calories purchased at this retailer from processed food and SSBs throughout the course of the pandemic, compared with people who started or stopped using WIC benefits during the pandemic, though it is important to note the differences across groups were small in magnitude. This is consistent with existing research that documents participation in the WIC program being associated with improved diet quality [44–46], though we are not measuring diet in this study and these prior studies were not conducted during the pandemic. It is possible that either consistent or new enrollment in the WIC program during the pandemic, compared with losing WIC benefits, helped, at least in part, buffer families against declines in purchase quality (i.e., more processed foods, less FV). However, this study alone cannot determine whether that was the case or not, so future research should explore this phenomenon using other sources of data such as WIC administrative data or food consumption data and by comparing food purchases of WIC participants to income-eligible nonparticipants during this time.

Finally, this study adds to the growing literature of shifts in food behaviors during the pandemic that may be used to inform future emergency food response policy to prevent widening of diet-related disparities. For example, we observed higher quality food purchases at this retailer among people consistently or newly using WIC EBT during the pandemic, suggesting that policies that increase access to federal nutrition assistance programs may be important during public health emergencies. Additionally, given the relatively larger immediate increases observed in processed food and SSB purchases compared with FV purchases at this retailer, emergency food assistance policies that facilitate purchases of nutrient-dense options, such as the 2021

increase in the WIC CVB, could play an important role in mitigating the effects of disasters on nutrition disparities. Finally, public health authoritative bodies should consider messaging and education about strategies to stockpile shelf-stable, low-cost, nutrient-dense food options in future public health emergencies.

Strengths and limitations

This study uses longitudinal food transaction data and adds to the literature by focusing on households with low incomes, who were disproportionately negatively affected by the pandemic. There are limitations to our approach and to using loyalty-card data more generally. This dataset only includes food purchases at this retail chain, not all food purchases, and therefore our results should be interpreted with that in mind. Our approach captures a large share of WIC shopper grocery store purchases in North Carolina because 1) most foods purchased with WIC benefits are purchased at large grocery stores, 2) this is 1 of the top 2 food retailers in North Carolina, and 3) this is the preferred retailer for redeeming WIC in North Carolina due to better shelf labeling of WIC approved foods [17,27; unpublished analysis of Nielsen Homescan Consumer Panel Data]. However, we cannot rule out the possibility that some of the observed shifts in food purchases at this retailer, particularly in the early phase of the pandemic, may be attributable to factors such as switching grocery store chains due to food shortages and other factors. That said, we have no reason to believe WIC shoppers differentially shifted their purchases away from or to this retailer for the food categories examined. Additionally, we may have misclassified some WIC shoppers and included observations of individuals that are not currently enrolled in WIC given our definitions of consistent, new, and previous WIC shoppers and using WIC EBT use as a proxy for WIC participation. However, there are also limitations to using stricter criteria such as excluding true WIC shoppers that do not shop at this retailer for a certain period. As with all deidentified loyalty-card data, we were not able to control for shopper-level demographic characteristics and therefore cannot rule out the possibility of unmeasured confounding by unmeasured, time-varying shopper-level characteristics. However, we addressed differences in time-invariant shopper-level characteristics by using fixed effects models and comparing shoppers to themselves over time. Additionally, this dataset only includes food purchases made with loyalty cards, but the majority (90%–95% by some estimates) of grocery store transactions involve loyalty cards. Also, we are assuming that one loyalty card is used per household; however, it is possible that some households use 2 or more loyalty cards. Finally, these data are also geographically limited to North Carolina, so our findings may not be generalizable to other locations.

Conclusions

Changes in WIC shoppers' purchases in terms of share of total calories purchased at this retailer from each food group were small in magnitude. There were notable immediate increases in absolute calories purchased per day at this retailer from all food groups examined among WIC shoppers in March 2020, with the largest increases being observed in the more calorically dense and frequently purchased food groups of processed foods and SSBs. Overall, trends of purchases into 2021 suggest that purchasing patterns among WIC shoppers at this retailer were largely trending back toward prepandemic levels. Shoppers

consistently using WIC had slightly better overall purchase quality (i.e., lowest processed food and SSBs, highest FV) during the pandemic compared with shoppers that either started or stopped using WIC during the pandemic, but the differences were small in magnitude.

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Author contributions

The authors' responsibilities were as follows – EWD, SWN, MB, CRD, MDM, MGH, JM, LST: conceptualization, methodology, writing, and revising the manuscript, EWD, MB: formal analysis; EWD: developed the original manuscript draft; LST: supervision; and all authors: read and approved the final manuscript.

Conflict of interest

The authors report no conflicts of interest.

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Data availability

Data described in the manuscript will not be made publicly available because it is proprietary, but our analytic code can be made publicly available upon request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cdnut.2024.102098>.

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