ESTIMATING THE EFFECTS OF THE SHOCK OF THE COVID-19 PANDEMIC AND A FRUIT AND VEGETABLE BENEFIT INCREASE ON SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN (WIC) PARTICIPANTS IN NORTH CAROLINA: A MIXED METHODS STUDY

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Nutrition (Epidemiology) in the Gillings School of Global Public Health.

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ABSTRACT

Emily Welker Duffy: Estimating the Effects of the Shock of the COVID-19 Pandemic and a Fruit and Vegetable Benefit Increase on Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Participants in North Carolina: A Mixed Methods Study
(Under the direction of Lindsey Smith Taillie)

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal nutrition assistance program that provides access to nutritious food, nutrition and breastfeeding education, and health care and social service referrals to more than six million families in the US, including more than 260,000 North Carolina families. To address the drastic increases in food insecurity during the COVID-19 pandemic, WIC increased the amount of money available to participants for fruits and vegetables by about $25/person/month through the Cash Value Benefit (CVB). Understanding how WIC participants' food purchases changed during the pandemic and in response to the CVB increase can inform WIC policy in emergency and non-emergency settings.

Using longitudinal food transaction data from a large grocery store chain in North Carolina, we examined WIC shoppers' food purchases before and after the shock of the pandemic. We then used longitudinal food transaction data and focus groups with WIC participants in North Carolina to estimate the effects of the CVB increase on WIC households' fruit and vegetable purchases.

After the pandemic, we observed increases in total calories purchased per day from all food categories examined, small decreases in the share (%) of total calories purchased from fruits and vegetables, and small increases in the share of total calories purchased from processed foods and sugar-sweetened beverages (SSBs) among WIC shoppers. After the CVB increase, WIC shoppers purchased a larger quantity and variety of fruits and vegetables

compared to non-WIC shoppers. WIC participants had positive perceptions of the CVB increase, but experienced some challenges redeeming CVB benefits, and many felt they needed more than the increased CVB amount to meet their family's needs.

Policies such as healthy food incentives and expanded access to nutrition assistance programs may be important in providing access to FV and other nutrient-dense foods in future public health emergencies. This study also provides important and timely evidence of the effectiveness of the CVB increase in improving WIC participant fruit and vegetable purchases and satisfaction with the foods provided by WIC that can inform improvements to the foods provided by WIC in non-emergency settings.

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LIST OF ABBREVIATIONS AND SYMBOLS

CI	Confidence Interval
COVID-19	Disease caused by SARS-CoV-2
CTC	Child Tax Credit
CVB	Cash value benefit
CVV	Cash Value Voucher
DID	Difference-in-differences
EBT	Electronic Benefit Transfer
FV	Fruits and vegetables
NASEM	National Academies of Science, Engineering, and Medicine
NC	North Carolina
SNAP	Supplemental Nutrition Assistance Program
SSB	Sugar sweetened beverage
USDA	United States Department of Agriculture
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

CHAPTER 1. INTRODUCTION

Background

Fruit and vegetable (FV) consumption is important for children's health. Adequate FV consumption reduces the risk of diet-related chronic diseases[1-3] and, in early childhood, is vital for establishing lifelong health-promoting dietary habits.[4,5] Most young children in the US do not meet FV consumption recommendations.[6-9] For example, one in two children ages one to five do not eat a vegetable daily and one in three children do not eat a fruit daily.[9] Children living in households with low incomes and from intentionally marginalized racial or ethnic groups are at greater risk of inadequate FV consumption due to a variety of structural and historical factors.[9-14] The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides nutrition assistance to more than six million pregnant and postpartum women and children from birth to age five in low-income households in the US, including about half of infants born in the US.[15] Historically, WIC provided $9 or $11/participant/month for FV, in what is called the Cash Value Benefit (CVB), which equates to less than 1-cup of FV per day.[16] Scientific experts and WIC participants say this amount is inadequate and have called for increases in the value of the CVB.[16,17] An increase in the CVB component of the WIC food package could be one important component of reducing FV consumption disparities.

Public health emergencies have the potential to exacerbate these pre-existing disparities in FV consumption. In early 2020, the COVID-19 pandemic created unprecedented societal challenges and a public health emergency. As with prior public health emergencies, individuals from intentionally marginalized groups and individuals with low incomes, such as nutrition assistance program participants, were disproportionately negatively

affected by the pandemic. The COVID-19 pandemic exacerbated food insecurity among families with low incomes,[18-21] due to disproportionately high rates of job loss, widespread food shortages, increases in food costs, and, at least in the early stages of the pandemic, more limited access to prior forms of food assistance such as meals from school or daycare.[19,22,23] These factors may have worsened existing diet-related disparities.

To design better emergency food response policies in the future, we need to understand how food purchases shifted during the COVID-19 pandemic among individuals with low incomes and experiencing food insecurity. Prior studies examining the relationship between the pandemic and consumption or purchases of foods of public health interest such as fruits and vegetables and non-essential processed foods are inconsistent, perhaps due to use of convenience samples, self-reported behaviors, or limited time points of data collection in most existing studies.[24-30] Importantly, of these existing studies, very few examine food consumption or purchase behavior during this time specifically among individuals with low incomes or individuals participating in federal nutrition assistance programs[31,32], such as WIC. Using longitudinal food retailer transaction data to examine purchases of individuals shopping with federal nutrition assistance program benefits during the pandemic can fill these important gaps. Understanding whether and how WIC shoppers' food purchases shifted during the COVID-19 pandemic can be used to inform future emergency food response policies such as financial supports for purchasing nutrient-dense foods and expanding program access that can mitigate the effects of public health emergencies on diet-related disparities.

Policy changes could buffer some of these disproportionate negative impacts of public health emergencies, but there is little existing evidence of the effects of US pandemic-response policies. The United States Department of Agriculture (USDA) made a variety of policy changes to increase access to and benefit amounts within federal nutrition assistance programs during the pandemic. One such change was USDA temporarily increased the CVB for FV, from $9-11 to $35/person/month at first and later to $24-$47/person/month.[33]

Understanding how the pandemic-related increase in the WIC CVB affected WIC participant food purchases and behaviors can inform future emergency food response policy and improvements to the WIC food package in non-emergency settings. Additionally, the 2021 CVB increase was designed to be a temporary increase in benefits; however, nutrition scientists and advocates have stated this increase should be made permanent given FV consumption disparities, the rising cost of food, and the inadequacy of the pre-pandemic CVB amount to meet FV intake recommendations. Documenting the effects of this WIC policy change using rigorous methods can inform these ongoing debates. Prior studies of a 2009 increase in the WIC CVB and of other FV monetary incentive programs designed for individuals with low incomes demonstrate that FV incentives often increase FV intake and purchases.[34-40] To date, few studies have examined the effects of the 2021 CVB increase. Existing studies have used self-reported measures to describe shifts in food consumption and perceptions of the WIC food package associated with the CVB increase,[41-43] but these methods are subject to various forms of bias such as recall and social desirability bias. Longitudinal food transaction data are a useful tool to examine WIC shoppers' FV and other food purchases objectively at the point-of-sale before and after the CVB increase. We also do not understand WIC participants' lived experiences with the CVB increase such as barriers and facilitators to redeeming the higher CVB amount and how participants perceived the CVB increase changed their household food environment. Importantly, we do not know if these experiences differed by sociodemographic characteristics such as participant geography. Estimating the effects of the CVB increase as well as understanding participants' experiences with this policy change can inform USDA efforts to update and improve the WIC food package in 2023[44] as well as the design and implementation of future emergency food response policies.

The overarching goals of this research were to 1) describe WIC participant food purchases during the COVID-19 pandemic and 2) estimate the effects of the pandemic-related CVB increase on WIC participant food purchases. We used a unique longitudinal dataset of

food transaction data from a large supermarket chain with 496 stores across 86 counties (of 100) in North Carolina (NC) from October 2019 through April 2022. These longitudinal data allow us to estimate the effect of two exogenous shocks, the COVID-19 pandemic and the WIC CVB increase, on food purchases, while controlling for secular trends and potential confounders using quasi-experimental methods. We also collected qualitative data using virtual focus groups from a geographically and demographically diverse sample of NC WIC participants (n=55) regarding CVB use facilitators or barriers and perceptions of the CVB increase that cannot be identified using food transaction data but are vital to understanding policy effects and informing future policy implementation.

Research Aims

Aim 1. Describe the association between the shock of the COVID-19 pandemic and WIC shopper food purchases

1a. Examine differences in the association between the shock of the pandemic and WIC shopper food purchases by duration of WIC participation

Aim 2. Estimate the effect of the CVB increase on WIC shopper purchases of FV and other food groups of public health concern

Aim 3. Examine perceptions and awareness of the CVB increase, barriers and facilitators to using the increased CVB, and perceived effects of the CVB increase on household fruit and vegetable consumption

3a. Explore whether experiences and perceptions of the CVB increase differ by WIC participant geography

CHAPTER 2. LITERATURE REIVEW

Adequate Fruit and Vegetable Consumption is Critical for Maternal and Child Health

Consuming FV in early childhood is critical to the formation of lifelong healthy dietary habits and to diet-related chronic disease prevention.[1-5] FV are key sources of nutrients underconsumed by young children in the US such as potassium and fiber, and FV are protective against long-term risk of chronic health conditions such as obesity, cardiovascular disease, and some cancers.[1-3,6,45] The 2020-2025 Dietary Guidelines for Americans recommend that young children consume between 0.67-1.5 cups/day of vegetables and 0.5-1.5 cups/day of fruits, depending on their age and calorie requirements[6]. The vegetables consumed should include a variety of types such as dark green, red/orange, and other vegetables as well as beans, peas, and lentils. About 60% of young children meet the fruit intake recommendations, only about 10% meet the vegetable recommendations, and there are disparities in FV consumption in early childhood.[6,9] In early childhood, the reward sensation for consumption sweet and salty foods and the aversive reaction to bitter foods are pronounced compared to later in life,[4,46] so children must be exposed to FV, and especially vegetables, repeatedly, anywhere from 5 to 15 times before they will accept them. Equally as important as repeated exposure in early childhood is the variety of flavors and textures experienced. Experiencing this variety not only increases acceptance of foods children are exposed to in early childhood but their willingness to try new foods later in life.[4] Additionally, it is well understood that dietary habits established early in life track into adulthood,[5] marking early childhood as a critical time for public health intervention. Providing access to not only a sufficient amount, but also sufficient variety of FV is critical for diet-related disease prevention and optimal growth and development in early childhood.

In addition to the importance of FV consumption in early childhood, adequate FV consumption during pregnancy and postpartum is also vital for a pregnant person's health as well as their child's.[6] Pregnant and postpartum people should consume between 2.5-3.5 cups/day of vegetables and 1.5-2.5 cups/day of fruit to meet nutrient requirements.[6] However, most people in the US do not consume adequate FV during pregnancy and postpartum.[6] In addition to consuming FV for one's own health, parent FV consumption also affects their children's health and FV consumption. For example, during pregnancy and postpartum some dietary volatiles from FV are transferred via amniotic fluid and human milk, bridging flavors consumed in utero to those in early childhood.[4,47] Additionally, as children grow older, they are more likely to consume FV if they see their caregivers modeling these behaviors.[48] We need to examine and document the effects of public health interventions designed to improve FV intake during pregnancy and postpartum.

Addressing Disparities in Early Childhood Nutrition

Due to a variety of historical, sociopolitical, and environmental factors, children living in households with low incomes in the US are less likely to meet FV intake recommendations.[49] As a result of systematic racism, there is often overlap and intersectionality between children living in households with low incomes in NC and children from intentionally marginalized racial/ethnic groups such as Hispanic or Latinx, Black or African American, and Asian children. Compared to children living in households with high incomes, children in households with low incomes maybe be less likely to consume whole fruit, dark green vegetables, and red/orange vegetables but more likely to consume less nutrient dense FV varieties such as 100% fruit juice and starchy vegetables.[49-51] Also, compared to white children, Black or African American children may be less likely to consume red/orange vegetables or whole fruit, but more likely to consume starchy vegetables and 100% juice.[52,53] Additionally, compared to white children, Asian children may be more likely to have low fruit and vegetable intake and Hispanic or Latinx children may be more likely to consume 100% fruit juice.[52-54] In NC in particular, there is also considerable

intersectionality of income, race, ethnicity, and urbanicity/rurality and these intersectional identities contribute to differential risk of food insecurity and inadequate FV consumption.[55]

Below we summarize a few of the barriers to consuming adequate FV that likely contribute to these disparities in intake. We aim to identify barriers to consuming adequate FV experienced by WIC households in our qualitative aim and assess if the CVB increase alleviated some of these barriers in both our qualitative and quantitative aims.

Many studies have documented the inverse relationship between the nutrient density and cost of foods, demonstrating there are significant financial barriers to achieving recommended intakes of food groups like FV.[56,57] This financial barrier is a notable contributor to the observed disparities in FV consumption described above.[58] In addition to the relative cost of FV to energy-dense nutrient-poor foods, we must also consider the cost to families of the repeated exposure to and variety of FV that were mentioned earlier as critical components of healthy taste preference development. Prior research has demonstrated that caregivers in households with low incomes may be particularly hesitant to serve foods to their children that they may not accept such as FV.[59,60] Preliminary studies suggest that these barriers have been at least somewhat reduced with the increase in CVB and that participants perceive they are consuming a greater variety of FV;[41,43] however, few, if any, studies, have quantitatively evaluated whether the 2021 CVB increase was associated with increased quantity and variety of FV purchased among WIC participants.

There is a wealth of literature documenting disparities in access to FV in communities with low incomes.[61,62] In addition to income-based disparities, there are also disparities in access to FV by urbanicity. Few studies have examined how the local food environment influences food choices among rural and urban North Carolinians,[55,63,64] and few if any studies have examined how CVB use after the benefit increase may be affected by physical FV access. These studies generally suggest that there are some access issues that are similar between very urban (e.g., downtown urban areas) and rural areas such distance to a supermarket, but

some barriers such as lack of variety of availability of culturally-appropriate FV may be more common in rural areas in NC.[55,63,64] In order to inform public health nutrition interventions, we need to understand how CVB use may differ by WIC participants' physical access to FV. We will address this gap by conducting focus groups stratified by urbanicity with WIC participants in NC.

In addition to financial and physical access barriers that contribute to disparities in FV intake, researchers have highlighted the role of disenfranchisement in nutrition-related disparities, specifically 1) being denied or experiencing delays in public benefits such as WIC benefits, 2) being afraid to access benefits, and 3) receiving an inadequate amount or unacceptable food through benefit programs.[21,55,64,65] We explore participant awareness of the CVB increase, implementation issues that may have contributed to delays in issuing the CVB increase, as well as acceptability of the increase with WIC participants in our qualitative study to document and understand barriers to using the increased CVB. To our knowledge, no studies have examined the role of disenfranchisement in CVB use and FV intake disparities among WIC participants. This information can inform improvements in the implementation of FV benefit at the state level or the design of changes to the CVB at the federal level.

The COVID-19 Pandemic Likely Exacerbated Diet-Related Disparities

Intentionally Marginalized Communities and Public Health Emergencies

Intentionally marginalized communities, or groups that experience discrimination and exclusion such as certain racial/ethnic groups or households with low incomes, are disproportionately negatively impacted when there are public health emergencies such as pandemics and natural disasters. These communities are also disproportionately burdened with a range of chronic health conditions, which are exacerbated by these societal shocks.[66-70] Such communities often have fewer resources to buffer against the financial, physical, and mental shocks that these kinds of disasters create.[68,69] We must design evidence-based policies, programs, and services that promote equity and protect the health and well-being of marginalized groups. There is some evidence for the design of these policies from public health

emergencies such as hurricanes and other natural disasters, but due to the nascency of pandemics relative to other emergencies, little research exists to inform equity promoting policies during pandemics in the US. We will fill this gap by examining whether and how food purchases of food groups of public health interest shifted among WIC participants in response to the COVID-19 pandemic.

Intentionally Marginalized Communities and the COVID-19 Pandemic

Like patterns from prior public health emergencies, families with low incomes or from intentionally marginalized racial/ethnic groups have been more likely to experience job loss and food insecurity because of COVID-19, and this has the potential to worsen existing diet-related health disparities.[18,20,71-73] Additionally, some families with low incomes and from intentionally marginalized groups were likely to access COVID-19 emergency food response programs due to the disenfranchisement, systematic racism, and other structural factors described previously, further widening disparities.[21,74-76] The shock of COVID-19 may have altered food shopping behaviors due to a variety of economic, supply chain, and/or psychological factors, and preliminary studies suggest WIC participants may have been disproportionately affected due to the limited varieties of foods that can be purchased with WIC benefits.[77,78] The research that exists on the effects of COVID-19 and food purchases and consumption in the US generally either relies on self-report and/or does not focus on populations with low incomes, historically marginalized groups, or WIC participants.[25,27-30,79-82] Scientists predict that the frequency and severity of environmental and societal shocks, like COVID-19, will increase,[83,84] so using objective, point-of-sale food transaction data to describe the effects of the COVID-19 pandemic on food purchasing patterns of WIC shoppers can guide future federal emergency food response efforts that promote health and reduce disparities.

Emergency Food Systems and Health Disparities

One potential contributor to the disparate negative impacts of public health emergencies on historically marginalized communities is the emergency food system. Advocates have been

calling for improvements in the quality of food provided by emergency food response efforts for over a decade. In response to COVID-19, the USDA implemented a myriad of emergency food response programs such as expansions in the monthly allotment for SNAP, expanded access to Pandemic-Electronic Benefit Transfer for families with children, and increases in the WIC CVB.[85] The effects of USDA's COVID-19 emergency food response programs on participants' food purchases are currently not well understood. In addition to understanding how food purchases change in response to COVID-19, we also need to generate evidence on the effectiveness of USDA's response to COVID-19 in preventing food insecurity and encouraging purchases of health-promoting foods such as FV. Existing research on program modifications generally suggests they provided a crucial safety net and improved food security;[77,86-88] however, important barriers to benefit use exist such as delays in receipt of benefits, fear of accessing benefits, and provision of inedible or undesirable foods.[21,43] Our qualitative aim will add to this evidence by gathering data on barriers and facilitators to use of the increased CVB and experiences navigating the CVB changes over time among WIC participants in NC. Additionally, to date, no studies in the US have used food purchasing data to examine the effects of USDA's COVID-19 emergency food response programs. We will fill this gap in our third aim by utilizing food transaction data and quasi-experimental methods to estimate the effects of the CVB increase on WIC participant food purchases.

WIC Supports Improved Nutrition, But There Are Notable Barriers to Use

WIC provides supplemental foods (i.e., the WIC food packages), nutrition and breastfeeding education, and referrals to other key health care and social services for more than six million families with low incomes in the US.[15] There is a large body of research detailing the many potential benefits to parents and children associated with participating in WIC. WIC participation has been associated with increased food security, improved birth outcomes, higher overall diet quality, lower risk of abuse and neglect, as well as improved cognitive development.[38,89-93]

In terms of FV intake specifically, studies show mixed results as to whether WIC participating children consume more FV than income-eligible non-participants depending on the age group studied or the measure (i.e., percent consuming any FV vs. amount consumed). Some studies show that WIC participating children are more likely to consume any fruits and vegetables (percent consuming) compared to income-eligible non-participants.[10,94] However, some studies suggest WIC participants may be less likely to meet FV intake recommendations (amount consumed) or to consume any FV compared with income eligible non-participants.[94,95] Other studies show no differences between WIC participants and income-eligible non-participants.[49,96] Overall, these studies suggest there is room for improvement in the CVB component of the WIC food package and WIC participant FV consumption.

Many studies have documented barriers to use of WIC food package benefits. For example, participants report experiencing challenges identifying WIC eligible products, products being deemed ineligible at checkout that were labeled eligible in WIC mobile applications or on the shelfs, inadequate supply of WIC eligible products, and feeling stigmatized by grocery store staff or other customers when using WIC benefits.[23,97-99] Additionally, studies have found barriers to using WIC benefits or enrolling in the WIC program that may be experienced differentially by race, rurality, or income and widen existing nutritional disparities. For example, some researchers have examined how racist structures and ideologies affect people's enrollment in federal nutrition assistance programs.[65] With respect to WIC, researchers have documented how Black mothers may be more likely to perceive the monitoring imposed by WIC about infant feeding and weigh-ins to be high stakes, and potentially rightly so as research has documented the Black and Hispanic/Latinx women may be more likely to be sanctioned than white women in other social support programs for the same violations.[65] Among the Hispanic/Latinx community there are barriers to WIC enrollment such as concerns about deportation due to being a "public charge" and to use of WIC benefits such as fears of driving to the grocery store or lack of culturally-relevant foods in the food packages.[21,55,65,100,101] Racism

and rudeness in food stores or with WIC staff and the “cultural whiteness of public health campaigns” may also be critical deterrents to WIC benefit use and participation.[102-104] Additionally, in the rural South there are legacies of stigma around use of social support programs that can act as barrier to WIC participation.[64,65,105] Exploring these systematic barriers to WIC enrollment and WIC benefit use and how they may differ by race/ethnicity, rurality, and income is critically important in understanding solutions to existing nutritional disparities and informing federal WIC policies such as expanding online shopping, employee and vendor training policies, vendor stocking standards, and updates to the food packages.

Why Study the 2021 CVB Increase? Why is This Study Urgent?

Prior to 2009, the WIC food package did not include fruits beyond 100% fruit juice or vegetables except dried beans and peas, and canned or fresh carrots for breastfeeding participants.[37] In 2009, the WIC food package was revised to include the Cash Value Voucher (CVV) for FV. The CVV provided $6/month for children and $10/month for women and could be used on canned, fresh, frozen whole or cut fruit without added sugar or fat.[37] Many studies have estimated the effect of adding the CVV to the WIC food package on participant FV purchases and consumption and found this benefit change significantly increased FV purchases and consumption.[37-40] These data provide a strong proof of concept that we would expect similar increases in purchases and consumption with the 2021 increase in the CVB.

In NC, the CVB (formerly CVV) can be used on fresh, frozen, or canned FV with no added sugar, fats, oils, salt, or artificial sweeteners. Prior to June 2021, this benefit was $9/month for children ages one to four years and $11/month for pregnant and postpartum people. These amounts have been deemed inadequate to reach FV consumption recommendations by both WIC participants and the National Academies for Science, Engineering, and Medicine (NASEM).[16,98,106,107]

Additionally, prior to 2014, participants received CVB in the form of paper vouchers and, in some states, participants could not use a separate form of payment to cover the difference if

a fruit or vegetable purchase exceeded the CVB value.[108] These aspects of the CVB created barriers to use as documented by low redemption rates and interviews with WIC participants. Starting in 2014, states began to transition all WIC benefits to an Electronic Benefit Transfer (EBT). North Carolina implemented WIC EBT in 2018. Few studies have examined CVB redemption since the transition to EBT.[109,110] However, purchasing data suggest that about 75-80% of the CVB value may be redeemed by WIC participants, but still as many as 20% of participants do not redeem any of their CVB.[111] More recent studies of purchasing data have also found CVB redemption may differ by sociodemographic factors such as urbanicity, number of children in the household, and race/ethnicity.[109,111]

In response to increased food insecurity resulting from the COVID-19 pandemic, the USDA temporarily increased the CVB from $9-11/month/participant to $35/month/participant from June 2021 to September 2021. In September 2021, congress voted to extend the CVB increase but the levels shifted to the NASEM recommended amounts of $24/month for children, $43/month for pregnant and postpartum participants, and $47/month for breastfeeding participants until December 2021. These benefit levels have subsequently been extended multiple times and are now set to expire in September 2023. A few studies have examined WIC participant perceptions of the CVB increase using self-report methods and found that participants were satisfied with the increase and reported consuming more and a greater variety of fruits and vegetables.[41,43,112] We will gain qualitative insights into barriers to CVB use and perceived influences of the CVB increase on FV consumption and household diet, and quantitatively estimate the effect of the benefit on the amount and variety of FV purchased using objective, point-of-sale food transaction data. This information can inform efforts to determine whether and how to extend the higher CVB amount and to increase CVB redemption.

CHAPTER 3. SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN (WIC) PARTICIPANT GROCERY STORE PURCHASES DURING THE COVID-19 PANDEMIC IN NORTH CAROLINA

Overview

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 such as job losses and food shortages, but we do not yet understand how WIC participant food purchases may have shifted during this time. We used longitudinal grocery store transaction data from 496 stores in North Carolina between October 2019 and May 2021 to describe the association between the shock of the pandemic and WIC shoppers' food purchases. We observed small decreases in the share of total calories purchased from fruits and vegetables (FV)(-0.4%) and small increases in the share of calories from processed food (1.1%) and sugar sweetened beverages(SSB)(0.5%) when comparing the pre and post March 2020 periods. Compared to shoppers that started or stopped using WIC benefits during the pandemic, shoppers that used WIC benefits consistently had higher FV and lower processed food and SSB purchases. These findings can inform future emergency food response policies and efforts to reduce the effects of public health emergencies on diet-related disparities.

Introduction

As a result of the COVID-19 pandemic, households with low incomes and young children experienced high rates of employment loss and large increases in food insecurity.[18,20,71] These disproportionate effects are due in part to structural factors that have left groups with low incomes with less access to resources to recover from such emergencies. These downstream effects of the pandemic have the potential to exacerbate existing diet-related disparities since

food insecurity is often associated with higher consumption of energy-dense, nutrient-poor foods,[113] yet these effects are still being explored.

Of particular interest are participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). WIC is a federal nutrition assistance program that serves more than six million families with low incomes in the US and more than 260,000 North Carolinians. Preliminary data suggests that WIC families faced barriers to accessing healthy foods during the pandemic due to job loss, loss of nutrition assistance from school or daycare, and food supply disruptions.[77,78] However, we do not yet understand how WIC shoppers' food purchases may have shifted during the COVID-19 pandemic. This information can be used to design better emergency food response policies, as the frequency and severity of natural disasters and pandemics will likely increase.[83,84,114]

There is already some evidence that the COVID-19 pandemic led to unprecedented disruptions in the food supply, food acquisition behaviors, and food consumption behaviors.[24,28,115] For example, stay-at-home orders made it difficult to get to grocery stores, fear of contracting the virus lowered shopping frequency, restaurants, schools, and daycares closed so there was less food procured away from home, and there were widespread food shortages.[27-30,80,115,116] Prior studies have examined these pandemic-related shifts largely using self-reported measures of food consumption or purchases at one or only a couple of time points and the results are mixed[24-26] when it comes to food categories of public health interest such as fruits and vegetables (FV) and processed foods. For example, one systematic review found both increases and decreases in intake of fast foods and FV depending on the study and on the timing of the measures.[24] However, results are unclear potentially due to the self-reported nature of measures of food consumption or purchases used in existing studies, which could lead to inaccurate recall of what was consumed or socially desirable responding. One report using nationally representative retail-based scanner data found people were purchasing more of their food from food retail outlets (e.g., grocery stores, mass merchandisers) as opposed to food

away from home, but the overall composition of foods they purchased from retailers remained relatively stable during the pandemic.[30] Food retailer transaction data can shed light on the association between the disruption of the pandemic and nutrition-related behaviors, since purchases are independently measured at the point-of-sale rather than reported by participants. Importantly, few, if any, existing studies of food purchases during the pandemic focus explicitly on households with low incomes or participants in federal nutrition assistance programs despite the disproportionate impact of the pandemic on these populations.

In addition to shifts in food-related behaviors during the pandemic, there were concomitant changes within WIC that are useful to understand. For example, there were increases in WIC enrollment during the pandemic due to the economic downturn.[117] Examining differences in nutritional quality of food purchases among individuals longitudinally enrolled in WIC versus those newly enrolled or dropping off WIC during the pandemic can give us an understanding of the role nutrition assistance programs may play in buffering against the negative effects of public health emergencies on nutrition disparities.

Our primary objective was to describe the association between the shock of the COVID-19 pandemic and WIC shopper food purchases at a large grocery store chain in North Carolina. A secondary objective was to understand if those associations differed among three subgroups of WIC shoppers: 1) people who used WIC both before and during the pandemic, 2) people who started using WIC during the pandemic, and 3) people who stopped using WIC during the pandemic. Understanding how WIC shoppers' food purchases shifted in response to the societal shock of the pandemic can inform future emergency food response policies in the WIC program and more broadly.

Methods

Food Transaction Data and Food Groups

We used loyalty-card food transaction data[118,119] from October 2019 to May of 2021 from 496 stores belonging to a large grocery chain located in 86 of North Carolina's 100 counties.

These data include every food and non-food item purchased 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.[120-122]

Our analysis focused on several food categories of public health interest[123-125]: 1) *all* fruits, vegetables, nuts, and legumes *with and without* added salt, fat, or sugar (FV); 2)FV *without* added salt, fat, or sugar; 3)non-essential processed foods (i.e., salty snacks, candy, and desserts), and 4)sugar-sweetened beverages (SSB). 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 prior to 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, ultra-processed, shelf stable foods that families may have stockpiled in response to public health guidance to have at least two weeks' 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 Supplementary Table 3.1 in detail.

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 electronic benefit transfer (EBT) card at least once in the study period they were considered a WIC shopper. We included only WIC shoppers who had at least

two data points in the pre-COVID period (October 2019-February 2020) and at least two data points in the post 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 entire period of data available (n=2,989,116). To understand the purchasing patterns of shoppers consistently enrolled in WIC throughout the pandemic, we focused our primary analyses on loyalty card IDs of those who used WIC at least one time in the pre period and at least one time in the post period. We are calling this group '*consistent WIC shoppers'* (n=1,450,038 shopper-month observations).

To account for the increases in WIC enrollment during the pandemic[117] and to account for potential unmeasured differences in characteristics between shoppers participating in WIC before and after the pandemic, we decided to also examine purchases of two additional groups of WIC shoppers in secondary analyses: 1) '*previous WIC shoppers*' defined as loyalty card IDs who used WIC at least one time in the pre period but did not use WIC in the post period (n=389,180 shopper-month observations) . We are presuming these are largely individuals who either lost eligibility or dropped off WIC during this time; and 2) '*new WIC shoppers'* defined as loyalty card IDs who did not use WIC in the pre period but did use WIC at least one time in the post period (n=1,149,898 shopper-month observations). These groups allow us to understand, relative to using WIC and presumably being enrolled in WIC throughout the course of the pandemic (consistent WIC), how does the nutritional quality of food purchases among people newly enrolled in WIC (new WIC) and those dropping off or losing WIC eligibility during the pandemic (previous WIC) compare?

Exposure

Our primary exposure of interest was the shock introduced by the COVID-19 pandemic and associated stay-at-home orders or 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.[126] Therefore, we decided to specify our pre period as October 2019 (first month of data available) to February 2020 and our post period as March 2020 to May 2021.

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. Secondary outcomes were calories purchased per day from these four food groups. We selected the share outcomes as our primary outcomes because we expected that absolute calories 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 purchases from different food groups 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 de-identified 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: average minimum temperature, average 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 average maximum and minimum temperatures in Raleigh, North

Carolina each month using temperature data from the National Oceanic and Atmospheric Administration.[127,128]

Statistical Analysis

We compared mean purchases from each food group in the pre-period and in the post-period using unadjusted linear regression models with standard errors clustered at the loyalty card ID level. We then used an interrupted time series design in our adjusted models to describe the association between the shock of the pandemic and WIC shopper purchases**.** 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 pre and post period. Additionally, we used fixed effects models to control for time-invariant shopper characteristics that we are unable to observe. All adjusted models used cluster robust standard errors, and we used the Holm-Bonferroni method[129] to adjust p values for multiple comparisons. To assess differences in the immediate effects and pre- and post-slopes across the three 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 three groups due to the stratified models. All analyses were conducted using Stata version 17. This study was deemed non-human 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 vs. 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, 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 Post Periods

When comparing the pre-period (Oct 2019-Feb 2020) to the post-period (Mar 2020- May 2021) among consistent WIC shoppers, the unadjusted monthly mean share of calories from all FV decreased (-0.4%) (Table 3.1). In contrast, the unadjusted share of calories from processed foods and SSBs increased (1.1% and 0.5%, respectively). There were increases in calories per day from all food groups comparing the pre to post period (Table 3.1).

Changes in WIC Shopper Food Purchases from Adjusted Models

Fruits, Vegetables, Nuts and Legumes (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 (-0.3%, $p<0.001$) (Table 3.2). In the post period, the slopes or trends over time in the share of calories from FV shifted from negative to positive (Table 3.2), perhaps suggesting purchases were returning to pre-pandemic levels after the March 2020 immediate decrease; however, the overall change in slope from pre to post 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 post period (Table 3.2 and Figure 3.1). The results for FV without added salt, sugar, and fat were similar to those for all FV (Supplementary Tables 3.2, 3.3, 3.4, 3.5).

Processed Foods: Among consistent WIC shoppers, there was an immediate increase in March 2020 in the share of total calories from processed foods (0.8%, $p<0.001$). The trends over time in share of total purchases from processed foods shifted from positive in the pre period to negative in the post period (overall change of -0.2%, $p<0.001$) (Table 3.2 and Figure

3.2). 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 post period (overall change of -14.8 calories per day, $p<0.001$)) (Table 3.2 and Figure 3.1).

Sugar Sweetened Beverages (SSBs): Among consistent WIC shoppers, there was a small, immediate decrease in March 2020 in the share of total calories coming from SSBs (-0.2%, $p<0.001$) (Table 3.2). For both share of total calories from SSBs and calories per day from SSBs, the overall changes in the slope from the pre to post period were small (0.2%, $p<0.001$ and 1.2 $p<0.001$, respectively), but there was a sign change from negative to positive trends over time (Table 3.2, Figure 3.1, Figure 3.2). In contrast to the immediate decrease in share of calories from SSBs, there was an immediate increase in the calories purchased per day from SSBs in March 2020 (42.4 calories, $p<0.001$) (Table 3.2).

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 3.2), compared to new and previous WIC shoppers. Comparing the pre to post period, the new WIC group experienced the largest increase in share of calories and calories purchased per day from FV (Figure 3.1 and 3.2, Supplementary Table 3.4). 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 to increases among consistent and previous WIC shoppers (Figure 3.2, Supplementary Table 3.4). 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 group experienced small decreases (Figure 3.2, Supplementary Table 3.4).

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 in the pre and post periods (Supplementary Tables 3.6 and 3.7). In terms of the estimates of the immediate effects and slopes, for the absolute (oz/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 (Supplementary Table 3.8). We did not find evidence of modification by SNAP use.

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 food transaction data. Among consistent WIC shoppers, there were small decreases in the share of calories from FV and small increases in the share of calories from processed food and SSBs when comparing the pre and post periods. We also observed immediate increases in absolute food purchases 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 largely closed during the early stages of the pandemic as well as directives from the federal government to stockpile about two weeks' worth of food.[29,30]

However, upon examining the trends in purchases in the 14 months following the initial shock, it appears that purchases in the food groups examined were trending toward where they were pre-pandemic. These trends back to pre-pandemic levels are consistent what has been observed using nationally representative retail scanner data[30]. 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.[29,30]

In terms of WIC shoppers' FV purchases, there were few changes of potential public health significance over this period. For example, the observed decrease of 0.4% of calories from the pre to post period when an average WIC household is buying between 2400-2800 calories/day from this retailer, is a difference of about 10 calories of FV per household per day. However, the share of calories purchased from FV remains far below the share of calories from SSBs and processed foods which is 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. 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.[24,29,31,32]

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 our results are largely consistent with these studies. For example, one report using retail scanner data from IRI InfoScan[130] found similarly large immediate effects of the pandemic on retail food purchases (e.g., grocery stores and mass merchandisers), documenting a 57.5% increase in food retail sales during the week of March 15, 2020, and that higher overall retail food sales endured into 2021.[30] Despite these large changes in total food sales, this study also found small changes in the relative composition of food sales[30], similar to our findings regarding the share of total calories from the food groups examined. One other nationally representative study used self-reported purchase data from the U.S. Census Bureau and found that declines in spending on food away from home were offset by food at home purchases, and the categories that increased the most in terms of the share of total expenditures were processed foods such

as desserts, salty snacks, and prepared meals, which is consistent with the increases in share of calories from processed food we observed in WIC shoppers.[29] On the other hand, this study also found relatively large increases in the share of the total food budget coming from FV. This difference may be attributed to the use of dollar expenditures as the outcome as opposed to calories. For example, shoppers may have been spending more on FV due to inflation,[30] but purchasing fewer total FV. 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[131] and that intakes during the lockdown period compared to shortly after were higher in discretionary foods, desserts, juice, and other beverages, and lower in fruits, vegetables and dairy.[24] This review also found that individuals with lower incomes had worse outcomes related to shifts in dietary behaviors during the pandemic.[24] Though these reviews include studies from international contexts in addition to the US, they are relatively consistent with what we found in this study. Similarly, studies conducted in the US using convenience samples and self-report have generally concluded that there were decreases in vegetables purchased during this period,[28] and individuals with low incomes or those experiencing food insecurity, in particular, reported purchasing lower cost foods, and purchasing more packaged, shelf-stable foods.[31,32,43] The current study adds to this literature by examining objective, longitudinal food retailer transaction data from nearly 500 grocery stores.

We also found that people who consistently used WIC prior to and during the COVID-19 pandemic regularly had the highest share of calories from FV and the lowest share of calories from processed food and SSBs throughout the course of the pandemic, compared to people who started or stopped using WIC during the pandemic, though the differences across groups were small in magnitude. This is consistent with existing research that documents participation in the WIC program is associated with improved diet quality,[132-134] though we are not measuring

diet in this study and these prior studies were not conducted during the pandemic. It also appears that people who started using WIC during the pandemic experienced a decrease in share of calories from processed food and SSBs and a slight increase in share of calories from FV over the course of the pandemic; whereas those consistently using WIC and stopping WIC use during the pandemic experienced increases in share of calories from processed food and SSBs and decreases in share of calories from FV (though those consistently using WIC still had the highest overall purchases of FV and lowest purchases of processed food and SSBs). It is possible that either consistent or new enrollment in the WIC program during the pandemic, compared to 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.

This study adds to the growing literature of shifts in food behaviors during the pandemic that can inform future emergency food response policy to prevent widening of diet-related disparities. For example, we observed higher quality food purchases among people consistently or newly enrolled in WIC 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 to FV purchases, 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, nutrient-dense food options in future emergencies.

Strengths and Limitations

The primary strength of this work is our use of longitudinal, food transaction data starting five months prior to the COVID-19 pandemic stay at home orders and following shoppers for

over one year after the shock of the pandemic. This study also adds to the literature by focusing on households with low incomes, which are known to be disproportionately negatively affected by public health disasters such as the pandemic. Additionally, we feel confident that, although these are only data from one retailer and do not include food purchased away from home, we are capturing a large share of WIC shopper grocery store purchases in North Carolina. We know from prior research that most foods purchased with WIC benefits are purchased at large grocery stores and that this retailer is the preferred retailer for redeeming WIC in North Carolina due to better shelf labeling of WIC approved foods.[116,135] There are limitations to our approach and to using loyalty card data more generally. For example, due to our definition of WIC shoppers, we may have some misclassification of WIC shoppers and include observations of individuals that are not currently enrolled in WIC. However, there are also limitations to using more strict criteria such as excluding true WIC shoppers that simply do not shop at this retailer for a certain period or use their WIC benefits at this retailer in a given month. Additionally, we are not able to control for or measure the effects of other societal and policy changes that occurred during this time period; however, theoretically these changes would have impacted our three WIC groups similarly and the overall aim of this paper is to understand how WIC shopper purchases changed during this time period despite or as a result of these secular trends and changes. Future work will be able to better assess how factors such as pandemic-related changes in other social support programs and flexibilities in the WIC program may explain some of our findings. Additionally, as with all de-identified loyalty card data, we were not able to control for shopper-level demographic characteristics such as income, race/ethnicity, or household size. However, we are able to address differences in time-invariant shopper-level characteristics by using fixed effects models and comparing shoppers to themselves over time. These data are also geographically limited to North Carolina, so our findings may not be generalizable to other locations.

Conclusions

There were notable immediate increases in calories purchased per day 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 food and SSBs. Overall, trends of purchases into 2021 suggest that purchasing patterns among WIC shopper purchases were largely trending back toward pre-pandemic levels. Shoppers consistently enrolled in WIC reliably had the best overall purchase quality (i.e., lowest processed food and SSBs, highest FV) during the pandemic compared to shoppers that either started or stopped using WIC during the pandemic. Our results, in addition to existing research in this area, suggest that additional supports for purchases of health promoting food groups may be needed for households with low incomes experiencing food insecurity in critical periods of life during future public health emergencies.

Tables and Figures

Table 3.1. 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 monthly mean between the pre and post period among consistent WIC shoppers (n=1,450,038 shopper-month observations)

Food Group	Pre Period (Oct 2019-Feb 2020)	Post Period (Mar 2020-May 2021)	Difference between pre and post period
	Mean Calories Purchased Per Day (SD)		
Total	2411.6 (2118.0)	2820.8 (2413.9)	409.2*
All FV	195.4 (197.9)	218.7 (218.3)	23.4*
Processed foods	652.2 (692.2)	774.8 (771.9)	122.7*
SSB	229.9 (299.0)	283.6 (363.6)	53.8*
	Mean Percentage of Total Food and Beverage Calories Purchased (SD)		
All FV	9.4 (10.3)	9.0 (9.9)	-0.4*
Processed foods	25.4(16.7)	26.4 (16.3)	1.1*
SSB	10.3(13.1)	10.7 (12.9)	0.5*

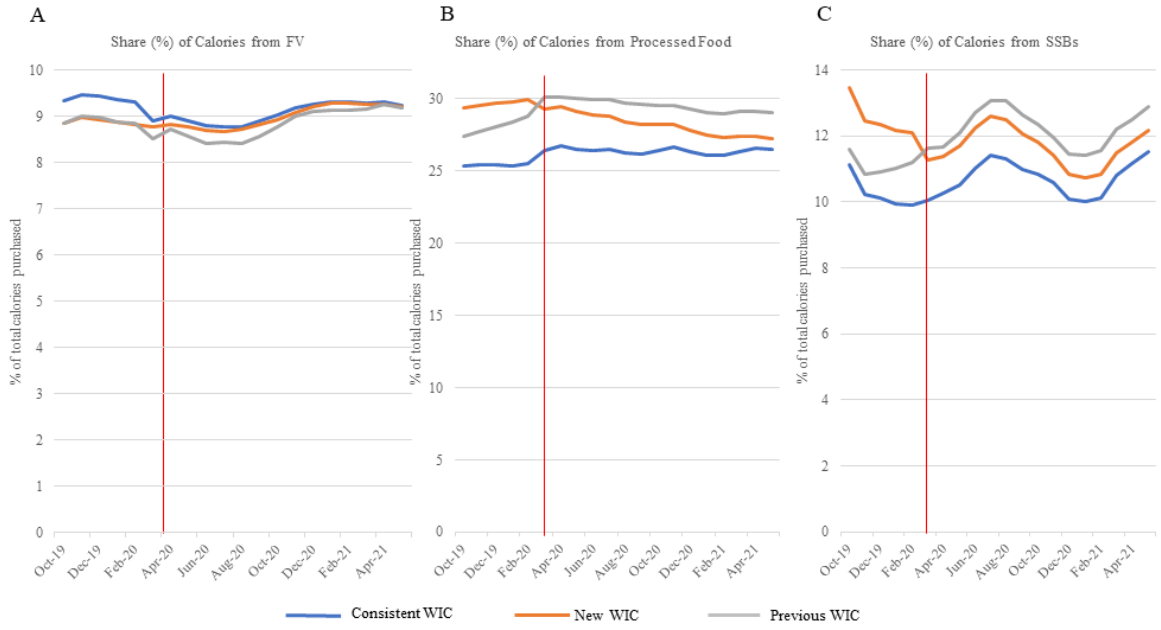
FV: fruits, vegetables, nuts, and legumes; SSB: sugar sweetened beverages, SD: standard deviation
*Statistically significant after Holm-Bonferroni adjustment for multiple comparisons

Table 3.2. Estimates and 95% confidence intervals from adjusted fixed effects models of the immediate effect (change in intercept), the slope in the pre period, the slope in the post period, and the overall change in slope from the pre to post 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 pre	Slope post	Change in slope
	Share of Total Calories Purchased (%)			
All FV	-0.3* (-0.4,-0.3)	-0.04* (-0.06, -0.01)	0.02* (0.02, 0.03)	0.06* (0.04, 0.08)
Processed Foods	0.8* (0.6, 0.9)	0.1* (0.08, 0.2)	-0.03* (-0.04, -0.02)	-0.2* (-0.2, -0.1)
SSBs	-0.2* (-0.3, -0.1)	-0.1* (-0.1, -0.07)	0.07* (0.06, 0.07)	0.2* (0.1, 0.2)
	Calories Purchased per Day			
All FV	35.9* (34.5, 37.3)	-1.5* (-1.9, -1.2)	-1.3* (-1.4, -1.2)	0.2 (-0.2, 0.6)
Processed Foods	151.4* (146.7, 156.1)	7.9* (6.8, 9.0)	-6.9* (-7.2, -6.5)	-14.8* (-16.0, -13.5)
SSBs	42.4* (40.3, 44.5)	-1.0* (-1.5, -0.5)	0.2* (0.01, 0.4)	1.2* (0.6,1.7)

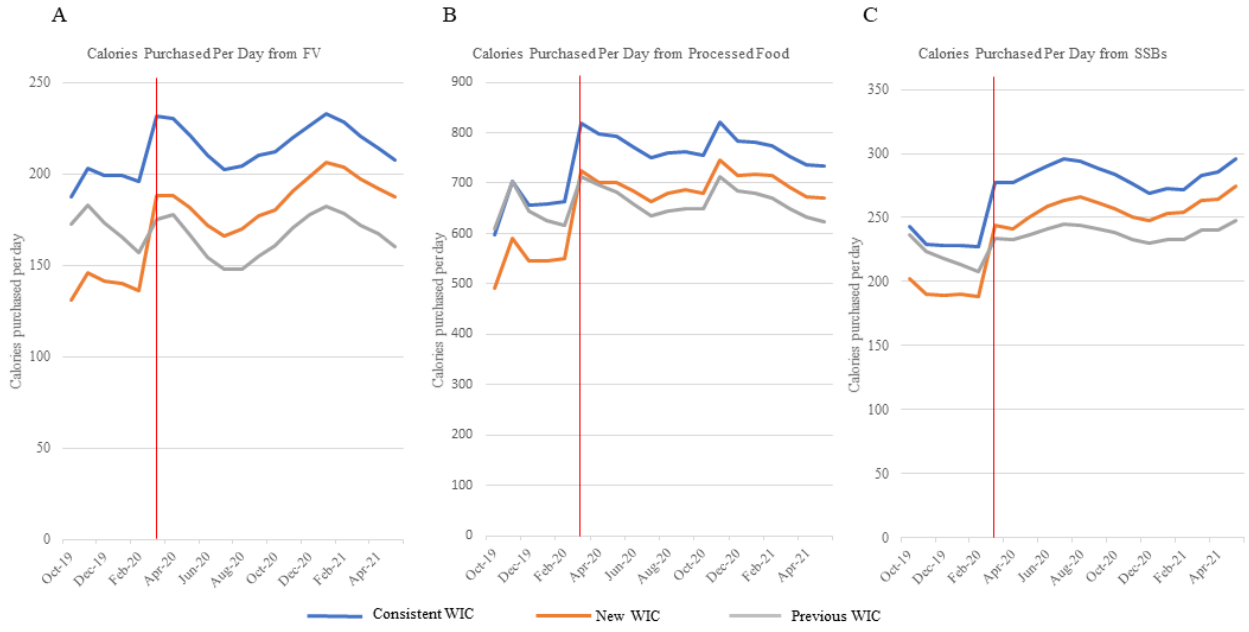
*Statistically significant after Holm-Bonferroni adjustment for multiple comparisons
95% CI's are not adjusted for multiple comparisons
FV: Fruits, vegetables, nuts, and legumes, SSB: sugar sweetened beverage

Figure 3.1. Monthly means of predicted values from adjusted fixed effects models for all food groups in terms of share of total calories purchased, October 2019 to May 2021



Footnote: (A)Share of total calories from fruits, vegetables, nuts and legumes, (B) Share of total calories from processed foods, (C)Share of total calories from sugar sweetened beverages. Red line denotes March 2020.

Figure 3.2. Monthly means of predicted values from adjusted fixed effects models for all food groups in terms of calories purchased per day, October 2019 to May 2021



Footnote: (A)Calories purchased per day from fruits, vegetables, nuts and legumes, (B) Calories purchased per day from processed foods, (C)Calories purchased per day from sugar sweetened beverages. Red line denotes March 2020.

Supplemental Table 3.1. Detailed description of food groups, example products, and rationale for inclusion

Food Group	Example Products	Rationale
Fruits, vegetable, nuts, and legumes with and without added salt, sugar, and fat	Fresh fruits, fresh vegetables, canned vegetables with and without salt, canned peaches in syrup, canned beans with and without salt	Underconsumed in the US. Associated with lower risk of diet-related chronic diseases. Cost of fruits and vegetables affected by inflation.
Fruits, vegetables, nuts, and legumes without added salt, sugar, and fat	Fresh fruits, fresh vegetables, canned fruit without added sugar, canned vegetables without added salt, frozen fruits, frozen vegetables without added salt or fat, canned beans without added salt	Underconsumed in the US. Associated with lower risk of diet-related chronic diseases. Cost of fruits and vegetables affected by inflation. Fruits and vegetables without added salt, fat, or sugar are part of the WIC food packages in NC and this component was increased in June 2021.
Processed foods	Grain- and dairy-based desserts, potato chips, tortilla chips, pretzels, candy, chocolate, frosting	Overconsumption associated with diet-related chronic disease. Studies have reported increased purchases of foods in this category associated with the shock of the pandemic. Shelf stable foods that may have been more likely to be stockpiled.
Sugar sweetened beverages	Sodas, fruit and vegetable drinks with <100% juice, sweetened coffee and tea, energy drinks, sports drinks	Overconsumption associated with diet-related chronic disease. Studies have reported increased purchases of foods in this category associated with the shock of the pandemic. Shelf stable foods that may have been more likely to be stockpiled.

Supplemental Table 3.2. Unadjusted mean percentage of total food and beverage calories purchased from each food group pre and post March 2020 for consistent, new, and previous WIC shoppers

WIC Group	Food Group	Mean Share (%) of Calories Purchased (SD)		Difference between pre and post period
		Oct 2019-Feb 2020	Mar 2020-May 2021	
Consistent	All FV	9.4 (10.3)	9.0 (9.9)	-0.4*
New	All FV	8.9 (12.9)	9.0 (11.2)	0.1*,†
Previous	All FV	9.0 (11.4)	8.8 (12.0)	-0.2*,†
Consistent	FV without added salt sugar or fat	7.4 (9.6)	6.9 (9.1)	-0.5*
New	FV without added salt sugar or fat	6.4 (11.5)	6.6 (10.0)	0.2*,†
Previous	FV without added salt sugar or fat	6.7 (10.4)	6.3 (10.8)	-0.4*
Consistent	Processed food	25.4(16.7)	26.4 (16.3)	1.1*
New	Processed food	29.6(20.7)	28.2 (18.1)	-1.4*,†
Previous	Processed food	27.9(18.7)	29.6 (19.4)	1.7*,†
Consistent	SSB	10.3(13.1)	10.7 (12.9)	0.5*
New	SSB	12.5(17.5)	11.7 (15.0)	-0.8*,†
Previous	SSB	11.2(15.0)	12.2 (16.2)	0.9*,†

SD: standard deviation; FV: fruits, vegetables, nuts, and legumes; SSB: sugar sweetened beverages
*Significantly different comparing the pre and post period means
†Significantly different pre to post period difference compared to the pre to post period difference for the consistent WIC group

Supplemental Table 3.3. Unadjusted mean calories purchased per day from total foods and beverages and from each food group pre and post March 2020 for consistent, new, and previous WIC shoppers

WIC Group	Food Group	Mean Calories Purchased Per Day (SD)		Difference between pre and post period
		Oct 2019-Feb 2020	Mar 2020-May 2021	
Consistent	Total Food and Beverage	2411.6 (2118.0)	2820.8 (2413.9)	409.2*
New	Total Food and Beverage	1840.5 (1926.3)	2421.5 (2263.4)	581.0*,†
Previous	Total Food and Beverage	2101.0 (2018.6)	2279.8 (2260.8)	178.8*,†
Consistent	All FV	195.4 (197.9)	218.7 (218.3)	23.4*
New	All FV	140.2 (182.3)	186.1 (208.2)	45.9*,†
Previous	All FV	163.0 (185.3)	168.9 (200.1)	6.0*,†
Consistent	FV without added salt sugar or fat	144.5 (156.0)	157.6 (170.4)	13.0*
New	FV without added salt sugar or fat	95.1 (133.4)	129.1 (156.9)	34.0*,†
Previous	FV without added salt sugar or fat	114.1 (140.1)	114.0 (147.9)	-0.1†
Consistent	Processed food	652.2 (692.2)	774.8 (771.9)	122.7*
New	Processed food	551.8 (639.6)	694.1 (729.2)	142.3*,†
Previous	Processed food	609.4 (668.3)	678.1 (735.8)	68.7*,†
Consistent	SSB	229.9 (299.0)	283.6 (363.6)	53.8*
New	SSB	194.5 (293.5)	255.7 (360.6)	61.2*,†
Previous	SSB	209.8 (289.1)	241.8 (337.8)	31.9*,†

SD: standard deviation; FV: fruits, vegetables, nuts, and legumes; SSB: sugar sweetened beverages
*Significantly different comparing the pre and post period means
†Significantly different pre to post period difference compared to the pre to post period difference for the consistent WIC group

Supplemental Table 3.4. Estimates from adjusted fixed effects models of the immediate effect (change in intercept) in March 2020, the slope in the pre period and the slope in the post period for all food groups in terms of the share of total calories purchased from the food group by WIC group

	Immediate effect (95% CI)	**Slope pre (95% CI)**	**Slope post (95% CI)**
All Fruits, Vegetables, Nuts, and Legumes			
Consistent WIC	-0.3* (-0.4,-0.3)	-0.04* (-0.06, -0.01)	0.02* (0.02, 0.03)
New WIC	0.03 (-0.09, 0.2)	-0.04* (-0.07, -0.01)	0.03* (0.03, 0.04)
Previous WIC	-0.2* (-0.4, -0.03)	-0.03 (-0.07, 0.02)	0.04* (0.03, 0.05)
Fruits, Vegetables, Nuts, and Legumes without Added Salt, Sugar, or Fat			
Consistent WIC	-0.5* (-0.6, -0.4)	0.01 (-0.01, 0.03)	0.02* (0.01, 0.02)
New WIC	-0.05 (-0.2, 0.06)	0.00 (-0.03, 0.03)	0.04* (0.03, 0.04)
Previous WIC	-0.4* (-0.6, -0.3)	-0.01 (-0.06, 0.03)	0.03* (0.02, 0.04)
Processed Foods			
Consistent WIC	0.8* (0.6, 0.9)	0.1* (0.08, 0.2)	-0.03* (-0.04, -0.02)
New WIC	-0.9* (-1.1, -0.7)	0.2* (0.2, 0.3)	-0.2* (-0.2,-0.2)
Previous WIC	0.8* (0.5, 1.1)	0.4* (0.3, 0.5)	-0.09* (-0.1, -0.07)
Sugar Sweetened Beverages			
Consistent WIC	-0.2* (-0.3, -0.08)	-0.1* (-0.1, -0.07)	0.07* (0.06, 0.07)
New WIC	-1.2* (-1.4, -1.1)	-0.1* (-0.2, -0.08)	0.03* (0.02, 0.04)
Previous WIC	-0.2 (-0.4, 0.08)	0.1* (0.05, 0.2)	0.06* (0.05, 0.08)

*Statistically significant after Holm-Bonferroni adjustment for multiple comparisons
95% confidence intervals are not adjusted for multiple comparisons
CI: confidence interval, FV: Fruits, vegetables, nuts, and legumes, SSB: sugar sweetened beverage

Supplemental Table 3.5. Estimates from adjusted fixed effects models of the immediate effect (change in intercept) in March 2020, the slope in the pre period and the slope in the post period for all food groups in terms of calories purchased per day by WIC group

	Immediate effect (95% CI)	**Slope pre (95% CI)**	**Slope post (95% CI)**
All Fruits, Vegetables, Nuts, and Legumes			
Consistent WIC	35.9* (34.5, 37.3)	-1.5* (-1.9, -1.2)	-1.3* (-1.4, -1.2)
New WIC	53.2* (51.7, 54.7)	-2.4* (-2.8, -2.0)	0.2* (0.1, 0.3)
Previous WIC	27.5* (24.9, 30.1)	-7.1* (-7.7, -6.4)	-1.0* (-1.1, -0.8)
Fruits, Vegetables, Nuts and Legumes without Added Salt, Sugar, and Fat			
Consistent WIC	21.7* (20.6, 22.9)	-0.6* (-0.9, -0.3)	-1.05* (-1.13, -0.96)
New WIC	37.2* (36.1, 38.4)	-1.4* (-1.7, -1.1)	0.3* (0.3, 0.4)
Previous WIC	16.7* (14.7, 18.7)	-5.4* (-5.9, -4.9)	-0.6* (-0.7, -0.4)
Processed Foods			
Consistent WIC	151.4* (146.7, 156.1)	7.9* (6.8, 9.0)	-6.9* (-7.2, -6.5)
New WIC	173.8* (168.8, 178.8)	4.8* (3.6, 6.0)	-3.6* (-4.0, -3.2)
Previous WIC	112.2* (103.6, 120.9)	-7.0* (-9.1, -4.9)	-6.8* (-7.5, -6.1)
Sugar Sweetened Beverages			
Consistent WIC	42.4* (40.3, 44.5)	-1.0* (-1.5, -0.5)	0.2* (0.01, 0.4)
New WIC	48.7* (46.4, 51.0)	-1.6* (-2.1, -1.0)	1.5* (1.4, 1.7)
Previous WIC	25.3* (21.5, 29.2)	-5.4* (-6.4, -4.5)	0.3 (-0.01, 0.6)

*Statistically significant after Holm-Bonferroni adjustment for multiple comparisons
95% confidence intervals are not adjusted for multiple comparisons
CI: confidence interval, FV: Fruits, vegetables, nuts, and legumes, SSB: sugar sweetened beverage

Supplemental Table 3.6. Unadjusted mean volume purchased per day from total foods and beverages and from each food group pre and post March 2020 for consistent, new, and previous WIC shoppers

WIC Group	Food Group	Mean Volume Purchased Per Day (SD)		Difference between pre and post period
		Oct 2019-Feb 2020	Mar 2020-May 2021	
Consistent	Total	80.7 (67.3)	97.5 (80.2)	16.8*
New	Total	60.8 (62.0)	84.0 (76.5)	23.2*,†
Previous	Total	69.5(63.9)	77.8 (74.6)	8.3*,†
Consistent	All FV	8.5 (8.6)	10.0 (9.9)	1.4*
New	All FV	6.4 (7.9)	8.6 (9.3)	2.2*,†
Previous	All FV	7.3 (8.1)	7.9 (9.0)	0.6*,†
Consistent	FV without added salt sugar or fat	7.3 (7.7)	8.5 (8.8)	1.2*
New	FV without added salt sugar or fat	5.3 (6.9)	7.2 (8.2)	1.9*,†
Previous	FV without added salt sugar or fat	6.1 (7.1)	6.6 (7.9)	0.5*,†
Consistent	Processed food	8.1 (8.5)	9.9 (9.6)	1.8*
New	Processed food	6.9(8.0)	8.8 (9.1)	1.9*,†
Previous	Processed food	7.6(8.3)	8.6 (9.2)	1.0*,†
Consistent	SSB	21.7 (27.2)	28.1 (33.3)	6.4*
New	SSB	19.1 (27.2)	26.0 (33.4)	6.9*,†
Previous	SSB	20.4 (26.8)	24.7 (31.6)	4.3*,†

SD: standard deviation; FV: fruits, vegetables, nuts, and legumes; SSB: sugar sweetened beverages
*Significantly different comparing the pre and post period means
†Significantly different pre to post period difference compared to the pre to post period difference for the consistent WIC group

Supplemental Table 3.7. Unadjusted mean percentage of total food and beverage ounces purchased from each food group pre and post March 2020 for consistent, new, and previous WIC shoppers

WIC Group	Food Group	Mean Share (%) of Volume Purchased (SD)		Difference between pre and post period
		Oct 2019-Feb 2020	Mar 2020-May 2021	
Always	All FV	11.9(11.2)	11.6 (11.0)	-0.2*
New	All FV	12.0 (14.0)	11.8 (12.2)	-0.2*
Previous	All FV	11.7 (12.6)	11.8 (13.2)	0.1†
Always	FV without added salt sugar or fat	10.4 (10.8)	10.1 (10.5)	-0.2*
New	FV without added salt sugar or fat	10.1 (13.2)	10.1 (11.6)	-0.1*,†
Previous	FV without added salt sugar or fat	10.0 (11.9)	10.0 (12.4)	0.0†
Always	Processed food	10.8 (10.8)	11.2 (10.6)	0.4*
New	Processed food	13.9 (15.4)	12.3 (12.4)	-1.6*,†
Previous	Processed food	12.4 (13.0)	13.4 (13.9)	1.0*,†
Always	SSB	24.0 (20.5)	25.9 (20.3)	1.9*
New	SSB	28.3 (24.6)	27.9 (22.3)	-0.4*,†
Previous	SSB	26.3 (22.5)	28.9 (23.4)	2.5*,†

SD: standard deviation; FV: fruits, vegetables, nuts, and legumes; SSB: sugar sweetened beverages
*Significantly different comparing the pre and post period means
†Significantly different pre to post period difference compared to the pre to post period difference for the consistent WIC group

Supplemental Table 3.8. Estimates from adjusted fixed effects models of the immediate effect (change in intercept) in March 2020, the slope in the pre period and the slope in the post period for all food groups in terms of the share of total volume and volume per day purchased from the food group for consistent WIC shoppers

	Immediate effect (95% CI)	**Slope pre (95% CI)**	**Slope post (95% CI)**	**Change in slope (95% CI)**
	Volume (ounces) purchased per day			
All FV	1.4* (1.4,1.5)	-0.04* (-0.05, -0.03)	-0.03* (-0.03,-0.02)	0.01 (0.00,0.03)
Processed Food	1.5* (1.4, 1.5)	0.2* (0.2,0.2)	-0.06* (-0.07,-0.06)	-0.3* (-0.3,-0.2)
SSBs	3.8* (3.6,4.0)	0.04 (0.00,0.09)	0.03* (0.02,0.05)	-0.01 (-0.05, 0.04)
	Share of total volume purchased			
All FV	0.2* (0.08,0.3)	-0.09* (-0.1,-0.06)	0.00 (-0.01, 0.00)	0.08* (0.06,0.1)
Processed Food	0.4* (0.3,0.5)	0.03* (0.00,0.05)	-0.01* (-0.01, 0.00)	-0.04* (-0.06,-0.01)
SSBs	0.5* (0.3,0.6)	-0.1* (-0.2,-0.07)	0.06* (0.05,0.07)	0.2* (0.1, 0.2)

*Statistically significant after Holm-Bonferroni adjustment for multiple comparisons
95% confidence intervals are not adjusted for multiple comparisons
CI: confidence interval, FV: Fruits, vegetables, nuts, and legumes, SSB: sugar sweetened beverage

CHAPTER 4. ESTIMATING THE EFFECT OF THE 2021 CASH VALUE BENEFIT INCREASE ON SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN (WIC) SHOPPERS' FOOD PURCHASES

Overview

In June of 2021, the United States Department of Agriculture (USDA) increased the component of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food package that can be used for fruits and vegetables (FV) (i.e., the Cash Value Benefit (CVB)) from $9-11/person/month to $35/person/month. We do not yet understand whether and how this CVB increase may have changed WIC shoppers' FV purchases. We used longitudinal food transaction data from a large grocery store chain in North Carolina from WIC shoppers (n=536,349 shopper-month observations) and a comparison group of non-WIC shoppers (1,894,056 shopper-month observations) between June 2020 and April 2022. We used a propensity-score weighted difference-in-differences (DID) approach to estimate the effect of the CVB increase on WIC shoppers' food purchases. WIC shopper CVB-eligible FV purchases increased by $12.4 per shopper per month (99.4% Confidence Interval (CI), $12.0 to $12.9) after the CVB increase (DID $9.30 (99.4% CI, $8.7 to $10.0)). The volume and variety of FV purchased also increased more among WIC shoppers relative to non-WIC shoppers (DID 67.1 ounces (99.4% CI, 61.9 to 72.3) and 1.9 varieties (99.2% CI, 1.8 to 2.0), respectively). There were small increases in the volume of processed food and sugar-sweetened beverages purchased among WIC shoppers compared to non-WIC shoppers. These results can inform ongoing discussions about permanently increasing the amount of CVB in the WIC food packages and in the design of future emergency food response policies.

Introduction

Adequate fruit and vegetable (FV) consumption is critical for maintaining health and preventing diet-related chronic diseases throughout the life course.[1-3,6] However, most pregnant or postpartum people in the US do not consume enough FV.[6] Additionally, one in every two young children does not consume vegetables daily and one in every three children does not consume fruit daily.[9] Due to a variety of historical, sociopolitical, and environmental factors, there are disparities in FV intake in the US, with individuals with low incomes being less likely to consume adequate FV.[49-51]

Federal nutrition assistance programs help increase access to FV for pregnant and postpartum people and children with low incomes in the US. Specifically, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal nutrition assistance program that provides access to nutritious foods (i.e., food packages), healthcare referrals, and nutrition education to more than 6 million families with low incomes in the US.[15] Beginning in 2009, WIC provided $9/child/month and $11/adult/month for FV through a component of the food packages called the Cash Value Benefit (CVB). This amount equates to less than one cup of FV per day per person.[16] Both WIC participants and scientific experts have deemed this amount inadequate to achieve FV intake recommendations and called for increases to the CVB.[16,17]

For years, an increase to CVB has been proposed as an important policy measure to reduce these disparities; however, there has been little opportunity to understand whether and how an increase in the CVB would affect FV purchases of WIC families. Additionally, considering that young children more often consume too few vegetables than too few fruits and recommendations differ for fruits and vegetables,[6,9] it is worthwhile to understand if both fruit and vegetable purchases would increase with a higher CVB. Given the importance of an adequate amount and variety of FV starting in utero and throughout the life course for establishing healthy dietary behaviors, it is also worth examining whether families would use a

higher CVB to increase the diversity of FV purchased.[4,47] Finally, it is important to understand if families use the money saved on FV from a higher CVB to buy other foods and to assess the nutritional quality of those foods.

Recent changes to the WIC food packages provide a unique opportunity to address these research questions. In response to the COVID-19 pandemic, the US Department of Agriculture (USDA) increased the CVB component of the WIC food package in June 2021, initially from $9-11/month/person to $35/month/person and eventually to $24-47/month/person (Supplemental Figure 4.1).[33] Several studies have examined the effects of the 2021 CVB increase using qualitative methods and self-reported data[41-43,112,116] and found that participants perceived the pre-pandemic CVB amount to be insufficient, expressed high levels of satisfaction with the CVB increase, and perceived that the CVB increase allowed their families to consume a greater quantity and variety of FV.

Additionally, studies from California WIC participants have reported increases in self-reported FV consumption of about 0.3 cups per day associated with the CVB increase[42] and increases in FV expenditures with the CVB from $1.1 million in September 2020 to $3.7 million in June 2021.[136] These data suggest this policy change has the potential to mitigate existing income-based disparities in FV consumption; however, in addition to self-report data, we need objective measures of food purchasing behavior since self-report diet data are subject to social desirability and recall biases and we need studies with non-WIC comparison groups to differentiate policy effects from secular trends.[137] Therefore, the aim of this study is to estimate the effect of the 2021 CVB increase on WIC shoppers' purchases of CVB-eligible fruits and vegetables using longitudinal food transaction data from a large grocery store retailer in North Carolina using a difference-in-differences approach. These estimates will help decision makers understand whether and how to make this CVB increase permanent through the revised WIC food packages[44] and whether further efforts are needed to support redemption of this higher

CVB amount to mitigate existing disparities in FV consumption in the prenatal, postpartum, and early childhood periods.

Methods

Food Transaction Data and Food Groups

We used loyalty card food transaction data[118,138] from June 2020 to April 2022 from 496 stores in a large grocery store chain in 86 of North Carolina's 100 counties. These data include every food and non-food item purchased 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. We are not able to determine which food items were purchased with which payment type, only that certain payment type(s) were used in a given 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, and USDA's Food and Nutrient Database for Dietary Studies.[122,120,121]

Our analyses focused on five food groups of public health interest and directly related to the WIC CVB: CVB-eligible fruits, CVB-eligible nutrient dense vegetables (e.g., carrots, spinach, broccoli), CVB-eligible starchy vegetables (e.g., potatoes, corn, peas), non-essential packaged, processed foods (processed foods) (e.g., salty snacks, candy, desserts), and sugar-sweetened beverages (SSB). Documentation from the North Carolina Department of Health and Human Services and nutrition label and product data were used to determine CVB-eligible fruits and vegetables.[139,140] In North Carolina, fresh, frozen, and canned fruits and vegetables without added sugar, fats, salt, or artificial sweeteners can be purchased with the CVB.[139,140] The CVB cannot be used to purchase dried fruit or 100% fruit juice (juice is covered by another WIC food package component). We were interested in understanding whether and how fruit and vegetable purchases changed differentially after the CVB increase, given a much lower percentage of young children achieve vegetable intake recommendations than fruit intake recommendations.[6,9] Additionally, given differences in public health nutrition guidance and

nutrient composition in starchy and nutrient-dense vegetables, we separated these categories of vegetables using USDA definitions.[6] Finally, we wanted to understand whether any potential changes in purchases of FV were associated with changes in purchases of energy-dense, nutrient-poor food groups such processed foods and SSBs as other studies have reported WIC participants may have used the increased CVB to reduce their out-of-pocket FV spending and used the saved funds to purchase other food categories.[41,43,112,116]

WIC Shopper and Non-WIC Comparison Shopper Selection

WIC shoppers were identified in the food transaction dataset by the payment type used in a transaction. If a shopper paid with a WIC Electronic Benefit Transfer Card at least once in a given month, they were deemed a WIC shopper for that month. In our initial sample, we defined WIC shoppers as shoppers that paid with WIC at least one time in the study period (n= 261,174 shoppers, 4,333,495 shopper-month observations). To reduce the computational burden of using the complete set of shopper-month observations from loyalty card users that never paid with WIC during the study period (non-WIC shoppers) (n= 5,999,111 shoppers), we selected a random sample of non-WIC shoppers equal to the number shoppers that ever used WIC during this time period and initially included all observations from this random sample of non-WIC shoppers (n=261,174 shoppers, 2,768,596 shopper-month observations). We then excluded observations from loyalty cards that were either 1) in the top 1% of expenditures in a given month because these are likely ‘store cards’ used by cashiers for many shoppers (i.e., when someone does not have their own loyalty card) or 2) participating in other, active FV incentive or prescription programs in NC (Supplemental Figure 4.2).

We were most interested in the purchases of individuals enrolled in and using WIC benefits throughout our study period, so we further limited our sample of WIC shoppers to those that used WIC once every three months during the study period (n=536,349 shopper-month observations). We chose every three months as opposed to every month in the event that a shopper redeemed their WIC benefits at a different retailer in a given month, but continued

participating in the WIC program. We then also further restricted our non-WIC comparison shoppers to those that shopped at this retailer at least once every three months because, at least theoretically, individuals shopping regularly at this grocery store chain are more alike than those that sporadically shop at this grocery store chain. Consequently, the comparison group is comprised of 1,894,056 shopper-month observations (Supplemental Figure 4.2).

Outcomes

Our primary outcomes of interest were dollar expenditures and volume (ounces) purchased per loyalty card ID per month of total CVB-eligible FV, CVB-eligible fruits, CVB-eligible nutrient dense vegetables, and CVB-eligible starchy vegetables. The CVB is the only component of the WIC food package that is disbursed in terms of dollar units as opposed to a certain number of units of a specific size (e.g., 1 quart of yogurt), so we were interested in how dollar expenditures on FV changed over time. Given that prices of fruits and vegetables vary across form (e.g., fresh vs canned) and variety (e.g., organic vs. conventional) and FV recommendations are in terms of cups per day, we also were interested in volume of FV purchased.

Secondary outcomes include number of unique varieties of total CVB-eligible FV, CVB-eligible fruits, nutrient-dense vegetables, and starchy vegetables given self-reported increases in the variety of FV consumed after the CVB increase and the importance of eating a variety of FV in early childhood and during pregnancy and breastfeeding for healthy taste preference development,[4,43,47,116] and volume of processed foods and SSBs purchased per month.

Exposure

Our exposure of interest is the CVB increase that occurred in June 2021 in NC. We operationalize this exposure using a binary indicator variable (i.e., postpolicy) for observations in months before the CVB increase (June 2020-May 2021, postpolicy=0) and observations in months after the increase (June 2021-April 2022, postpolicy=1).

Statistical Analysis

We first compared unadjusted mean purchases per month for all outcomes before and after the CVB increase. To address limitations presented by the de-identified and observational nature of the food transaction data while leveraging the longitudinal structure of the data, we used a propensity score difference-in-differences (DID) approach to estimate the effect of the CVB increase among WIC shoppers relative to non-WIC comparison shoppers on all outcomes before and since the change in the CVB.[118,141] Under the usual DID assumptions (no spillover or anticipatory effects and parallel trends), the average effect of the CVB increase among WIC shoppers is identified. There is no risk of spillover effects as non-WIC shoppers cannot use WIC EBT based on our shopper definition so could not have received CVB. There is also little, if any, risk of anticipatory effects as it is unlikely due to financial barriers and the high cost of FV that WIC shoppers would notably increase FV purchases without a monetary incentive to do so. In addition, we used overlap weights to simulate randomization and strengthen the internal validity as it relates to the parallel trends assumption. The overlap weights also limit, but do not eliminate, the likelihood of co-interventions differentially influencing our WIC and non-WIC groups. Overlap weights are propensity-score based weights constructed as the predicted probability of belonging to the opposite group.[141] Overlap weights perfectly balance observed covariates in the pre-period between our WIC and non-WIC group using pre-policy data while limiting the influence of observations with extreme propensity score values.[141] To estimate shopper-level propensity scores for the overlap weights, we used logistic regression of being a WIC shopper on the pre-intervention means of the variables listed in Supplemental File 1, such as shopping frequency, types of payment methods used, and absolute and relative purchases across a variety of food categories.[142] As with all loyalty card data, we do not have shopper demographic characteristics so were not able to use those characteristics in weighting.

Due to a relatively large number of non-purchasers of FV (25-58%), we used overlap weighted two-part models for the dollar and ounce outcomes with the first part being a probit

model and the second part being a generalized linear model with a gamma distribution and log link with standard errors clustered at the shopper level.[143] Since the variety outcomes are over dispersed counts, we used zero inflated negative binomial models with standards errors clustered at the shopper level to estimate changes in the variety of FV purchased.[144,145] All models included an indicator for the month of the year to control for seasonality[127] and an indicator 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. We used pooled estimators throughout. We used Stata's margins command to estimate marginal effects from the two-part and zero inflated negative binomial models. We used the Bonferroni correction to adjust for multiple comparisons, grouping our primary outcomes (8 outcomes, two-sided alpha of 0.00625) and secondary outcomes (6 outcomes, two-sided alpha of 0.00833) together for adjustment. This study was reviewed by the University of North Carolina at Chapel Hill Institutional Review Board and deemed non-human subjects research.

Sensitivity Analysis

In North Carolina, there were implementation challenges when the federal CVB amount changed from $35/person/month to the National Academies of Science, Engineering, and Medicine recommended amounts of $24-47/person/month at the end of September 2021. North Carolina was not able to implement this change quickly enough, so the CVB amount returned to $9-11/person/month for October 2021 before increasing to $24-47/person/month in November 2021. Therefore, in a sensitivity analysis to understand the effect of the policy as intended, we removed October 2020 (for seasonality) and October 2021 from our dataset and re-ran all models described above.

Results

Shopper Characteristics

In the unweighted sample pre-policy, WIC shoppers had higher numbers of shopping episodes and episodes using SNAP benefits each month as well as larger total food expenditures and absolute expenditures on each food group compared to non-WIC shoppers (Supplemental Table 4.1). WIC shoppers had lower percentages of their total food purchases coming from the five food groups examined compared to non-WIC shoppers. Upon applying overlap weights, all measured shopper characteristics were balanced in the pre-policy period as expected (Supplemental Table 4.1).

Unadjusted Food Group Purchases Pre and Post CVB Increase

After the CVB increase, unadjusted monthly dollar expenditures on CVB-eligible fruits and nutrient-dense vegetables at this retailer increased among both WIC and non-WIC shoppers, but the increase was larger among WIC shoppers (Table 4.1). Monthly expenditures on starchy vegetables increased among WIC shoppers only. Unadjusted monthly ounces purchased of CVB-eligible FV and processed foods increased after the policy for both WIC and non-WIC shoppers, but increases were larger among WIC shoppers. The unadjusted number of unique varieties of CVB-eligible FV purchased per month increased after the CVB increase among WIC shoppers and either remained the same or decreased slightly among non-WIC shoppers (Table 4.1).

Weighted and Adjusted Results

Changes in FV Expenditures and Volume

Estimates from overlap weighted and adjusted models for effects of the CVB increase on purchases were similar to unadjusted estimates. After the CVB-increase, WIC shopper purchases of CVB-eligible FV at this retailer increased by $12.4 per month (99.4% CI, $12.0 to $12.9), which was $9.30 (99.4% CI, $8.7 to $10.0) greater than the increase in monthly expenditures among non-WIC shoppers (Figure 4.1, Supplemental Table 4.2). Most of this

increase came from increases in fruit expenditures, followed by nutrient-dense vegetables (Figure 4.2, Supplemental Table 4.2). The pattern was similar for volume of CVB-eligible FV purchased: for WIC shoppers, the volume of FV increased by 68.8 oz per month (99.4% CI, 65.0 to 72.5) or approximately 17 half-cup servings per month, this was 67.1 ounces (99.4% CI, 61.9 to 72.3) greater than the increase experienced by non-WIC shoppers (Figure 4.3, Supplemental Table 4.2). Similar to expenditures, most of this increase came from increases in volume of fruit purchased, followed by nutrient-dense vegetables (Figure 4.3, Supplemental Table 4.2).

Changes in Unique Varieties of FV

The CVB increase was associated with an increase in the number of unique CVB-eligible FV varieties purchased per month for WIC shoppers. WIC shoppers purchased 1.9 more varieties of FV per month (99.2% CI, 1.8 to 2.0) at this retailer after the CVB increase, which was 2.1 (99.2% CI, 2.0 to 2.3) more than non-WIC shoppers who experienced a decrease in the number of FV varieties purchased per month (Figure 4.4, Supplemental Table 4.2).

Changes in Processed Food and SSB Volume Purchased

After the CVB increase, WIC shoppers also purchased 30.0 (99.2% CI, 26.5 to 33.6) more ounces of processed food per month from this retailer, which was 22.0 ounces (99.2% CI, 17.2 to 26.9) more than non-WIC shoppers. WIC shoppers also purchased 31.2 (99.2% CI, 19.7 to 42.7) more ounces of SSBs per month, which was 49.1 (99.2% CI, 33.4 to 64.9) more ounces than non-WIC shoppers who experienced a 17.9 ounce (99.2% CI, -29.1 to -6.7) decrease (Figure 4.3, Supplemental Table 4.2).

Sensitivity Analyses

Results when excluding October 2020 and 2021 to account for implementation challenges in NC did not differ meaningfully and can be found in Supplemental Table 4.3.

Discussion

The objective of this study was to estimate the effect of the 2021 increase in the WIC CVB on North Carolina WIC shoppers' FV purchases. This study adds to the existing literature on this policy change by providing quantitative estimates of changes in food purchasing behavior that can be triangulated with qualitative data,[43,112,116] food consumption data,[42] and WIC benefit redemption data[136] to holistically understand the effects of this policy change.

After the CVB increase, there were estimated increases of $12.40 and 68.8 ounces per month (17 half-cup servings/month, or roughly 0.3 cups per day) in CVB-eligible FV purchases among WIC shoppers at this retailer in North Carolina. These are likely meaningful increases from a public health standpoint considering recommended FV intake for a young child ranges from 1⅓ to 3 cups per day and so few children currently meet FV intake recommendations.[6] Our findings are consistent with existing qualitative studies in which WIC participants perceived they purchased and consumed more FV after the CVB increase.[43,112,116] Our findings are also consistent with the one study that has measured self-reported consumption of FV after the CVB increase and found a 0.3 cup/person/day increase, although, depending on household composition which is unknown in our study, the increases we observed may be smaller in smaller magnitude.[42] This difference may be because our dataset is limited to FV purchases from one retailer or may be due to over-reporting of FV consumption due to social desirability bias.[146,147] The observed increase in dollar expenditures is less than the per person amount of the benefit increase ($15-$36 depending on participant characteristics and month) and this may be attributable to substitution of payment methods (CVB for prior out-of-pocket or other non-WIC expenditures), use at other retailers or low redemption. Barriers to CVB redemption after the 2021 increase have been documented such as food shortages, quality of FV in food retail outlets, and difficulty identifying WIC-eligible FV.[116]

We also observed increases in unique varieties of FV purchased per month among WIC shoppers, primarily in varieties of fruits and nutrient-dense vegetables. Exposure to a variety of

FV is essential for healthy taste preference development beginning in utero and into early childhood.[47] Amniotic fluid and breastmilk serve as flavor 'bridges' from parents to infants and consuming a wide variety of FV consumed while pregnant and breastfeeding gives an infant an advantage in accepting a wider variety of FV in early childhood.[4] Additionally, consuming a wide variety of FV in early childhood not only increases acceptance of FV, but also increases willingness to try other novel foods.[4] In other studies, WIC participants have also reported purchasing a larger variety of FV after the CVB increase and that the increase gave families more agency to purchase previously cost-prohibitive varieties of FV that their young children wanted to try.[43,112,116] Given the importance of not only consuming recommended FV but also consuming a wide variety of FV in pregnancy, postpartum, and early childhood, capturing change in varieties in the food transaction data in addition to the volume and expenditures is a unique contribution of this study and important from a public health perspective.

Finally, we observed small increases (0.7 to 1.6 oz/household/day) in processed food and SSB purchases among WIC shoppers, a potential unintended consequence of the CVB increase that should be examined in future research. Some WIC participants have reported using the CVB increase to substitute WIC funds for FV they ordinarily would have purchased with non-WIC funds and using the saved non-WIC funds to purchase meat, seafood, grains, or other household items.[41,43,112,116] These substitutions may explain both expenditure increases on FV being lower than the per person CVB increase and the increases in purchases of processed foods and SSBs. Similarly, one study describing the effects of the initial CVB increase in 2009 found WIC participants substituted about 4.5-5.5 cups (36-44 ounces) of FV previously purchased with non-WIC payments for purchases made with WIC.[37] Future studies using WIC administrative data or other sources of food transaction data may be able to better assess CVB redemption and substitution of payment methods and disentangle whether the difference observed between the per person CVB increase and FV expenditures may be more so due to substitution or low CVB redemption.

This work has implications for current and future WIC policy such as the 2023 proposed revisions to the WIC food packages[44] and efforts to increase redemption of the CVB. For example, given the very low percentage of young children that meet FV intake recommendations and the apparent success of this policy change in increasing FV purchases, returning to the pre-pandemic CVB amounts of $9-11/person/month would be a step back toward meeting FV intake recommendations. Additionally, fewer children meet vegetable intake recommendations compared to fruit recommendations, and we observed smaller increases in expenditures on nutrient-dense vegetables compared to fruits, so further efforts will be needed within WIC and other public health entities to incentivize and facilitate vegetable consumption in early childhood.[148] Finally, given the small increases observed in processed food and SSB purchases, it may be wise to pair FV incentives with disincentives for energy-dense nutrient poor foods such as restrictions on marketing of ultraprocessed foods and SSBs to children, excise taxes, or warning labels or require WIC-approved retailers to have such policies in place.[149]

This study has many strengths including the use of longitudinal, objectively measured food transaction data with one year of data before and 11 months of data after the CVB increase. Additionally, we used a quasi-experimental design including a non-WIC comparison group to account for secular trends in purchasing and co-interventions, as well as overlap weights to account for baseline differences between WIC and non-WIC shoppers. We also used policy and public-health relevant food groups including three groups of CVB-eligible FV in NC that are not usually available in food purchasing or transaction datasets. Finally, although this dataset is limited to transactions from one retailer, this is one of the top two food retailers in NC and is the preferred retailer for WIC redemption in NC due to excellent shelf labeling of WIC approved products, so we feel confident that we are capturing most WIC purchases.[116,150] That said, it is likely that our estimates of changes in purchases after the CVB increase are underestimates as WIC participants may have redeemed their CVB at other food retailers. As

with all loyalty card data, we are lacking demographic and household composition data, so cannot assess racial, ethnic, or geographic differences in purchases despite documented differences in experiences with the pandemic and food assistance policy changes by characteristics such as race, ethnicity, or geography.[21,100,101,151] Due to the de-identified nature of the data, we also do not know the exact dollar amount of each household's CVB increase because it was dependent on household composition. Future studies using WIC administrative data will be better able to address the question of CVB redemption. Additionally, we are unable to assess substitution of payment methods and purchases of a wide variety of food groups with this dataset, but given the small observable shifts in purchases of processed foods and SSBs, this should be important to explore in future studies with a wider variety of food groups to understand potential spillover effects on the total diet and health of substitution of CVB for non-WIC funds. Finally, while it is the purpose of our non-WIC shoppers to control for the effect of secular trends and co-interventions, they are matched on shopping characteristics, not demographic characteristics since these are unmeasured, so we cannot guarantee that some of the effects observed are due, in part, to co-interventions such as the 2021 Child Tax Credit increase.

Conclusions

Overall, this study adds to the existing research on the 2021 CVB increase that suggests this policy was associated with an increase in the amount and variety of FV purchased and consumed by WIC participants. This information can be used in ongoing discussions about permanently increasing the amount of CVB in the WIC food packages and in the design of future emergency food response policies. While this policy appears to have been generally beneficial, a comprehensive suite of nutrition policies that promote FV and disincentivize energy-dense, nutrient-poor foods will likely be needed to reduce disparities in FV consumption in early childhood and bring young children's dietary intake closer in line with recommendations.

Tables and Figures

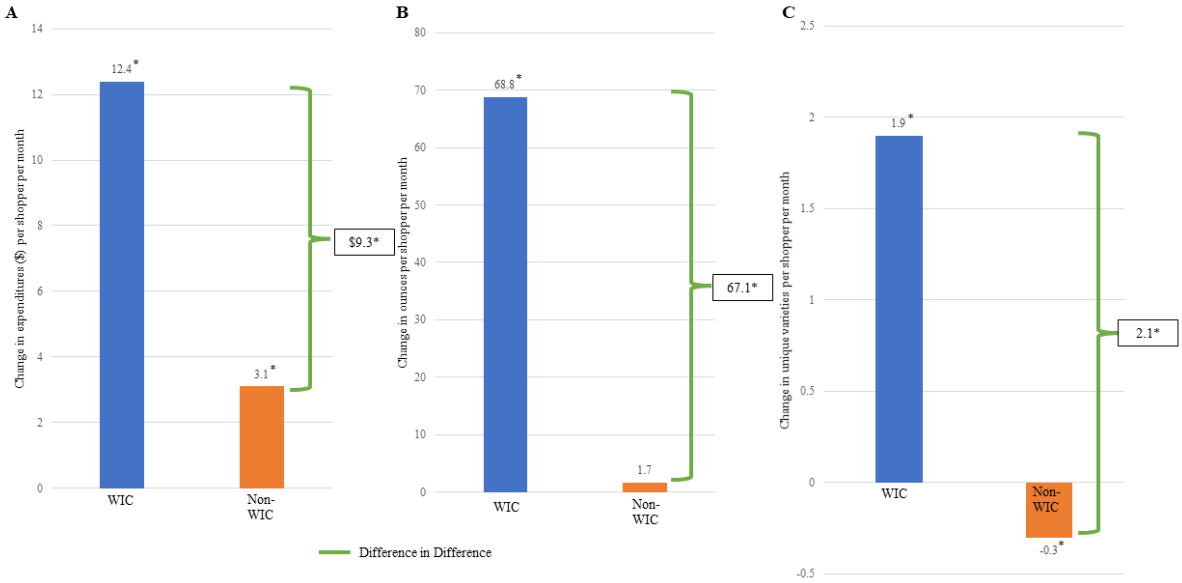
Table 4.1. Unweighted and unadjusted mean purchases and 95% confidence intervals of food groups of interest in terms of dollars, ounces, and unique varieties pre and post CVB increase in WIC and non-WIC shoppers, unadjusted change in purchases between the pre and post period, and the unadjusted difference-in-difference

	WIC Shoppers			**Non-WIC Shoppers**			
	Pre-Policy	**Post-Policy**	**Difference**	**Pre-Policy**	**Post-Policy**	**Difference**	**Unadjusted Difference-in-Difference**
Total CVB FV dollars	32.0 (31.9, 32.1)	44.8 (44.6,44.9)	12.8 (12.6, 13.0)	20.7 (20.6, 20.7)	23.1 (23.0, 23.2)	2.4 (2.3, 2.5)	10.4 (10.1, 10.6)
Fruit dollars	15.4 (15.3, 15.5)	23.8 (23.8, 23.9)	8.5 (8.3, 8.6)	8.5 (8.5, 8.5)	10.0 (10.0, 10.0)	1.5 (1.5, 1.6)	6.9 (6.8, 7.1)
Nutrient dense vegetable dollars	13.4 (13.3, 13.4)	17.2 (17.1, 17.2)	3.8 (3.7, 3.9)	10.1 (10.0, 10.1)	10.9 (10.9, 10.9)	0.8 (0.8, 0.9)	3.0 (2.9, 3.1)
Starchy vegetable dollars	3.2 (3.2, 3.2)	3.8 (3.7, 3.8)	0.5 (0.5, 0.6)	2.2 (2.1, 2.2)	2.2 (2.2, 2.2)	0.0 (0.0, 0.1)	0.5 (0.4, 0.5)
Total CVB FV oz	280.0 (279.1, 281.0)	352.9 (351.7, 354.0)	72.8 (71.0, 74.7)	175.6 (175.2, 176.0)	183.3 (182.8, 183.7)	7.7 (6.9,8.4)	65.2 (63.2, 67.1)
Fruit oz	137.0 (136.5, 137.6)	184.9 (184.2, 185.6)	47.8 (46.7, 49.0)	74.7 (74.5, 74.9)	79.8 (79.5, 80.0)	5.1 (4.6, 5.5)	42.8 (41.6, 44.0)
Nutrient dense vegetable oz	98.5 (98.1, 98.9)	115.0 (114.5, 115.5)	16.5 (15.7, 17.2)	70.6 (70.4, 70.8)	71.6 (71.4, 71.8)	1.0 (0.7, 1.3)	15.5 (14.7, 16.3)
Starchy vegetable oz	44.5 (44.2, 44.8)	53.0 (52.7, 53.3)	8.5 (8.0, 9.0)	30.3 (30.2, 30.4)	31.9 (31.8, 32.0)	1.6 (1.4, 1.8)	6.9 (6.4, 7.4)
Processed food oz	304.2 (303.2, 305.2)	333.9 (332.8, 335.0)	29.7 (28.0, 31.3)	204.5 (204.0, 204.9)	214.4 (214.0, 214.9)	10.0 (9.2, 10.7)	19.7 (17.9, 21.5)
SSB oz	842.7 (839.1, 846.2)	864.0 (860.1, 867.9)	21.4 (15.6, 27.1)	520.9 (519.3, 522.4)	521.6 (519.9, 523.3)	0.7 (-1.7, 3.2)	20.6 (14.4, 26.8)
Total CVB FV varieties	9.8 (9.7, 9.8)	11.7 (11.7, 11.7)	1.9 (1.9, 2.0)	6.7 (6.7, 6.7)	6.5 (6.5, 6.6)	-0.2 (-0.2, -0.1)	2.1 (2.0,2.1)

Fruit varieties	3.6 (3.6, 3.6)	4.8 (4.8, 4.8)	1.2 (1.2, 1.2)	2.1 (2.1, 2.1)	2.1 (2.1, 2.1)	0.1 (0.1, 0.1)	1.1 (1.1, 1.2)
Nutrient dense vegetable varieties	5.2 (5.2, 5.2)	5.8 (5.8, 5.9)	0.7 (0.6, 0.7)	3.9 (3.9, 3.9)	3.8 (3.7, 3.8)	-0.2 (-0.2, -0.1)	0.8 (0.8, 0.9)
Starchy vegetable varieties	1.0 (1.0, 1.0)	1.1 (1.1, 1.1)	0.1 (0.1, 0.1)	0.7 (0.7, 0.7)	0.7 (0.6, 0.7)	-0.1 (-0.1, 0.0)	0.1 (0.1, 0.1)

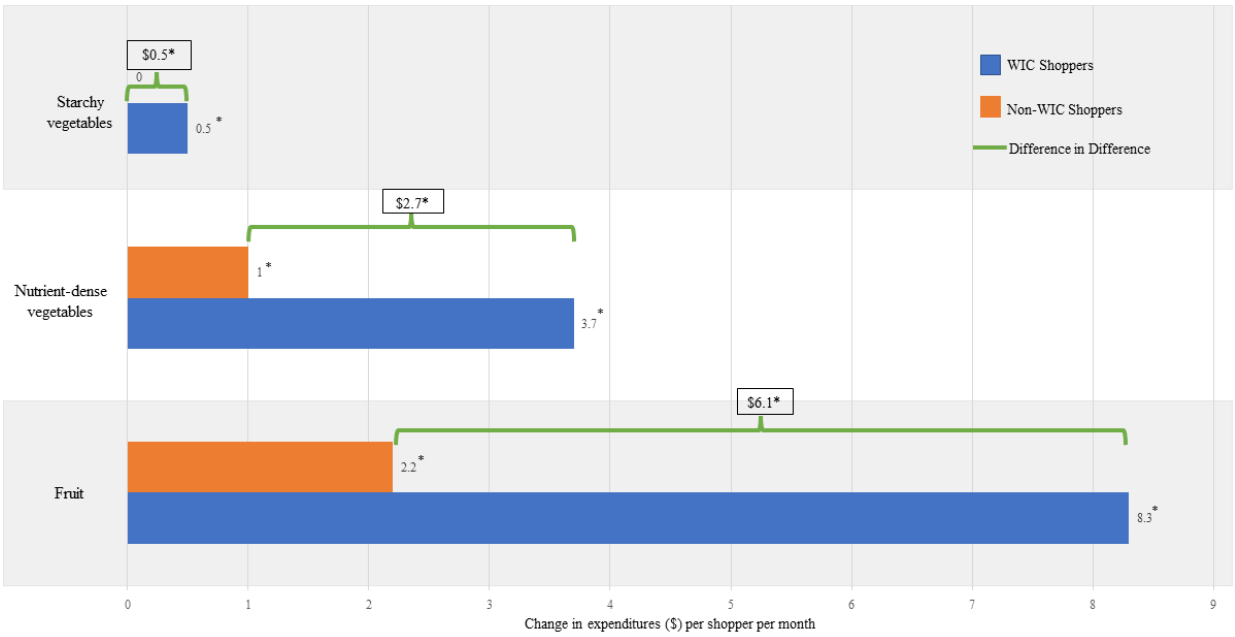
CVB: cash value benefit; FV: fruits and vegetables

Figure 4.1. Changes in (A) dollar expenditures (B) ounces and (C) unique varieties of total CVB-eligible fruits and vegetables per month per shopper after the CVB increase among WIC shoppers, non-WIC shoppers, and the difference-in-difference



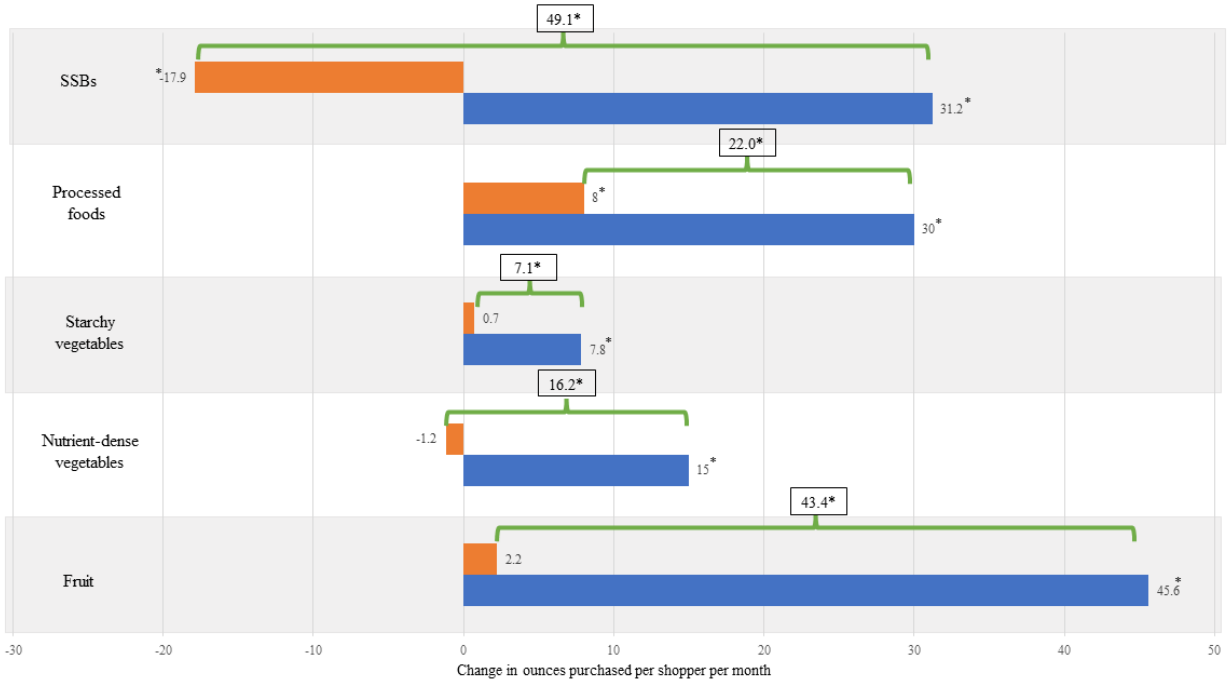
*Statistically significant after Bonferroni adjustment for multiple comparisons

Figure 4.2. Changes in dollar expenditures on CVB-eligible fruits, nutrient-dense vegetables, and starchy vegetables per month per shopper after the CVB increase among WIC shoppers, non-WIC shoppers, and the difference-in-difference



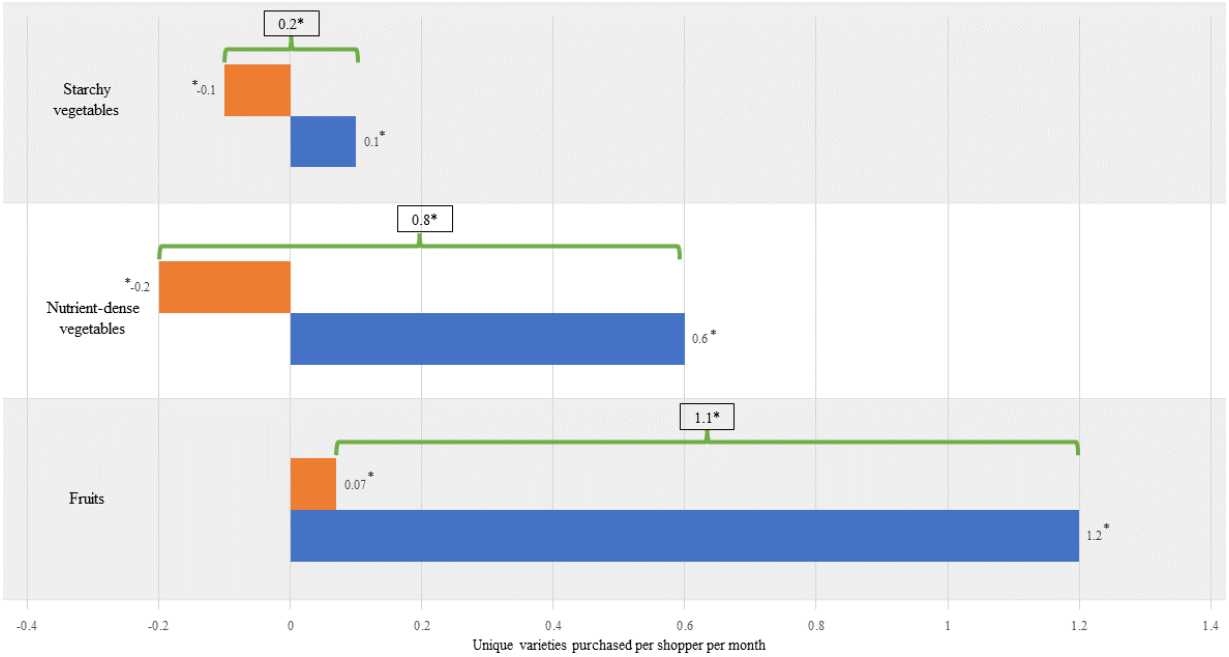
*Statistically significant after Bonferroni adjustment for multiple comparisons

Figure 4.3. Changes in volume (oz) purchased of CVB-eligible fruits, nutrient-dense vegetables, starchy vegetables, processed foods, and SSBs per month per shopper after the CVB increase among WIC shoppers, non-WIC shoppers, and the difference-in-difference



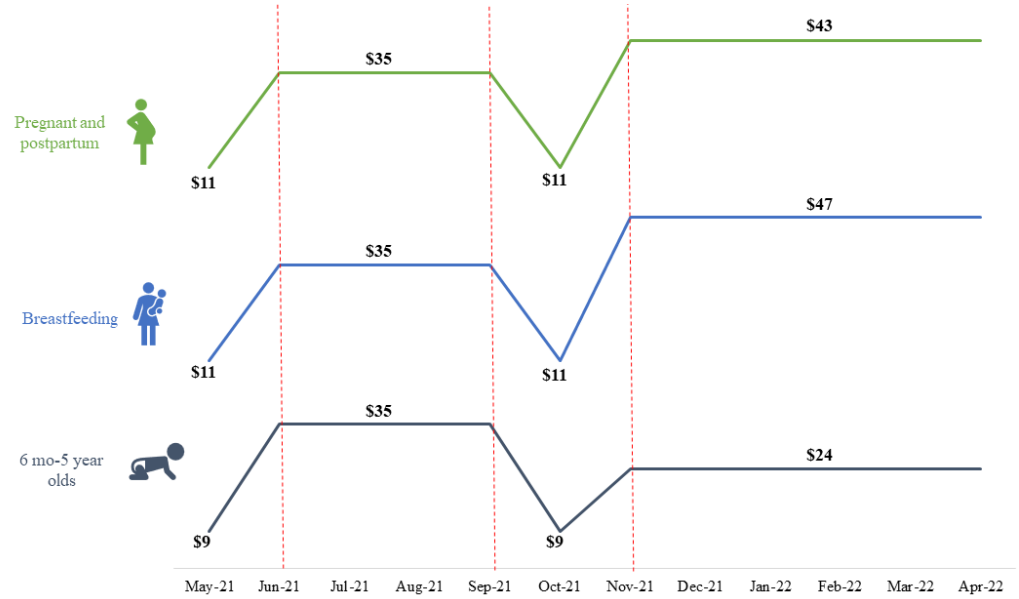
*Statistically significant after Bonferroni adjustment for multiple comparisons

Figure 4.4. Changes in unique varieties purchased of CVB-eligible fruits, nutrient-dense vegetables, and starchy vegetables per month per shopper after the CVB increase among WIC shoppers, non-WIC shoppers, and the difference-in-difference

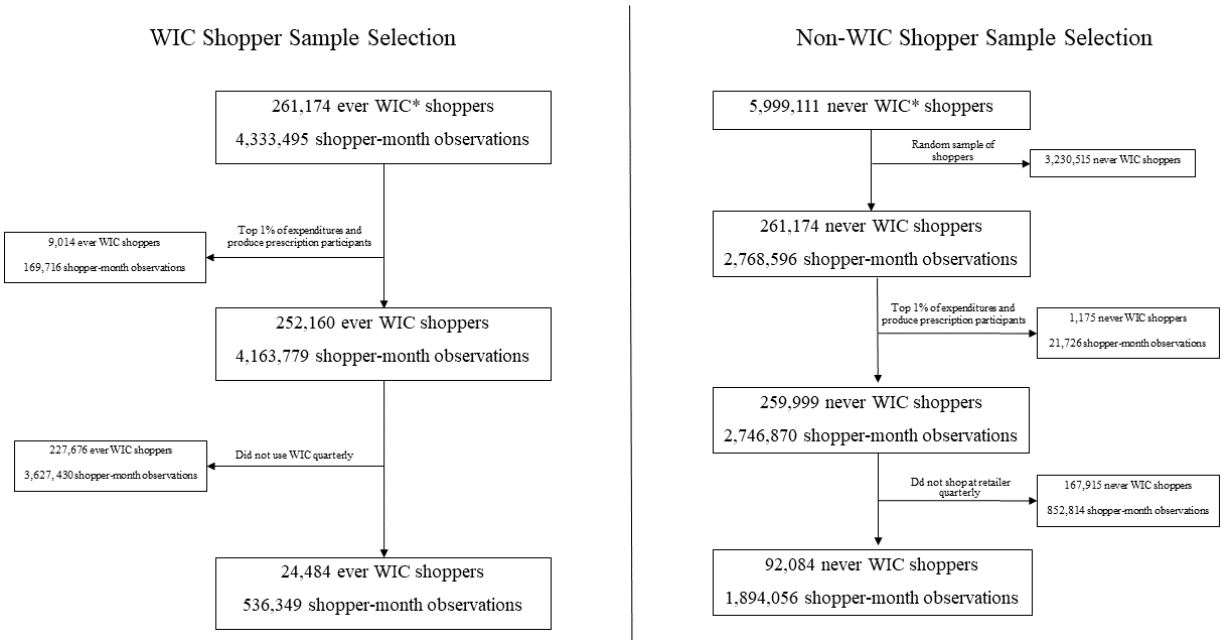


*Statistically significant after Bonferroni adjustment for multiple comparisons

Supplemental Figure 4.1. Timeline of changes to CVB amounts between May 2021 and April 2022 in North Carolina



Supplemental Figure 4.2. WIC and non-WIC shopper sample selection



*Ever WIC shoppers are loyalty card IDs that ever used WIC EBT as a payment type during the study period, never WIC shoppers are loyalty card IDs that never used WIC EBT as a payment type during the study period

Supplemental Table 4.1. Unweighted and weighted descriptive characteristics and 95% confidence intervals of WIC and non-WIC shoppers in the pre-period (n 1,273,443 shopper month observations)

Characteristic	Unweighted		Weighted	
	Non-WIC Shoppers	WIC Shoppers	Non-WIC Shoppers	WIC Shoppers
Number of shopping episodes/month	4.7 (4.7, 4.7)	6.5 (6.4, 6.5)	6.3 (6.2, 6.4)	6.2 (6.1, 6.3)
Number of episodes using SNAP/month	0.5 (0.5, 0.5)	2.7 (2.7, 2.8)	1.8 (1.8, 1.9)	1.8 (1.7, 1.8)
Percent of transactions using cash	20.5% (20.4, 20.7)	14.1% (14.0, 14.3)	16.1% (15.8, 16.4)	16.0% (15.7, 16.3)
Percent of transactions using debit	25.3% (25.0, 25.5)	6.3% (6.2, 6.5)	9.2% (8.9, 9.4)	9.2% (8.9, 9.6)
Percent of transactions using credit	42.3% (42.1, 42.5)	25.2% (25.0, 25.5)	31.2% (30.8, 31.7)	31.2% (30.7, 31.6)
Food expenditures ($)/month	189.8 (188.8, 190.7)	336.7 (334.5, 338.9)	301.4 (297.9, 305.0)	297.1 (294.0, 300.3)
Processed food expenditures ($)/month	46.2 (45.9, 46.4)	68.4 (67.9, 69.0)	67.7 (66.8, 68.5)	66.6 (65.7, 67.5)
SSB expenditures ($)/month	22.3 (22.1, 22.5)	36.5 (36.1, 36.9)	35.0 (34.3, 35.7)	34.5 (33.9, 35.1)
Fruit Expenditures ($)/month	8.5 (8.4, 8.6)	15.4 (15.2, 15.5)	13.4 (13.2, 13.8)	13.3 (13.0, 13.5)
Nutrient Dense Vegetable Expenditures ($)/month	10.1 (10.0, 10.1)	13.4 (13.2, 13.5)	13.5 (13.2, 13.7)	13.3 (13.0, 13.5)
Starchy Vegetable Expenditures ($)	2.2 (2.1, 2.2)	3.2 (3.2, 3.3)	3.2 (3.1, 3.2)	3.1 (3.1, 3.2)
% of Volume Purchased from Processed Foods	14.3% (14.3, 14.4)	9.8% (9.7, 9.8)	11.2% (11.1, 11.3)	11.2% (11.2, 11.3)
% of Volume Purchased from SSBs	25.0% (24.9, 25.1)	23.1% (22.9, 23.3)	25.1% (24.8, 25.4)	25.0% (24.7, 25.2)
% of Volume Purchased from Fruit	5.2% (5.2, 5.3)	5.0% (5.0, 5.1)	4.8% (4.7, 4.9)	4.8% (4.7, 4.9)
% of Volume Purchased from Nutrient Dense Vegetables	4.9% (4.9, 4.9)	3.5% (3.4, 3.5)	3.9% (3.8, 3.9)	3.9% (3.8, 3.9)
% of Volume Purchased from Starchy Vegetables	1.8% (1.8, 1.8)	1.4% (1.4, 1.4)	1.6% (1.5, 1.6)	1.6% (1.5, 1.6)

Fruit varieties	2.1 (2.1, 2.1)	3.6 (3.6, 3.6)	3.0 (3.0, 3.1)	3.2 (3.2, 3.3)
Nutrient Dense Vegetable Varieties	3.9 (3.9, 3.9)	5.2 (5.1, 5.2)	5.2 (5.1, 5.2)	5.1 (5.0, 5.2)
Starchy Vegetable Varieties	0.7 (0.7, 0.7)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (0.9, 1.0)

Supplemental Table 4.2. Differences in purchases and confidence intervals* (CI) of food groups of interest in terms of dollars, ounces, and unique varieties pre and post CVB increase among WIC shoppers and non-WIC shoppers and the difference-in-differences and CI's between WIC and non-WIC shoppers from overlap weighted and adjusted models

Outcome	**WIC**	**Non-WIC**	**Difference-In-Difference**
Total CVB FV dollars	\$12.4** (12.0, 12.9)	\$3.1** (2.7, 3.6)	\$9.3** (8.7,10.0)
Fruit dollars	\$8.3** (8.0, 8.6)	\$2.2** (1.9 ,2.4)	\$6.1** (5.7, 6.5)
Nutrient dense vegetables dollars	\$3.7** (3.4, 3.9)	\$1.0** (0.8, 1.2)	\$2.7** (2.4, 3.0)
Starchy vegetable dollars	0.5** (0.5,0.6)	0.0 (-0.06,0.06)	\$0.5** (0.5, 0.6)
Total CVB FV ounces	68.8** (65.0,72.5)	1.7 (-2.2, 5.5)	67.1** (61.9, 72.3)
Fruit ounces	45.6** (43.5,47.8)	2.2 (-0.01, 4.5)	43.4** (40.3, 46.5)
Nutrient dense vegetables ounces	15.0** (13.4, 16.6)	-1.2 (-2.8, 0.4)	16.2** (14.0, 18.4)
Starchy vegetable ounces	7.8** (6.8, 8.8)	0.7 (-0.2, 1.6)	7.1** (5.7, 8.4)
Processed food ounces	30.0** (26.5, 33.6)	8.0** (4.6, 11.5)	22.0** (17.2, 26.9)
SSB ounces	31.2** (19.7, 42.7)	-17.9** (-29.1, -6.7)	49.1** (33.4, 64.9)
Total CVB FV varieties	1.9** (1.8, 2.0)	-0.3** (-0.4, -0.2)	2.1** (2.0, 2.3)
Fruit varieties	1.2** (1.1, 1.2)	0.07** (0.03, 0.1)	1.1** (1.1, 1.2)
Nutrient dense vegetable varieties	0.6** (0.6, 0.7)	-0.2** (-0.3, -0.2)	0.9** (0.8, 1.0)
Starchy vegetable varieties	0.1** (0.1, 0.1)	-0.1** (-0.1, -0.1)	0.2** (0.1, 0.2)

*Significance threshold for primary outcomes (FV dollars and ounces) is 0.00625 so 99.4% confidence intervals are presented, significance thresholds for secondary outcomes (FV variety, processed food and SSB ounces) is 0.00833 so 99.2% confidence intervals are presented
**Statistically significant after Bonferroni adjustment for multiple comparisons

Supplemental Table 4.3. Differences in purchases and 95% confidence intervals for food groups of interest in terms of dollars, ounces, and unique varieties pre and post CVB increase among WIC shoppers and non-WIC shoppers and the difference-in-differences between WIC and non-WIC shoppers from overlap weighted and adjusted models with October 2020 and 2021 excluded

Outcome	**WIC**	**Non-WIC**	**DID**
Fruit Dollars	8.3 (8.1, 8.5)	2.1 (1.9, 2.3)	6.2 (5.8, 6.4)
Nutrient Dense Vegetables Dollars	3.5 (3.4, 3.7)	0.9 (0.7, 1.1)	2.6 (2.4, 2.9)
Starchy Vegetable Dollars	0.5 (0.5, 0.6)	0.00 (-0.1, 0.0)	0.5 (0.5, 0.6)
Fruit Ounces	45.4 (43.8, 47.0)	1.8 (0.2, 3.4)	43.6 (41.4, 45.8)
Nutrient Dense Vegetables Ounces	14.2 (13.0, 15.3)	-1.8 (-3.0, -0.7)	16.0 (14.4, 17.6)
Starchy vegetable ounces	7.7 (6.9, 8.4)	0.5 (-0.1, 1.2)	7.1 (6.2, 8.1)
Fruit varieties	1.2 (1.2, 1.2)	0.1 (0.0, 0.1)	1.1 (1.1, 1.2)
Nutrient dense vegetable varieties	0.6 (0.6, 0.7)	-0.3 (-0.3, -0.2)	0.9 (0.8, 0.9)
Starchy vegetable varieties	0.1 (0.1, 0.1)	-0.1 (-0.1, -0.1)	0.2 (0.1, 0.2)

CHAPTER 5. "I THINK THAT'S THE MOST BENEFICIAL CHANGE THAT WIC HAS MADE IN A REALLY LONG TIME": PERCEPTIONS AND AWARENESS OF AN INCREASE IN THE WIC CASH VALUE BENEFIT

Overview

During the COVID-19 pandemic, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Cash Value Benefit (CVB) for fruits and vegetables increased by roughly $25/month/person. We sought to understand WIC participant perceptions of this change and barriers and facilitators to using the CVB. We conducted 10 virtual focus groups (5 rural, 5 urban/suburban) with WIC participants (n=55) in North Carolina in March 2022. Focus groups were recorded and transcribed. We open coded the content and used thematic analysis to uncover consistencies within and between sampled groups.

Participants expressed favorable perceptions of the CVB increase and stated the pre-pandemic CVB amount was insufficient. Barriers to using the increased CVB were identifying WIC approved fruits and vegetables in stores and insufficient supply of fruits and vegetables. Barriers were more pronounced in rural groups. Facilitators of CVB use were existing household preferences for fruits and vegetables and the variety of products that can be purchased with CVB relative to other components of the WIC food package. Participants felt the CVB increase allowed their families to eat a wider variety of fruits and vegetables. The CVB increase may improve fruit and vegetable intake, particularly if made permanent, but barriers to CVB and WIC benefit use may be limiting the potential impact.

Introduction

Consuming a sufficient amount and variety of fruits and vegetables in early childhood is critical to forming lifelong health promoting dietary habits.[4,5] A nutritionally adequate diet in early

childhood is key for optimal physical and cognitive growth and development.[152,153] Fruits and vegetables are key sources of nutrients commonly underconsumed by young children in the US, and they reduce lifetime risk of chronic health conditions.[1-3,6,45]Consumption of fruits and vegetables, especially nutrient-dense varieties, is often lower among children living in rural households and households with low incomes and children from historically marginalized racial or ethnic groups[49-54,154]. Across the US, structural factors such as high cost and disparate physical access to fruits and vegetables as well as divestment in communities make it more challenging for children living in rural areas, in households with low incomes, and from historically marginalized racial/ethnic groups to meet fruit and vegetable intake recommendations[21,49-58,61-64,154]. In the rural Southeastern US, these geographic, income, and race/ethnicity groups often intersect and overlap, contributing to potentially greater risk of inadequate fruit and vegetable intake[55].

Historically marginalized communities are disproportionately impacted by public health emergencies such as pandemics and natural disasters[66-70]. The COVID-19 pandemic has followed a similar pattern: families living in rural areas, with low incomes, and from historically marginalized racial/ethnic groups in the US have been more likely to experience job loss and nutrition insecurity because of the pandemic[18,20,21,71-73,155,156]. These downstream effects of the pandemic have the potential to exacerbate disparities in fruit and vegetable consumption by income, race/ethnicity, and rurality. The pandemic has also created food supply chain issues, including widespread food shortages and rising food costs due to inflation[157,158]. These issues may have disproportionately impacted people living in rural areas: even prior to the pandemic, many factors such as food cost and access to emergency food programs were more notable barriers to achieving a healthy diet in rural areas compared to urban areas[55,159]. Thus, it is important to understand differences in the effects of the pandemic on diet-related behaviors and disparities by rurality.

To counteract some of the negative effects of the pandemic on nutrition security, the United States Department of Agriculture (USDA) implemented a series of modifications and augmentations to its existing federal nutrition assistance programs[160]. The Cash Value Benefit (CVB) is a component of the food package for the Special Supplemental Nutrition Assistance Program for Women, Infants, and Children (WIC) that can be used for fresh, frozen, or canned fruits and vegetables without added sugar, salt, or fat. Prior to the pandemic, the CVB was $9-$11/month/person, an amount that many WIC participants and nutrition experts deemed insufficient[16,98,106,107]. In June 2021, USDA temporarily increased the CVB to $35/month/person initially for four months, but ultimately this increase was extended until September 2022, but at slightly different amounts (Figure 5.1).

Preliminary quantitative research on the CVB increase generally suggests that it has been positively received by WIC participants and may be associated with increased intake of fruits and vegetables[136]. Additional qualitative studies can complement this existing research by exploring WIC participants' lived experiences with the CVB increase. Moreover, to understand the potential public health benefits of the CVB increase and to inform future changes to the WIC food package, it is essential to understand WIC participants' awareness of the change, barriers and facilitators to using the higher CVB amount, and perceived changes in dietary behaviors. However, studies have not yet explored these questions or examined differences in experiences based on rurality. This information is critical for developing evidence-based public health emergency response policies as well as informing discussions about extending the higher CVB amount beyond September 2022.

The primary objectives of our study were to qualitatively examine 1) perceptions and awareness of the CVB increase 2) barriers and facilitators to using the increased CVB and 3) perceived effects of the CVB increase on household fruit and vegetable consumption. We also aimed to understand whether experiences and perceptions of the CVB increase differed by rurality given disparities in food costs, food environments, and downstream effects of the

pandemic that may affect CVB use[55,63,64,155]. Finally, we examined facilitators and barriers to WIC benefit use beyond just the CVB component since any barrier to general WIC benefit use could, in turn, influence CVB use.

Methods

Sample

In February and March of 2022, we recruited 55 WIC participants living in North Carolina for virtual focus groups. To be eligible for the focus groups, participants had to be 18 years or older, enrolled in WIC any time after May 2021, take part in household grocery shopping, speak English, identify as a woman, live in North Carolina, not be an employee of WIC, and have access to Wi-Fi or a cell phone signal strong enough to participate in the Zoom call. We decided to not enroll men in our study given the small number of men are the primary caregiver for children participating in WIC in NC and because we wanted to create focus groups with individuals that share identities to facilitate sharing.[161] We stratified the focus groups by rural and urban/suburban residents. We categorized North Carolina's 100 counties using the North Carolina Rural Center's definitions (6 urban, 16 suburban, 78 rural)[162].

Recruitment

We partnered with the North Carolina Department of Health and Human Services (NC DHHS) and local WIC agencies across North Carolina to recruit participants. These agencies shared information about our study on their social media pages and through mailed flyers and flyers in clinics. We also shared information about our study with the statewide network of Supplemental Nutrition Assistance Program Education (SNAP Ed) agencies and through the local organizations that were part of our stakeholder advisory board. Interested participants completed an online screening questionnaire which was programmed into Qualtrics. We also applied additional criteria to screen out potentially fraudulent participants (e.g., individuals who did not live in the US or have a child but were misrepresenting this information). These criteria included confirming that IP addresses were in North Carolina, matching responses to duplicate

questions about age, using Qualtrics's bot detection item, preventing duplicate submissions, and screening out responses based on Qualtrics's fraud detection scores[163]. Additionally, we conducted brief screening Zoom calls with each participant who was deemed eligible based on both screener questions and Qualtrics meta-data to confirm eligibility and troubleshoot any issues with Zoom connectivity prior to the focus group discussions. Previous studies have used similar multistep approaches to improve screening for qualitative research [164,165]. Written informed consent was collected electronically from all participants. This study was reviewed and deemed exempt from further review by the University of North Carolina Institutional Review Board (IRB #21-2873).

Procedures

We collected demographic information from participants in the screening questionnaire. We conducted 10 virtual focus groups using Zoom in March of 2022. Focus groups were facilitated by one of two graduate students (EWD, DAV) trained in focus group facilitation techniques. Each focus group had four to eight participants and, when possible, groups were composed of participants of similar race and ethnicity to facilitate sharing and create comfort while discussing potentially sensitive topics[161]. Between 50-100% of participants that signed up for a focus group discussion slot attended on the day of the discussion. To measure race/ethnicity, we used two items using self-classification[166] from the 2020 United States Census Bureau[167]. We used participants' responses to these items to create a race/ethnicity variable combining self-classified race with Hispanic, Latina, or Spanish origin (Table 5.1). We conducted five focus groups each among rural and urban/suburban participants, and we reached a point of saturation in each subgroup[161]. We assessed saturation by determining that we were hearing the same themes repeatedly and no new codes were being developed.[168] Each focus group lasted approximately one hour, and participants received a $40 gift card for their time.

We used a semi-structured focus group guide for all discussions. This guide was developed in consultation with our stakeholder advisory board and NC DHHS. We also used prior research related to WIC grocery shopping and CVB use experiences to ensure that our questions aligned with relevant content. In North Carolina, the CVB amounts increased and decreased at multiple time points between June 2021 and our study period due to timing of congressional decisions and a change from $35/month/person to amounts recommended by the National Academies of Science, Engineering, and Medicine (NASEM) ($24/month for children 1-5 years, $43/month for pregnant and postpartum participants, and $47/month for breastfeeding participants) (Figure 5.1), so we were interested in participants' experiences with these changes over time. This change to the NASEM amounts was an increase for some families and a decrease for others, depending on household composition. The guide assessed: perceptions and awareness of the CVB increase, barriers and facilitators to using CVB at the higher amounts, perceived changes in household dietary behaviors, general barriers and facilitators to using WIC benefits and how that may have changed during the pandemic, and perceptions of the WIC food package (Appendix 1).

All focus groups were recorded and transcribed using Otter artificial intelligence transcription software[169]. If participants shared ideas in the Zoom chat, we incorporated their chat comments into the transcript. Either EWD or DAV double-checked the accuracy of transcripts and provided edits when needed using the recordings. Transcripts were not reviewed by participants, but a summary of key study findings was shared with participants but this process did not result in more data or change the interpretation of results.

Data Analysis

Focus group transcripts were analyzed using thematic analysis based on a phenomenological approach, which is used to study how people make meaning of their lived experiences[170]. We deemed this approach was suitable for data analysis given our interest in assessing participants' experiences with the pandemic and the CVB increase. An initial

codebook was developed *a priori* based on relevant research from relevant topics. After reading through (without coding) a random sample of three of the transcripts, we updated the codebook and refined emergent codes. All authors provided input on the codebook. Then, three transcripts were double coded by EWD and DAV and the codebook was updated and refined after each transcript was reviewed (Supplemental Table 5.1). EWD coded the remaining seven transcripts using the revised codebook. Based on these analyses, codes were aggregated into themes and memos were developed summarizing findings from each key theme. Coding density of each theme was examined among the rural and urban subgroups to identify similarities and differences. All coding and analyses were conducted using NVivo[171]. We used the COREQ checklist to ensure comprehensive and transparent reporting of our methods[172].

Positionality and Reflexivity

It is important to acknowledge our research team's positionality. Our team has lived experiences and social identities that are both similar to and different from our study participants and these identities can influence the way that we developed our research questions, wrote our focus group guide, facilitated focus group discussions, and analyzed and presented our results[173,174]. For example, the lead author [EWD], is a white woman that does not have lived experiences with federal food assistance programs, is not a parent or caregiver, and her primary research interest is in nutrition policies that effect early childhood nutrition. Although the study team used numerous measures to account for differences in our team and lived experience of our study participants, it is possible that these identities and interests influenced the types of questions that we asked (e.g., we may have missed important questions about using WIC due to lack of experience) or the way we presented results (e.g., selection of quotes). Throughout the data collection and analysis process, we examined and questioned our preexisting beliefs with the goal of identifying ways in which these beliefs could have influenced study results[173,174]. Additionally, in an effort to account for differences in lived experiences and identities we developed a stakeholder advisory board with WIC staff and community organizations

representing individuals with similar lived experiences to our participants and sought this board's input at each step of the research process.

Results

Participant Demographics

We had 55 participants in our 10 virtual focus groups, 29 in the urban focus groups and 26 in the rural focus groups (Table 5.1). The average age of mothers or caregivers was 30.4 years. Forty-two percent of participants reported an annual household income of $24,999 or less and 50% reported a household income between $25,000 and $49,999. Among all participants, 42% of the sample was Non-Hispanic/Non-Latina Black or African American, 24% were Hispanic or Latina, and 24% were Non-Hispanic/Non-Latina White. About half (51%) of participants reported currently participating in the Supplemental Nutrition Assistance Program (SNAP). About one quarter (22%) of participants had a high school education or less and roughly half (53%) had some college education or an associate degree. On average, participants from the urban groups were older, had higher incomes, had higher levels of education, and were more likely to participate in SNAP (Table 5.1).

Themes from Focus Groups

Below, we present findings based on pertinence to the CVB policy change, how topics were organized in our focus group guide, as well as our primary research questions. We structured our themes around the key topics of the focus group guide because these questions were designed to address specific gaps related to a policy change.[175] The main themes that emerged from the focus group discussions were perceptions of the CVB amounts before and after the pandemic, awareness and lack of awareness of CVB increase, barriers and facilitators to using CVB, barriers and facilitators to using WIC benefits in general, and desired changes to CVB and the WIC food package. These themes and relevant subthemes are described below and summarized in Supplemental Table 5.2.

Cash Value Benefit Increase

Perceptions of Pre-COVID CVB Amount

Overall, participants expressed that the CVB amount before June 2021 ($9-11/month/person) was insufficient. They described how this amount usually lasted for only one week and limited the varieties of fruits and vegetables they could buy. Many participants turned to more shelf stable, low-cost fruit and vegetable varieties such as bananas, a bag of oranges, or canned items to make the amount stretch. Additionally, some participants felt this amount was insulting because it was so low and inconsistent with the nutrition advice provided by WIC, which encourages parents and their children to consume a large amount of fruits and vegetables. For example, one participant stated:

> *I remember asking the nutritionist, like, "Why do you only give this small amount?" And she started trying to tell me about how "Oh, well the purpose of the WIC program is to be able to, you know, combine the different foods. So like, you can use a little bit of the fruits for like a smoothie and this and that." And I just remember feeling like not, not like I had any agency in deciding like how I wanted my diet to be…*

Awareness and Perceptions of the CVB Increase

Some participants were notified by their local WIC agency about the initial CVB increase in June 2021, the subsequent decrease in North Carolina in October 2021, and the changes to the NASEM amounts in November 2021. Rural participants were more likely to report receiving notification about the CVB changes as compared to their urban peers. However, many participants were not notified by their local WIC agency about these changes and found out by checking their WIC benefit balance on their BNFT app, during checkout, or from their grocery store receipts. Participants also mentioned how the changes in the CVB amount over time made it difficult to plan for meal preparation based on their available benefits as they normally would. This lack of awareness also created some challenges and uncertainty among participants about the accuracy of their WIC balance and the duration of the increased CVB. For example, several participants did not know about the one month decrease until they went to checkout at the

grocery store and then described having to put things back, use SNAP, or pay with their own funds to cover the difference. One respondent shared:

> *I wish I would got a text or a call from one of the representatives and be like "Hey, this month, we're gonna be cutting back on some of your, your money for fruit. We just wanna let you know." Instead of me going to store and me looking crazy 'cause I'm finna buy all this fruit and I can't 'cause I ain't got enough money*.

Despite these implementation challenges, participants had favorable perceptions of the CVB increase. Although, participants expressed some dissatisfaction with the initial increase to $35/month/person and the later decrease to $24/month/person for children. For example, one participant stated:

> *But now they can kind of dwindled it back down or whatever to only like 20 something dollars and it's just like "But why though?*

Participants also agreed that the CVB was one of the most valuable components of the WIC food package. They noted that they often spend use their CVB first before other WIC food package components (e.g., beans, cereal) each month and that the CVB was the component that needed to be increased the most during the pandemic. One participant stated:

> *…the fruits and vegetables I think is like the most important thing. And I think that is more important than eggs, more important than milk, more important than cereal. They all have their benefits. But I think the vegetables, especially if you're going to start the kids off when they're young, you have to give them the vegetables when they're little or they're not going to want them*.

Some mentioned that the CVB increase influenced their decision to remain enrolled in the WIC program. Participants shared that fruits and vegetables are a pivotal part of being able to provide healthy meals for their family, that their families enjoy eating and prefer fruits and vegetables and that this benefit increase allowed their families to achieve dietary patterns more closely aligned with their family's preferences and WIC recommendations. These perceptions were similar across the rural and urban groups.

<u>Barriers and Facilitators to Using CVB</u>

Most participants reported that they used the full amount of their CVB each month and many mentioned they go through the current (NASEM) amount in their first trip to the grocery

store after their benefits are renewed. These perceptions were similar among rural and urban participants. Participants felt they needed more than the current CVB amount to meet their family's needs, especially since the average cost of fruits and vegetables has increased with inflation and the CVB is the only dollar-value based component of the WIC food package. One participant stated:

> *…everything costs so much more, your $9 that would have gotten you, would have gotten you a lot more last summer than it's going to get you this summer…they also need to think about the reality of inflation and so that like what we can actually get is actually smaller…*

Participants mentioned that not being able to scan certain fruit and vegetable products in the BNFT app presented a challenge particularly when produce was not clearly labeled as WIC approved. Participants also described issues at checkout when fruits and vegetables they thought would be covered by WIC, such as frozen fruit, were not and they had to pay out of pocket for these products. Barriers to using the CVB were more pronounced among rural participants compared to urban participants. Rural participants often highlighted a lack of adequate supply of fruits and vegetables in grocery stores. The more general WIC use barriers discussed below such as the time and mental burden of using WIC benefits and lack of desired technologies like online shopping and self-checkout are also important barriers to CVB use. Despite these barriers, most participants felt it was easy to use the full CVB amount each month because of the variety of products (e.g., fresh, canned, or frozen fruits and vegetables) that could be purchased with CVB. Participants also said that it was easy to spend the full amount because their families preferred to eat fruits and vegetables, and they are part of their day-to-day meals. Finally, participants mentioned certain grocery stores or places such as farmers markets with fruit and vegetable incentive programs that had appealing and fresh produce that made it easy for them to use their CVB each month. Participants in rural and urban areas had similar perceptions of what factors facilitate their use of the CVB.

Perceived Changes in Household Food Behaviors

Participants believed the CVB increase allowed their families to eat healthier. They also stated the CVB increase allowed them and their children to eat a wider variety of fruits and vegetables and allowed their children to try new fruits and vegetables. One participant said:

> *And we've discovered that he loves asparagus and broccoli. So, we could like do that for lunch or like a little midday snack. I give him some grapes, and like broccoli, or strawberries, and asparagus, just for a healthier snack or lunch, instead of going to like freezer meals and potato chips and stuff like that.*

This theme of increased variety was common among rural and urban participants, but more pronounced among urban participants. Participants also said the CVB increase allowed them to introduce new fruit and vegetable varieties without the fear of wasting food that they had when the CVB was lower. Participants also felt the CVB increase led to a change in their dynamic with their children while grocery shopping. For example, children would ask for new varieties of fruits and participants were able to buy these products for their children for the first time.

Facilitators and Barriers to Using WIC Benefits in General

Clear and accurate labeling at the point of selection of which products were WIC approved was a key determinant of which stores participants preferred to use their WIC benefits in and a facilitator to using WIC benefits. Many participants also mentioned the transition from paper vouchers to the electronic benefit transfer (EBT) system has made using WIC benefits much easier. Some participants, and urban participants especially, also stated the WIC BNFT smartphone app made it easier to identify WIC approved products. Participants stated that, during the pandemic in particular, the flexibilities implemented by WIC in the food package such as substitutions of products within a category and remote/phone appointments supported their use of WIC benefits and they wanted these flexibilities remain in place beyond the pandemic.[176] Despite some retailers having clear and accurate labeling, participants mentioned significant barriers to identifying WIC approved products in most retailers due to non-existent or inaccurate

labeling which deterred them from using WIC benefits at these outlets, sometimes despite more competitive pricing. Similarly, participants mentioned issues at checkout due to incorrectly labeled WIC approved items they thought were approved. Participants also discussed the time and mental burden of using WIC benefits compared to other payment types such as challenges remembering which products were WIC approved, having to go to multiple stores to find WIC-approved items due to shortages, and remembering to use all their WIC benefits before they expire each month. Some participants also mentioned the stigma associated with using WIC and experiencing issues at checkout and coping mechanisms to avoid this stigma such as shopping at less popular times of day. Delays in receiving benefits due to limited staffing, unpleasant interactions with WIC staff, and lack of culturally relevant items in the food package also presented barriers to WIC use.

One of the most notable barriers to using WIC was the desire for new technologies such as the ability to use WIC at self-checkout or for online grocery shopping. This was particularly true during the pandemic. Participants described the inconvenience of not being able to use WIC for online shopping. They described the fear they often had going into grocery stores to use their WIC benefits because they did not want to risk exposure to COVID-19 for themselves or their children. Shortages, particularly milk, lactose, free milk, and infant formula presented challenges to using WIC benefits during the pandemic. These shortages were particularly common among participants living in rural areas. Additionally, participants noted higher food costs presented challenges for their families and sometimes contributed to food insecurity, particularly in rural participants. Each of these barriers to using WIC benefits in general can also be considered barriers to using the CVB component of WIC benefits.

Desired Changes to CVB and the Food Package

When asked about suggested changes to the CVB, participants wanted to continue to receive this benefit for their 6–12-month-old children once complementary foods were introduced so that they could make their own pureed baby foods instead of receiving the jarred

baby foods. They also stated they needed more than the current NASEM recommended amounts for fruits and vegetables to provide adequate fruits and vegetables for themselves and their children. Participants were also interested in the idea of being able to substitute components of the WIC food package across and within categories or personalize the food package to better suit their family's and children's preferences. One participant stated,

> *…if I could say, you know, you can keep this bread and give it to someone who would actually use this bread and someone who will actually use this cereal, go ahead and just give me $5 more for fruits and vegetables, and that would be fine. Like, I just think if it's like tailored to the child like that…*

Participants also wanted their WIC benefits to roll over for at least one month, similar to how SNAP benefits are administered. Many participants mentioned the current means of administering WIC benefits one month at a time created anxiety about forgetting to use benefits before they expired. Additionally, some participants stated that rolling over benefits would allow them to better meet their young children's constantly evolving food preferences. Urban participants tended to suggest more changes to the CVB amounts and WIC food package. Rural participants had fewer suggested changes, and some made statements such as "*I'm in no place to argue with them* [WIC administrators]" when asked about desired changes to the WIC food package.

Discussion

Through this qualitative study we found that, among North Carolina WIC participants, the CVB increase was positively perceived, the pre-pandemic CVB amount was insufficient to meet WIC participants' needs, and participants believed the CVB increase improved their households' total fruit and vegetable consumption and increased the variety of fruits and vegetables consumed. However, despite these positive changes, we observed barriers to CVB and WIC benefit use including lack of physical access and challenges identifying WIC approved products. There were a few key areas in which rural and urban participants differed as described further

below but overall experiences with the CVB increase were relatively similar between the two subgroups.

Our findings that participants perceived improvements in fruit and vegetable consumption following the CVB increase are consistent with a recent report[177], that also noted that CVB increases allowed WIC families to consume more fruits and vegetables and a wider variety of fruits and vegetables. Larger, quantitative studies with food purchasing or WIC redemption data will be needed, but our findings suggest the CVB increase may have improved fruit and vegetable intake in households with low incomes, from historically marginalized racial/ethnic groups, and in rural households, suggesting the promise of the CVB increase for mitigating disparities in fruit and vegetable intake in these populations. Also, repeated exposure to a variety of fruit and vegetable flavors and textures in early childhood is critical to developing a preference for these food groups[4]. However, the cost of this repeated exposure and the associated food waste is a barrier for families with low incomes to introducing young children to new foods they may not readily accept[59,60]. There was a consensus among participants in our study that this CVB increase allowed them and their children to try fruits and vegetables they had never been able to purchase before because they were cost prohibitive, or because they feared wasting food. Beyond simply measuring total fruit and vegetable consumption, future studies should also examine the variety of fruits and vegetables consumed or purchased before and after this policy change.

Participants highlighted several barriers to using the CVB specifically and discussed a variety of more general barriers to using WIC benefits which, in turn, present barriers to using the CVB component of the food package. Participants in our study described barriers such as inaccurate labeling and issues at checkout with fruits and vegetables being deemed ineligible that they thought were eligible, similar to what prior research has consistently documented[17,97,178]. This barrier is not unique to the CVB and appears to be more of an issue with redeeming WIC benefits in general. Similarly, like prior studies documenting WIC shopper

experiences[23,64,97,178,179], our study highlighted several general WIC use barriers such as issues with stigma and lack of desired technologies that participants felt affected their WIC and CVB redemption. In our study, WIC participants also described various forms of what Elliot et. al have described as disenfranchisement (i.e., structures that keep people from seeking public resources[21]) such as experiencing delays in receiving their WIC benefits due to staff shortages in rural areas, being afraid or hesitant to access benefits due to the risk of contracting COVID-19 or unpleasant interactions with WIC staff, and lacking access to fruits and vegetables or other foods in their communities. Additionally, we found that changes in the CVB amount over the period of June to December 2021, including a one-month temporary *decrease* in benefits, created a notable amount of confusion and uncertainty about redeeming CVB among North Carolina participants. These challenges are similar to the learning costs[75,99] associated with public assistance programs that present major barriers to use and these barriers should be considered by policymakers when designing future emergency food response programs. Overall, there are still a variety of barriers to using the CVB, and WIC benefits more generally, that urgently need to be addressed for WIC to have the greatest possible impact on reducing diet-related disease and fruit and vegetable consumption disparities by income, race/ethnicity, and rurality.

To our knowledge, this is the first study to examine differences in experiences with the CVB increase by WIC participant rurality. Contrary to our expectations, despite some reported WIC staff shortages in rural areas, rural participants more commonly reported being told by their local WIC agency about some of the CVB changes, compared to urban participants. We found that rural participants reported CVB and WIC use barriers like unclear labeling, issues with the BNFT app, and desire for self-checkout or online shopping. Others have described the potential promise of online grocery shopping to alleviate food access issues in rural areas[180,181], but there continues to be low availability of online grocery options in rural areas compared to urban areas[182,183]. WIC is slated to be approved for online grocery shopping in the near future[184], so

particular attention should be paid to uptake in rural communities. Consistent with other studies in NC describing challenges with healthy food access in rural communities[63,64], rural participants in particular noted that food supply issues such as a lack of fresh, culturally-appropriate, and appealing fruits and vegetables presented a barrier to using their CVB and this was exacerbated by shortages experienced because of the pandemic. Some studies suggest that rural communities may have been disproportionately impacted by many aspects of the pandemic[155,156], as is true with most public health emergencies. Future studies should continue to examine the disparate effects of COVID-response programs in rural and urban communities as this could inform whether differential supports are needed long-term and in future emergencies. However, our results and reported differences by rurality should be interpreted with caution as this was a small, qualitative study in one state and larger, more representative studies will be needed.

Strengths of this study include partnering with state and local-level stakeholders throughout the research project and timing the focus groups shortly after a policy change to capture responses when they were fresh in participants' minds. Additionally, we successfully recruited a sample that was racially and ethnically diverse as well as reached saturation of themes among rural and urban/suburban participants, so the perspectives described represent a wide variety of experiences. That being said, our sample size is relatively small and only the perspectives of North Carolinians are reflected in this study, so future studies using national samples and food consumption or purchasing data will be needed to more fully understand the effects of this policy change on WIC participants. Additionally, we were not able to adequately represent Hispanic/Latina WIC participants as we only were able to offer focus groups in English due to resource constraints. Given our recruitment strategies and the use of virtual focus groups, our sample likely reflects WIC participants that are more technologically savvy, have better cell phone service of Wi-Fi access, and are less hesitant about interacting with institutions such as universities. Finally, the use of one coder for the majority of the transcripts

can be considered a limitation as this coder's positionality may have influenced the interpretation of results.

Conclusions

Participants in our qualitative study had generally favorable perceptions of the pandemic-related CVB increase. Participants perceived that it improved their household's total fruit and vegetable consumption and increased the variety of fruits and vegetables consumed by caregivers and their children but reported barriers to CVB and WIC benefit use must be addressed. The effects of the pandemic on nutrition security among households with low incomes will likely persist for years[185], so public health and social support policies such as this CVB increase may be a promising strategy for increasing access to fruit and vegetables and mitigating the negative effects of the pandemic on diet-related disparities.

Tables and Figures

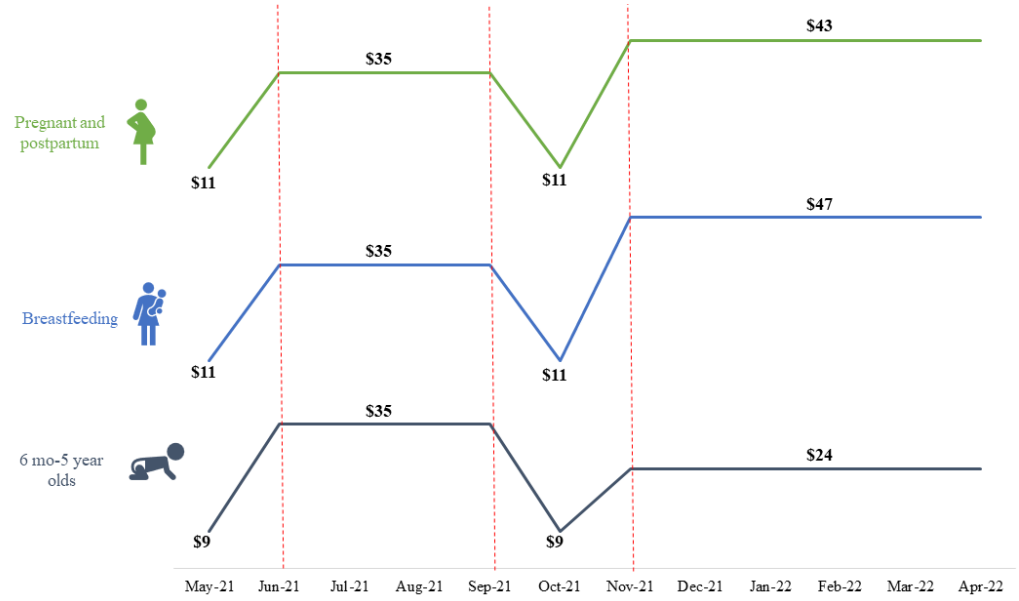
Table 5.1. Sample demographic characteristics (n=55)

	Rural (%) (n=26)	Urban (%) (n=29)	Total (%) (n=55)
Average age	29.2	31.6	30.4
Race/Ethnicity*			
Hispanic or Latina	4 (15)	4 (14)	8 (15)
Black or African American	7 (27)	16 (55)	23 (42)
White	9 (35)	4 (14)	13 (24)
Asian	0 (0)	1 (3)	1 (2)
Middle Eastern or North African	0 (0)	1 (3)	1 (2)
Black or African American & Hispanic or Latina	0 (0)	1 (3)	1 (2)
White & Hispanic or Latina	3 (12)	1 (3)	4 (7)
White & Black or African American	2 (8)	1 (3)	3 (5)
Income			
$0-$24,999	13 (50)	10 (34)	23 (42)
$25,000-$49,999	12 (46)	16 (55)	28 (51)
$50,000+	1 (4)	3 (10)	4 (7)
Education			
HS diploma or less	8 (31)	4 (14)	12 (22)
Some college or associate degree	16 (62)	13 (45)	29 (53)

4-year college degree or more	2 (8)	12 (41)	14 (25)
Participates in SNAP	12 (46)	16 (55)	28 (51)
Pregnant	2 (8)	2 (7)	4 (7)
Average number of children	1.7	2.1	1.9

HS: high school; SNAP: Supplemental Nutrition Assistance Program; *One participant in the rural group selected “Prefer not to answer” for their race/ethnicity.

Figure 5.1. Timeline of key CVB changes between 2021 and 2022 in North Carolina



Supplemental Table 5.1. Codebook including codes, subcodes, definitions, and examples of concepts to include and exclude

Code/subcodes	Definition	Inclusion	Exclusion
Cash Value Benefit			
Awareness	Notified by WIC of changes to CVB amount including initial increase and subsequent changes	Participant received a notification (email, text, phone call) from their local WIC agency about the initial CVB increase or any future changes	Participant found out about CVB increase from checking WIC app for benefit balance
Lack of awareness	Not notified by WIC of changes to CVB including initial increase and subsequent changes	Participant found out about CVB increase or future changes through some method other than local WIC agency	Participant found out about CVB change from local WIC agency
Information source	Resources identified by participants that inform them of changes within WIC, including CVB changes	Communication from WIC, websites, letters, flyers, emails, social media	Preferred information sources
BNFT App	Finding out about the CVB changes through the BNFT app	Mentions finding out about CVB changes through the BFNT app	Finding out about the change through another source
Receipt	Finding out about the CVB changes on their grocery store receipts	Mentions finding out about CVB changes by looking at grocery store receipt	Finding out about the change through another source
Call	Finding out about the CVB changes from a phone call from WIC staff	Mentions finding out about CVB changes by receiving a call from local WIC agency	Finding out about the change through another source
Text	Finding out about the CVB changes from a text from WIC staff	Mentions finding out about CVB changes by receiving a text from local WIC agency	Finding out about the change through another source
Email	Finding out about the CVB changes from an email from WIC staff	Mentions finding out about CVB changes by receiving an email from local WIC agency	Finding out about the change through another source
Preferred information source	Favorable communication channels and platforms for changes within WIC, including CVB changes	Methods of communication that WIC participants prefer for updates from WIC about changes	Method of communication used for CVB change

	Call	Preferring to receive a call from WIC when there are changes	Preferring to receive a call from WIC when there are changes	Preferring other sources
	Text	Preferring to receive a text from WIC when there are changes	Preferring to receive a text from WIC when there are changes	Preferring other sources
	Email	Preferring to receive an email from WIC when there are changes	Preferring to receive an email from WIC when there are changes	Preferring other sources
	App	Preferring a BNFT app notification when there are changes	Preferring to get a BNFT app notification when there are changes	Preferring other sources
Timing met needs		The CVB increase in June 2021 met the households' needs at that time and they did not need other components of the food package changed at that time	References to the CVB increase in June 2021 meeting households' needs at that time	References to using CVB first each month, saying CVB is the most valuable part of the WIC food package
Timing did not meet needs		Needing some other WIC food package component (other than CVB) increased in June 2021	References to needing some other WIC food package component (other than CVB) increased in June 2021	General references to desired changes to other components of the WIC food package
Challenges of temporary CVB decrease		Difficulties associated with the CVB decrease from $35 to $9-11/person/month in October 2021	Any difficulties with planning, shopping, or meeting household food needs experienced in October 2021 when the benefit decreased temporarily or negative feelings about this decrease	Lack of awareness of the CVB decrease in October
Benefits or positive perceptions of CVB increase		Positive aspects of larger CVB amounts (either $35/month or NASEM amounts)	General positive perceptions of the CVB increase at the initial $35/month or NASEM amounts	Positive perceptions of other WIC food package components or COVID-related changes to WIC
	Variety	Perceived changes in the types of fruits and vegetables purchased and consumed	New types of fruits and vegetables, different forms (i.e., fresh instead of frozen) of fruits and vegetables	Purchasing or eating more (volume not types) of fruits and vegetables generally
	Family/mother/ caregiver diet	Perceived improvements in the	Mentions of parents or the whole family eating	Mentions of eating more variety

		eating habits of family members other than the child enrolled in WIC	healthier because of the increase in fruits and vegetables	
	Child diet	Perceived improvements in the eating habits of children enrolled in WIC	Mentions of the child eating healthier because of the increase in fruits and vegetables, child snacking on fruit or eating fruit for breakfast, eating more fruits and vegetables	Mentions of the child eating more variety
	Engaging children in shopping	Mentions of children selecting new fruits and vegetables or talking about fruits and vegetables in the grocery store environment	Descriptions of child helping parent select new fruits and vegetables in the grocery store after the CVB increase	General references to increase in variety of fruits and vegetables or eating new fruits and vegetables
	Achieve family's/culture's dietary preferences	Being able to access foods that meet families preferred dietary behaviors/patterns (e.g., vegan, Latina, organic)	Describing being able to provide meals in line with preferred diet after the CVB increase such as vegan diets, purchasing organic, having more money to purchase more expensive, WIC ineligible foods such as meat	Other components of the WIC food package that do/do not align with household's food culture
	Food waste	Being less afraid to waste food when offering new fruits and vegetables to kids	Being less afraid after the CVB increase to waste food when offering new fruits and vegetables to kids	References to wasting foods other than fruits and vegetables or wasting components of the food package other than fruits and vegetables
Uncertainty about CVB amounts		Feeling uncertain about how long the CVB increase will remain in effect or changes in the CVB amount over time creating uncertainty	Lack of clarity about how long the CVB change will remain in place, uncertainty about the CVB amount participants should be receiving currently	Negative aspects of the October dip in benefits in NC
Amount of CVB used		The amount in terms of dollars or percentage etc. of the total CVB value that	Any reference to the amount of the monthly CVB allotment used by participants and/or	Mentions of the amount or percentage of the total WIC food

	each participant uses each month and/or how many trips to the store the CVB lasts for	how many trips to the grocery store the CVB lasts for	package used each month
Satisfaction with CVB amount	General approval or appreciation of having CVB for fruits and vegetables	Approval or satisfaction of either the old or new CVB amounts	Not liking the old or new CVB amounts
Old CVB	Contentment with and acceptance of $9-11 CVB pre-COVID	Approving of the $9-11/person/month CVB	Approving of the $35/person/month or NASEM amounts
New CVB	Contentment with and acceptance of new CVB amounts	Approving of the $35/person/month or NASEM amounts	Approving of the $9-11/person/month CVB
Dissatisfaction with CVB amount	General disapproval of having CVB for fruits and vegetables	Disapproval or dissatisfaction of either the old or new CVB amounts	Approving of the old or new CVB amounts
Old CVB	Discontentment with or disapproval of $9-11 CVB pre-COVID	Disapproving of the $9-11/person/month CVB	Negative aspects of the October dip in benefits in NC
New CVB	Discontentment with or disapproval of NASEM CVB amounts compared to the initial $35/month	Mentions of challenges associated with or disapproval of decreasing from $35/month to the NASEM amounts	Negative aspects of the October dip in benefits in NC
Facilitators of using CVB	Factors that make it easy to redeem the full CVB amount each month	Variety of fruit and vegetables options within CVB, supply in stores, preferences for fruits and vegetables, or other facilitators that make it easy to spend the full CVB amount	General facilitators to using WIC while grocery shopping
Variety of products offered/accepted	The variety of products that are approved through WIC CVB being a facilitator to spending CVB	Mentioning the many options for fruits and vegetables that can be purchased with CVB	Increasing variety of fruits and vegetables purchased or consumed after the CVB increase
Retail type	Access to sufficient fruits and vegetables in the store environment being a facilitator to spending CVB	Types of retail (either specific stores or formats) where it is easier to use and redeem CVB and sufficient supply of fresh and appealing fruits and vegetables	Store types where WIC participants generally like to use WIC benefits, mentions not specific to using CVB

	Household preferences	Household preferences for consuming fruits and vegetables being a facilitator to spending CVB	Mentions of families liking fruits and vegetables or that being part of their food culture and those things making it easy to use the full CVB amount	Mentions of household preferences related to other foods than fruits or vegetables or other WIC food package components
Barriers to using CVB		Factors that make it hard to redeem the full CVB amount each month	Unclear fruit and vegetable labeling, issues identifying eligible fruits and vegetables in the app, issues at checkout, insufficient supply or time to prepare fruits and vegetables, having too much for fruits and vegetables in combination with other incentive programs, or other barriers to using the full CVB amount	General barriers to using WIC while grocery shopping
	Unclear labeling	Unclear labeling of WIC eligible fruits and vegetables	Only references to unclear labeling of fruits and vegetables	Unclear labeling of other WIC approved items
	BNFT app	Inability to use the BNFT app to determine if some fruits and vegetables are WIC approved	References to the BNFT app not working well for fruits and vegetables	Other mentions of issues with the BNFT app not specific to fruits and vegetables
	Issues at checkout	Issues at the checkout stage with purchasing seemingly WIC approved fruits and vegetables	References to issues at checkout specifically related to fruits and vegetables and the CVB	Other issues at checkout related
	Retail type	Insufficient access or supply of appealing fruits and vegetables at certain stores or store types that participants like to purchase fruits and vegetables at not accepting WIC	Mentions of stores or retail types where people like to buy produce that do not accept WIC (e.g., ALDI) or mentions of stores they do shop at not having sufficient supply of appealing fruits and vegetables	Store types where WIC participants generally do not like to use WIC benefits, mentions not specific to using CVB
	Time to prepare food	Having insufficient time to prepare fruits and vegetables in	Insufficient time to prepare fruits and vegetables as a barrier	Mentioning time to prepare food as barriers to using

	meals due to other demands	to fully utilizing the CVB	other WIC food package components other than the CVB
Proposed changes to CVB	Recommendations for different amount for CVB, eligibility for CVB, or to improve use of CVB amount	Allowing 6+month olds to receive CVB instead of baby foods, statements about needing more than the current CVB amount	Proposed changes to other aspects of the WIC food package
Strategies to stretch CVB	References to using certain strategies or buying certain types of fruits or vegetables to maximize the amount of CVB available	Mentions purchasing bags of apples or oranges because of low cost and shelf life, only purchasing bananas because of low cost per oz	Mentions of increased variety now that the CVB is higher
Value of the CVB relative to other WIC food package components	Stating that the CVB is the most valuable component of the WIC food package, a reason for remaining in the WIC program, or that participants use their CVB first before other components of the WIC food package	Mentioning the CVB as a reason to remain enrolled in WIC, mentioning using CVB first before other WIC benefits, CVB being favorite component of food package	General benefits of participating in the WIC program
WIC Benefit Utilization Behaviors			
Utilization Facilitators	Aspects that make it easy for WIC participants to use WIC benefits while grocery shopping	Clear labels, BNFT app working well	Poorly labeled items, issues at checkout, BNFT app not working
Clear labeling	Clearly and accurately labeled WIC approved products	Products accurately and clearly labeled as WIC approved	Discussion about poorly labeled products
Store preferences	Specific stores that participants prefer to redeem WIC benefits in for a variety of reasons	Stating the participant prefers to use WIC at a specific store because they have accurate labeling of WIC products, easy checkout, friendly staff, etc.	Stores that WIC shoppers do not like because of labeling, staff, environment. Discussion of stores participants wish were WIC approved. Preferring a store because it is close to home or has lower prices (things not related to using WIC).

	WIC BNFT App	Use of the WIC BNFT app to know which products are WIC eligible or overall benefit amounts	App functioning well to help participants identify WIC eligible products or know how many benefits they have left	Issues with the app not working
	EBT transition	Transitioning from paper vouchers to EBT cards facilitating use of WIC benefits	Mentions of how the process of using WIC is easier now after the transition to EBT from paper	Mentions of EBT meaning SNAP, issues or negative aspects of WIC EBT
Utilization Barriers		Aspects that make it difficult for WIC participants to use WIC benefits while grocery shopping	Issues at checkout, poorly labeled products, store environment, mental or time burden of using WIC compared to other forms of tender	Facilitators to using WIC benefits in the store, changes participants want to see in the food package
	Unclear labeling	Lack of clear labels for WIC approved products	Unclear, inaccurate, or nonexistent labels for WIC approved products	Clear and accurate labels for WIC approved products
	Checkout experience	Issues at checkout with using WIC benefits	Mentions of items participants thought were eligible not being eligible, having to pay out of pocket or with SNAP for products participants thought were WIC approved, having to wait a long time to use WIC benefits because they cannot use the self-checkout lines	Issues at checkout during the October dip, self-checkout
	Store preferences	Specific stores that participants do not like to use their WIC benefits at for a variety of reasons	Stores that do not have clear labels, easy checkout, friendly staff	Mentions of these topics without reference to a specific store. Discussion of stores participants wish were WIC approved.
	WIC BNFT app	Issues with using the WIC app to identify approved products or benefit levels	BNFT app not working in store, BNFT app not accurately identifying WIC eligible products	BNFT app not working for fruits and vegetables specifically
	Mental or time burden	Having to think about which products are approved and using coping strategies to	Strategies used in store to remember which items are WIC approved, mentions of	Inaccurate or nonexistent labels of WIC approved products, general

		avoid this or having to go to multiple outlets to redeem WIC benefits	the challenges of identifying WIC approved items in store, traveling to more than one store to find WIC approved items	mentions of food shortages
	Stigma	Feelings of shame or social unacceptability of receiving WIC benefits or services	Being embarrassed using WIC benefits, not wanting other shoppers to have to wait for them using WIC benefits	Other issues at checkout not related to feeling embarrassed or ashamed
	Desire for new technologies	Wanting to use WIC benefits at self-checkout, using WIC during online grocery shopping, new systems in place at checkout	Mentions of how using self-checkout or being able to use WIC online would make it easier to use WIC benefits, changing grocery store systems to be able to use WIC to leverage deals like buy one get one free	Discussions about using other tender types online or at self-checkout
Desired stores		Stores participants would like for WIC benefits to be accepted	Mentioning other stores like ALDI or Sam's club where WIC benefits cannot be redeemed but participants would like to use WIC	Stores that already accept WIC that participants like or dislike
Frequency		How many trips participants take to use their WIC benefits	Mentions of how many trips participants take to use their WIC benefits	Changes in frequency due to COVID
WIC Food Package				
Favorable perceptions of component other than CVB		Any positive or favorable perception expressed about components of the WIC food package except for the CVB	Aspects of the WIC food package participants like, references to food preferences, using more of certain components, how these components fit into family's diets	CVB fruits and vegetables
	Juice	Approved 100% juice products	100% juice	Fruits or vegetables
	Dairy products	Items derived from cow's milk or non-dairy milk alternative	Milk, cheese, yogurt, soy milk	

	Grains/cereal	Approved grains in WIC food package	Breads, hot and cold cereals, rice, pasta, tortillas	Infant cereals
	Protein foods	Foods high in protein that are part of WIC food package	Beans, lentils, tofu, fish, eggs, peanut butter	Chicken, beef, pork, seafood other than fish, infant meats
	Eggs	Eggs approved in the WIC food package	Eggs	
	Infant foods	Specially formulated products for infants a part of WIC food package	Formula, infant fruits and vegetables, infant cereals, infant meats	
Unfavorable perceptions of component other than CVB		Any negative or unfavorable perception expressed about components of the WIC food package except for the CVB	Aspects of the WIC food package that participants do not like, references to food preferences, how these components do not fit into family's diets	Negative feelings about the CVB, desired changes to the WIC food package, saying they get too much or too little of something (should go under amount)
	Juice	Approved 100% juice products	100% juice	Fruits or vegetables
	Dairy products	Items derived from cow's milk or non-dairy milk alternative	Milk, cheese, yogurt, soy milk	
	Grains/cereal	Approved grains in WIC food package	Breads, hot and cold cereals, rice, pasta, tortillas	Infant cereals
	Protein foods	Foods high in protein that are part of WIC food package	Beans, lentils, tofu, fish, eggs, peanut butter	Chicken, beef, pork, seafood other than fish, infant meats
	Eggs	Eggs approved in the WIC food package	Eggs	
	Infant foods	Specially formulated products for infants a part of WIC food package	Formula, infant fruits and vegetables, infant cereals, infant meats	
Amount of full benefit		How long WIC benefits last each month and whether the amount offered is sufficient	References to the adequacy of the entire WIC food package to meet households' needs	References to the adequacy of the CVB component
SNAP EBT usage		Discussion of using SNAP/EBT in addition to WIC or as a supplement to WIC	Any reference to the role that SNAP/EBT provides in households meeting their grocery shopping needs	References to the WIC EBT card
Desired changes to WIC food package		Items participants would like more or	Items to reduce or increase in the food	Unfavorable perceptions of the

other than changes to CVB		less of in WIC food package, items that participants would like to be included in package, and changes in the administration of the WIC food package	package, items to add, differences in how benefits are administered	existing food package, desired changes to the CVB
	Household dietary preferences	More flexibilities in foods received to meet families' eating patterns (vegan, lactose intolerant, organic)	Flexibilities or changes to meet households' diverse dietary preferences, dietary restrictions, or needs related to food allergies or intolerances	Foods in the WIC food package households like generally, saying they want more or less of some component without additional context related to household preferences
	Substitutions	Substitutions within and across categories to meet needs not related to family's cultural patterns of eating or family's food restrictions	Discussion of substitutions like yogurt instead of milk or bottled water instead of juice	Substitutions related to fruits and vegetables (i.e. more CVB instead of baby food)
	Rolling over benefits	Allowing WIC benefits remaining at the end of the month to roll over to the next month	Rolling over WIC benefits from one month to the next to meet households' needs	Changes in benefit amounts, fear of forgetting to use benefits
	Package sizes	Flexibility in existing allowable package sizes for certain components of the food package and allowing different formats like juice boxes, individually packaged yogurts etc.	Using WIC for different package sizes to make it easier to find products or different serving styles (i.e., individually packaged items)	Shortages of package sizes during COVID
	Eligibility	Desired changes to who is eligible to receive food through WIC	Desired changes to WIC eligibility for the WIC food package e.g., people who breastfeed longer than 1 year, people whose children are on WIC	Barriers to enrollment
	Amount	Statements about desired changes to the amount of specific components of the	Wanting more formula for partially breastfeeding moms, wanting less milk	Statements about wanting different package sizes or formats (e.g.,

		WIC food package received		flexibility in package sizes or offering multipacks)
	Disconnect with nutrition advice	Feeling that the food package or components of the food package do not align with the nutrition education delivered by WIC	Nutrition advice given by WIC nutritionists being unattainable given the components of the WIC food package or the foods beings received from WIC not aligning with advice given by nutritionists	General mentions of nutrition advice from WIC
COVID-19				
Change in frequency		Any general changes to shopping frequency pre-pandemic to during pandemic	Changes due to the pandemic in the frequency of grocery shopping	General discussions of shopping frequency
	More frequently	Increase in how often participants went grocery shopping	Mentions of increasing the frequency of shopping during COVID	Mentions of change in frequency not related to COVID
	No change	No change in how often participants went grocery shopping	Mentions of no change the frequency of shopping during COVID	Mentions of change in frequency not related to COVID
	Less frequently	Decrease in how often participants went grocery shopping	Mentions of decrease the frequency of shopping during COVID	Mentions of change in frequency not related to COVID
Barriers to food access		Factors that made certain foods, WIC approved or not, more difficult to buy during the COVID-19 pandemic	Shortages, prices, fear, loss of income	General barriers to using WIC benefits not related to the pandemic
	Shortages	Limited or no availability of specific food products in grocery stores/food retail outlets during the COVID-19 pandemic	Lack of availability of foods, WIC approved or not due to the pandemic or during the time of the focus groups (which was during the pandemic)	General discussions of limited availability of foods like fresh produce
	Inflation	Increases in food prices during the COVID-19 pandemic	Discussion of the cost of food increasing during the pandemic	General comments about food cost, not relating to cost increasing
	WIC online shopping	Issues with accessing food or fear of	Any comments about wanting to be able to	Comments about online shopping with

		accessing food related to WIC not being accepted for online grocery shopping	use WIC for online shopping during COVID and any issues/increased risk of exposure related to that	other tender types such as SNAP
	Difficulties coordinating childcare	Having to find someone to watch their children to go grocery shopping or the inconvenience and/or fear of taking small children grocery shopping during the pandemic	Mentions of challenges related to finding someone to watch children when parents needed to go grocery shopping in person or the fear of taking their small children in a grocery store to redeem WIC benefits	Other mentions of non-shopping related grocery challenges
	Food insecurity related to job loss/change	Job loss or underemployment leading to food or nutrition insecurity	Experiencing food insecurity or job loss during the pandemic that made it hard to get sufficient food	Experiences with food insecurity or job loss not during the pandemic
Facilitators to food access		Factors that made certain foods easier to buy	Changes in WIC benefits and food package flexibilities, store inventory	General facilitators to using WIC, not specific to during COVID
	WIC flexibilities	Flexibilities in the WIC food package implemented during COVID-19	Changes to the sizes or varieties (e.g., organic) in foods that were WIC approved during the pandemic	Desired changes to the WIC food package or changes in package sizes or variety that occurred outside of the pandemic
	Online shopping	Online grocery shopping using payment methods other than WIC during COVID-19	Discussion of online grocery shopping during COVID using other forms of payment than WIC	Discussion of the desire to be able to use WIC for online grocery shopping
	Try new retailers	Shopping at different stores or food retailers than pre-COVID to try to avoid food shortages or other COVID-related barriers to accessing food	Discussion of trying new grocery stores or farmers markets to find food during the pandemic	Discussion of preferred stores for using WIC or general references to stores that have better supply of fruits or vegetables for CVB
Enrollment process changes		Perceptions, positive or negative, about changes to the process of WIC enrollment that	Statements about feelings about changes to enrollment or WIC appointments that happened	Statements about desired changes to the enrollment process or feelings about the enrollment

	occurred during COVID-19	during/as a result of COVID such as phone appointments	process prior to COVID-related changes
WIC Enrollment			
Enrollment process	Participant experiences with enrolling, certification, and education when first enrolling in WIC	Perceptions, positive or negative, about the WIC enrollment process and desired changes to WIC enrollment processes	Desired changes to WIC eligibility
Facilitators to enrollment	Positive aspects that helped participants enroll in WIC, can include processes that existed pre- or post-COVID	Family referrals, visits while in the hospital postpartum, remote appointments	Changes that would make it easier to enroll
Barriers to enrollment	Challenges to enrolling in WIC or remaining enrolled in WIC pre- or post-COVID	Limited staffing, missing WIC contact information, no reminders, in person appointments	Changes that would make it easier to enroll
Desired changes to enrollment	Elements of enrollment process that participants would like to see added or changed	Screening questions about mothers' weight, ways to improve discussions about household dietary preferences	Barriers to enrollment
Benefits of WIC enrollment	Other positive perceptions of being enrolled in WIC beyond the food package	Relationships with WIC staff, education offered, providing pumps, financial support/being able to save money that would have been used on food for other household needs	Benefits associated with the foods received through WIC
Drawbacks of WIC enrollment	Other negative feelings about being enrolled in WIC beyond the food package	Feeling judged by WIC staff, negative interactions with WIC staff, pressure to breastfeed	Drawbacks or negative perceptions about the food received through WIC, challenges that occur during the enrollment period

Supplemental Table 5.2. Themes, subthemes, and demonstrative quotes

Theme	Demonstrative Quote(s)
Subtheme	
Pre-COVID Cash Value Benefit	
Perceptions of amount	“It’s not enough. It's not it’s just like a bag of apples and a package of strawberries. I mean, what's that going to do? You know what I mean? Like it's nothing.”
Strategies to stretch Cash Value Benefit	“To a certain extent, it was just like, we just had to be more careful about the portion sizes and like pay attention, really like pay attention to the sizes like if he gets grapes and everything instead of like getting two pounds of grapes, we'll have to make sure like to get at least like one pound so he could get a vegetable to go along with the fruit.”
Awareness of Cash Value Benefit Changes	
Notified about changes	“I think my WIC, my WIC lady, the one that normally does the appointment, she kind of just called me like well you know you gettin’ extra benefits. She just kind of made me aware of it.”
Not notified about changes	“I remember when we got the first increase, I wasn't told about it. So I called WIC to make sure that it was accurate because I didn't want to spend it and then have to be responsible for repaying it…”
Challenges associated with October decrease	“Yeah, like going into the grocery store or whatever you get the receipt or whatever and you’re like “Dang, zeroed out. How is it zeroed out?” Then you look on your benefit amount and it's like “Oh, we ain’t get nowhere near as much,” and it’s like well…thank you EBT.”
Uncertainty about Cash Value Benefit amounts	“But yeah, like everybody else was saying, if it was something that we could rely on and was consistent, that would be better. But I mean, right now, it's kind of you just got to play it by ear, because you don't know what the changes are going to be.”
Perceptions of Cash Value Benefit Changes	
Achieve family’s preferences	“…and I'm Hispanic. So we do use a lot of vegetables, you know, in like sauces or in guacamole or you know, just fresh. It's just so amazing. I have all that fresh fruit and vegetables on hand and make and make more with it. You know? And I'm not worried about it being gone in a week.”
Value of the Cash Value Benefit	“I will repeat that because I brought that up when I first spoke to someone the fruits and vegetables I think is like the most important thing. And I think that is more important than eggs, more important than milk, more important than cereal. They all have their benefits. But I think the vegetables, especially if you're going to start the kids off when they're young, you have to give them the vegetables when they're little or they're not going to want them.”

	Dissatisfaction with amounts after November 2021	“The amounts we have, you know, since they're a little less of what we had in the summer, it does kind of limit what we can purchase.”
Cash Value Benefit Use Perceptions		
	Barriers	“A lot of times they'll be out of a lot of things or the selection isn't really good. It's moldy or, or aged or old. So I kind of have to skip getting certain things because they're, they're not really worth buying.”
	Facilitators	“Yeah there's so much you can get with it I don't know how you could not use it”
Perceived Changes in Food Behaviors		
	Variety	“With that increase in fruits and vegetables for my kids, I got to introduce them to vegetables that they would probably never eat at a young age. My child was asking me for asparagus all the time. And asparagus is expensive. Asking me for broccoli, like things that I would have never in 1000 years thought she would ask me for but she started asking me for this stuff.”
	Child diet	“Yeah, like she said fruits and vegetables are expensive. So whenever I didn't have, you know, for fruits and vegetables, like whenever I would use my cash value benefits for my child’s snacks, I would have to buy like cookies or something. So now they eat actually healthier.”
	Caregiver or family diet	“I do remember munching on fruits more than like grabbing a $2 pack of cookies you know those pregnancy cravings how those kick in and my husband would buy more fruits rather than you know, buying me a big old bag of chips or cookies.”
	Engaging children while shopping	“And he's getting to engage more in shopping and everything like that. So he’s like “well, I want this” and “I want this fruit, or I want this vegetable”, and everything like that. So it's giving him a chance to engage and eat healthier.”
WIC Utilization Barriers		
	Checkout experience	“And it gets frustrating because sometimes I have $0, I have no money, and I'm relying solely on my WIC card. So you know, I'm utilizing the app and I'm putting things into my cart that I think is WIC eligible, but then I go and I get it rung up and they say you have a balance of $17.82 that I have to pay out of pocket and I'm like well “Whoa, this is all WIC stuff. How am I owing you know, cash?” So then we have to go through that frustrating task of trying to see what exactly did I get that wasn't eligible? Was this juice too big? Was this cheese not the right brand? And that can get frustrating when you have, you know, a long line of people behind you when we got to start doing all of that.”
	Time or mental burden	“I know I often go same grocery store. Because I know like, like, if it doesn't change, I like know exactly where it is in the store. It's when I have to go to a different store that I get all confused because…because it is either marked differently or it's in a different section and so, yeah.”

	Desire for new technology	“And so like I finished my shift at six in the morning, and when I go to Food Lion there no registers open. It's just self checkout. And so I have to like find somebody to open a register just to get my WIC stuff for the kids for breakfast or something. So yeah, being able to use self checkout would be really nice.”
	Lack of labeling	“I don't ever go to Walmart either for WIC because usually they're not labeled or the label is a lot harder to find than it is that other grocery stores”
	Stigma	“If I tried to get the same products that I saw somebody else getting in the app, like I can't get it, it's not approved. And you know, I’m left embarrassed. I mean, you know, I gotta pay for it.”
	Store environment	“Normally I just avoid Walmart altogether and would rather though I could get more for my dollar at Walmart, I just avoid it because the lines and it's just aggravating to use WIC there.”
	BNFT app	“And I can definitely relate because when I go to the grocery store, I honestly the grocery store where I go to there's not a lot of phone service there. So I have to screenshot what benefits are available before I actually go to the store. Because I know once I get there, I'm not going to have any service to be able to check the app.”
WIC Utilization Facilitators		
	Electronic Benefit Transfer (EBT) transition	“Using WIC is pretty easy now that they have switched over to the card instead of paper vouchers. And we can shop freely and just swipe the WIC card and whatever is eligible will be taken off.”
	Labeling	“Well personally, I do side with everyone else that says Food Lion because Food Lion has a better variety of like WIC foods and it is also has labels that say it is WIC approved.”
	Store environment	“I also like Food Lion and we don't have a Harris Teeter but we have a Lowe's Foods and they are really good. But also what I've seen at Food Lion and Lowe's foods is that the employees are also really kind and helpful.”
	BNFT app	“Yes, we love that app. Because we did not have it when our when our boys were in it. And so I was like walking around with this huge book like trying to flip through it. The app is much nicer. Much easier.”
Food Access Barriers During COVID		
	Inflation	“And also, with all the shortages that are happening with fruits and vegetables, and sometimes the price increase, I'm like, well, WIC should think, okay, if the prices of fruits and vegetables, and all the other stuff are going up, shouldn’t WIC also up their [inaudible] to match that? Because it doesn't make sense if WIC is giving you a certain amount of money to buy some stuff, you can only get once like, it doesn't make sense. WIC should match whatever the benefits are to how we're living today…”
	Shortages	“Like last month my problem was finding formula for him. Because there was I guess a formula shortage. And I would have to be literally traveling for two hours all around North Carolina checking calling Wal-Mart to see if they have formulas available for him.”

	In-person shopping and risk	“And online you can't really use WIC you know they, they added the EBT but you can't, they didn’t add WIC up there. So it was more risky as for me to go inside and get the groceries. But like I couldn't really you know stand in the aisle and ponder “hmm, which can of beans do I want today.” I really had to like grab and go. You know, it was, it was scary. It still is scary out there. But it's gotten better. Yeah, it was difficult during the pandemic.”
Food Access Facilitators During COVID		
	WIC flexibilities	“But recently, during the shortages, they started allowing us to get 2% which has helped because again, a lot of this stuff is out of stock and it's continuously like I'll go to multiple stores and I can't find the organic skim milk, it's always out. So when they loosened the restrictions up a little bit and let us choose like a 2% option that helped tremendously.”
	Online shopping with other payment types	“AmazonFresh. Being able to use that, well not for WIC, but for EBT. That was great.”
Desired Changes to WIC Food Package		
	Cash Value Benefit changes	“So I wish that they would continue to give us the fruits and vegetable money once they turned six months. So that I could do that without having to spend you know my own money or I mean I don't mind spending my own money but it helps having you know the WIC to cover it but because she loves fresh fruits and vegetables as well.”
	Amount	“So all these gallons of milk that you give me like I don't need six gallons of milk for two kids. Like, I definitely need more eggs for two kids because they eat through that. And I definitely need more fruits and vegetables because they eat through that and more cereals...”
	Eligibility	“And then when you do breastfeed, they cut you off at a year. And there's moms who go past a year, so we don't get they cut, they don't allow the moms to have the packages after the year. And there's moms who breastfeed past a year.”
	Flexibility	“I think that it would be a positive turn for WIC to start thinking about families who have alternative diets. You know families who, you know, don't, don't eat dairy or because that, that I hate that that stuff goes to waste.”
	Rolling over benefits	“…with WIC I wish that a lot of the stuff would roll over. Like, like I said previously…certain things like with the eggs, my child doesn't eat them all the time. And then she turns around, and she’s scarfs ‘em down and sometimes I don't always get food stamps.”

CHAPTER 6. SYNTHESIS

Overview of Findings

The overarching goals of this research were to (1) describe WIC participant food purchases during the COVID-19 pandemic and (2) estimate the effects of the pandemic-related CVB increase on WIC participant food purchases among WIC participants in North Carolina.

The COVID-19 Pandemic and WIC Participant Food Purchases

Among WIC shoppers, there were large, immediate increases in calories purchased per day after the shock of the pandemic, but the composition of food purchases largely did not shift. We found small shifts in the share of total calories purchased from each food group, with declines in the share of calories from FV and increases in the share of calories from processed food and SSBs after the shock of the pandemic. We observed increases in the absolute calories per day purchased from all food groups among WIC shoppers, likely reflecting a larger proportion of total food acquired coming from grocery stores as opposed to food away from home.[28,80] However, 14 months after the shock of the pandemic, WIC shopper purchases were generally trending back to pre-pandemic levels, particularly in FV and processed foods similar to findings from other studies.[30] As a result, the effects of the pandemic, at least with regards to food purchases at the retailer included in our study, appear to have been relatively minor and short-lived. However, it was promising that WIC shoppers who consistently used WIC during the pandemic had slightly better purchase quality at this retailer than shoppers that either started or stopped using WIC benefits during the pandemic. These results suggest in future public health emergencies policies that facilitate purchases of nutrient-

dense options and increase access to nutrition assistance programs will be important to protecting public health.

Considering what the observed post-pandemic shifts in WIC shopper food purchases mean for public health is complicated by the fact that our dataset is limited to purchases from one grocery store retailer. Food consumed away from home at locations like fast food and other restaurants, which tends to be higher in total energy and nutrients of public health concern such as saturated fat and added sugars, decreased substantially during the pandemic.[186,187] Depending on the specific substitutions families made when transitioning from food away from home to more food purchased at grocery stores, observing an increase in purchases of processed food or SSBs at this retailer may actually amount to a decrease in processed food or SSBs in the total diet if a family was consuming a lot of these food categories from restaurants before the pandemic. Studies using scanner data with food purchases from a larger sample of retailers or using high quality food consumption data will be needed to gain a better understanding of what the shifts in purchases during the pandemic may mean for health.

WIC participants' lived experiences with the pandemic provide key context for interpreting shifts observed in the food transaction data. For example, we observed decreases in the share of total calories coming from FV after the shock of the pandemic. Participants in our focus groups described that the increased cost of foods, and FV in particular,[30] as well as unemployment[77] made it challenging to continue to purchase FV during the pandemic. These experiences provide context that is relevant to both the decreases we observed in the share of total calories from FV, but also potentially the increases in processed food and SSBs after the shock of the pandemic as WIC participants may have shifted from high cost, nutrient-dense options to low cost, ultraprocessed foods. Focus group participants also expressed frustration with being required to redeem WIC benefits in person and reducing shopping frequency to once a month because they feared being exposed to the virus. This behavior change may, in part, explain the rise in processed food purchases observed after the

pandemic as WIC participants may have turned to more shelf-stable, ultraprocessed products to make their groceries stretch throughout the month. Finally, WIC participants were disproportionately affected by the food supply disruptions caused by the pandemic.[188,189] When people began hoarding in response to the pandemic, the supply of WIC-approved varieties of dairy, grains, etc. became limited and our participants reported not being able to redeem WIC benefits or being forced to travel to many stores to redeem benefits. Without access to components of the WIC food package, WIC participants may have turned to low cost, ultraprocessed foods, potentially explaining the increase in processed food purchases after the pandemic observed in our study.

Understanding WIC shoppers purchasing behaviors during the early stages of the pandemic allows us to better understand the potential impact of the 2021 CVB increase. We observed small decreases in the share of WIC shoppers' total food purchases coming from FV over the course of the pandemic potentially due to the rising cost of these products, food shortages, and other pandemic-related factors. It is possible that the CVB increase provided necessary resources to make FV more affordable and accessible to WIC participants.

The 2021 CVB Increase and WIC Participant Food Purchases

Our qualitative and quantitative research provides robust evidence that the 2021 CVB increase was associated with increases in the amount and variety of FV purchased among WIC shoppers. Our quantitative study estimated $12.40/shopper/month and 68.8 oz/shopper/month increases in CVB-eligible FV purchases and purchases of 1.9 more unique varieties of FV/month. Most of these increases are attributable to increases in fruit purchases which aligns with focus group participant reports of their children preferring fruits over vegetables. Given vegetable intake in early childhood is substantially lower than fruit intake and vegetables are excellent sources of key nutrients,[6] future efforts should focus on increasing vegetable purchases and consumption in pregnant, postpartum, and early childhood periods.[148]

The changes observed in WIC shoppers' FV purchases and ability to select FV aligned with their preferences are of public health importance. In considering the potential implications of the results of our quantitative study examining the effects of the CVB increase, we compared the magnitude of our findings to other FV incentive programs widely deemed to be successful as well as the estimated effects of the 2009 CVB increase (from $0 to $6-10). These programs, which differ widely in incentive amount and structure, range in effect sizes from $8-27/household/month[118,138,190] and 3.5-29.7 cup equivalents/household/ month.[37,118,138,191] Our findings of $12.40 and 8.5 cup equivalents/household/month fall well within this range. It is also important to consider the CVB increase was, in part, directed toward children ages one to five years, and FV intake recommendations at this age are between 1⅓ to 3 cups/day depending on calorie needs, compared to 4.5-6.5 cups/day among adults.[6] Therefore, there is a larger relative impact of any size shifts in FV purchases on young children's diets because their cup requirements are lower (i.e., a 1 cup increase is ~33-75% of total daily needs vs. 15-22% of an adult's needs). Outside of increasing the amount of FV purchased, the 2021 CVB increase allowed families to purchase a wider variety of FV which we know is associated with healthy taste preference development.[4] Finally, we heard in our focus groups that the 2021 CVB increase gave WIC families the agency and dignity to purchase varieties of FV that their children were requesting and that aligned with cultural dietary patterns instead of simply what was cheap and shelf stable.

Strengths and Limitations

Strengths

Longitudinal Food Transaction Data

Longitudinal food transaction data are a unique source of monitoring and surveillance data that allow for robust evaluations of public health shocks and policies. A major strength of this research is the use of longitudinal food transaction data from a large grocery store chain beginning pre-pandemic and pre-CVB increase and leveraging those data in

two natural experiments. The time series nature of this dataset allowed us to use rigorous quasi-experimental methods in both quantitative studies. Also, food transaction data are not subject to some of the biases, such as social desirability and recall biases, inherent to measures traditionally used in nutritional epidemiological studies.[137] This is particularly valuable in the context of the evaluation of the CVB increase where WIC participants may be more likely to report consuming more FV than what is truly consumed due to social desirability bias. With the food transaction data we were also able to objectively identify shoppers as WIC shoppers by payment type; whereas, in other datasets, items on sensitive topics such as social support program participation or income are often left blank which can lead to biased estimates.[192,193]

Food Groups Relevant to WIC and Public Health

We developed food groups unique to this dataset that allow us to understand the specific effects of the CVB increase and detect differences in fruit versus vegetable purchases. We used documentation from the NC Department of Health and Human Services to construct new food groups for this research that include only CVB eligible FV, allowing us to better understand the effects of the CVB increase. Additionally, fresh FV make up the majority of CVB redemptions[109] and some food purchasing datasets do not include free weight, fresh produce, so the inclusion of all forms of FV in our transaction data is a major strength for the evaluation of the CVB increase. Additionally, our food groups allow us to better assess the public health impact of this policy change because fewer children meet vegetable recommendations than fruit recommendations,[9] dietary guidance differs for nutrient-dense and starchy vegetables, and more young children consume adequate starchy vegetables than adequate nutrient-dense vegetables.[6] Finally, our processed food and SSB food groups give us a preliminary understanding of whether or not shoppers are purchasing more FV in addition to the same or more processed food and SSBs, which has potential implications for the effects of the CVB increase on weight and health. However, future studies should examine substitution to a wider variety of food groups to better understand these potential effects.

Using a Community Advisory Board

We partnered with local, state, and national groups to maximize the relevance and impact of our research. The leader of this research is a non-Hispanic white woman that has never participated in a nutrition assistance program or experienced food insecurity and whose lived experiences differ in many ways from the target population of this research. These differences create blind spots and limitations, so we assembled a community advisory board representing staff from the state Department of Health and Human Services, individuals with lived experience with WIC, local community organizations representing communities of color, and a national WIC advocacy organization to provide input throughout the research process. Given the rapid response nature of this research intended to inform active policy discussions, establishing connections and building rapport and trust with these organizations was challenging, but we were able to overcome these challenges with regular meetings, clear roles and expectations, and responsiveness to community group feedback. Input from our board was critical to our ability to successfully recruit a diverse sample for our qualitative study, collect policy-relevant information, and disseminate our results to a range of stakeholders. For example, because of input from our advisory board, we developed an infographic summarizing our results to share with participants and two policy briefs that were used in advocacy efforts to extend the CVB increase in 2022.

Mixed Methods for Policy Evaluation

The ability to triangulate and synthesize results across our qualitative and quantitative studies is a major strength of this research. There are methodological strengths and weaknesses inherent to both focus groups and food transaction data, and one of the benefits of mixed methods is the ability of one method to compensate for the weaknesses of the other.[194] Our qualitative study provided information about the processes by which the changes we observed in our quantitative studies occurred. Additionally, our qualitative study informed the development of our quantitative models and selection of our outcomes. For

example, we added a sensitivity analysis to our third study dropping October 2020 and 2021 due to CVB implementation challenges we learned about in our qualitative aim. We also selected variety of unique FV as outcomes in our third study due to the large number of focus group participants that reported the CVB increase allowed their families to try new FV varieties. Finally, there is great value of mixed methods research for informing public policy.[195] Advocates rely on qualitative research and participant experiences in efforts to pass policy and scientific committees such as the NASEM WIC Food Package review committee rely on quantitative estimates of the effects of nutrition policy. Paired together, these methods provide a holistic understanding of the potential effects of nutrition policy change.

Translating Science to Policy

This research can and has informed public health nutrition policies intended to reduce diet-related disparities. The research questions addressed in these studies were formulated in response to the 2021 CVB increase. We then used a strategic science[196] model to connect our research to policy by identifying and integrating change agents in our community advisory board, developing strategic questions based on advisory board input and existing research, and using a variety of dissemination and communication strategies. Our qualitative study was conducted during the ongoing discussion of whether and how to extend the temporary CVB increase and was published in time to be used in advocacy efforts to extend the timeline for this increase. We developed not only peer-reviewed publications, but also policy briefs that can be easily used and understood by diverse stakeholders. Additionally, our research informed the public comment period on USDA's 2023 Revisions in the WIC Food Packages.[44,197] For example, our study was cited in the National WIC Association's model comment on USDA's revised food packages and in their 2023 State of WIC report.[198,199] Our research also adds to the growing body of evidence that can be used to inform future emergency food response policies such as expanding eligibility and benefit amounts in federal

nutrition assistance programs and messaging and support from public health authoritative bodies about strategies to stockpile shelf stable, nutrient-dense foods.

Limitations

Longitudinal Food Transaction Data

The food transaction data has many strengths but does not provide a complete picture of food purchased or consumed. For example, this dataset does not include food purchased away from home and is limited to grocery purchases at this specific retailer. Bias introduced by missing purchases may be less pronounced during the time period of our studies because food purchased away from home drastically decreased during the pandemic[29] and this specific retailer is one of the top two food retailers in NC and the preferred retailer for redemption of WIC benefits in NC.[116,150] However, during 2021 and 2022, purchases of food away from home, which tend to be higher in nutrients of public health concern found in processed foods,[186,187] began to increase[29,30] so our estimates of processed food and SSB purchases may underestimate the contribution of these food groups to the total diet. Additionally, we have likely underestimated the effect of the CVB increase on FV purchases since CVB may have been redeemed at other retailers throughout the month.

The food transaction data are de-identified, making it difficult to completely control confounding and estimate the public health impact of observed changes in purchases. For example, we do not know the household size or composition of loyalty card holders. In one study, we used fixed effects models to compare shoppers to themselves over time, so assuming that household composition did not change during the course of the study (which it may have in some families with children being born), the effects of household composition should not bias our estimates. In our study examining the effects of the CVB increase, weighting may account for some of the differences in purchases introduced by household composition because we matched on total household expenditures and other shopping behaviors that may be similar across households with similar compositions, but there

is no guarantee the weights have accounted for these differences. The weights also do not account for the issues with interpretation introduced by the CVB amount received being dependent on household composition. For example, if a household has only one child (increase from $9-24/month), the $12 increase observed may be considered high CVB redemption, but if the household has a pregnant person and two children (increase from $29-94/month), a $12 increase could be very low CVB redemption (depending on the amount of substitution of CVB for out-of-pocket spending). Additionally, without information on the household size, we cannot ascertain estimates on changes in purchases per *person* per day, which is of course the unit of interest in understanding potential health implications of changes in purchases.

The food transaction data do not tell us which products were purchased with which payment type. This means that we cannot determine if the increase in FV expenditures or volume is lower than anticipated because shoppers are not using the full CVB amount or because shoppers are buying the same amount of FV they usually would, plus some, and replacing the use of non-WIC funds for those FV with CVB. WIC administrative data would allow us to determine redemption but would not tell us how overall FV purchases may or may not have shifted, so unfortunately there is no perfect dataset to address these research questions, highlighting the need to triangulate results with studies using consumption and redemption data.

Additionally, the use of loyalty card data and our WIC shopper definitions introduce potential selection bias and misclassification. There are not studies examining the characteristics of loyalty-card holders in the US, but evidence from Finland suggests these shoppers may be more likely to be women, higher educated, and employed than the average adult in the Finnish population.[200] We may be underestimating the effects of the pandemic and overestimating the effects of the CVB increase since shoppers with lower levels of employment and education were likely disproportionately negatively affected by the pandemic and may experience greater barriers to CVB use. Regarding misclassification, in examining WIC shopper purchases during the pandemic, we classified shoppers as WIC shoppers if they used WIC one

or more times in the pre and/or post-pandemic period, so we may be classifying non-WIC shopper purchases as WIC purchases. However, there are also limitations to using more strict criteria such as excluding true WIC shoppers that simply do not shop at this retailer for a certain period or use their WIC benefits at this retailer in a given month. In estimating the effect of the CVB increase, we only included shoppers that used WIC or shopped at the retailer quarterly in our analyses, excluding many observations from shoppers that ever used WIC between June 2020 and April 2022 (65%). However, more lenient definitions may have led to non-WIC observations being misclassified as WIC observations and vice versa, potentially leading to biased results closer to the null than the true effect of the policy.

Potential biases are introduced by co-interventions during our study period. In our research describing WIC shopper purchases during the pandemic, this presents less of a limitation because the goal is not to isolate and estimate the effect of a given policy change. Policy changes such as SNAP emergency allotments, stimulus checks, or rent assistance may introduce bias in our results when examining differences in purchases by duration of WIC use if these changes are experienced differentially in our three WIC groups. We unfortunately do not have measures for many of these policies, but we have data on whether shoppers use SNAP benefits. In our first study, we did not find evidence that use of SNAP benefits modified the association between the shock of the pandemic and purchases of the food groups examined, so it is possible that even differential receipt of social programs would not bias our results. Importantly, the monthly payments from the Child Tax Credit (CTC) increase occurred one month after the CVB increase. In North Carolina, about half of all families reported spending the CTC money on food, followed by essential bills, clothing, and school expenses.[201] One of the goals of using weighted non-WIC shoppers was to control for these co-interventions; however, because weighting was conducted using purchasing behaviors, we simply cannot determine how well our non-WIC shoppers truly account for receipt of CTC benefits. Some of the effect on

FV and other food group purchases detected after the CVB increase may be attributable to the CTC increase.

There may be geographic differences in WIC participant experiences with the pandemic and the CVB increase that are important to explore. Unlike most federal nutrition assistance programs, WIC allows states flexibilities in terms of how the food packages are administered. For example, not all states have a mobile WIC application that allows participants to check benefit amounts and scan to check for eligible items and not all states allow the use of CVB on fresh, frozen, and canned FV. Our qualitative and quantitative findings generally align with research that has been released from California, Massachusetts, and Delaware where participants reported satisfaction with the CVB increase and greater FV purchases and consumption.[41,43,112] It will be important to understand how implementation of the various CVB increases occurred across a variety of states and regions as NC experienced unique implementation challenges that negatively impacted WIC participants. Future research should also examine how presence of technology such as apps or state agency policies around communication of pandemic-related policies influenced participant awareness of changes, retention, and benefit use.

This research unfortunately does not and cannot assess racial and ethnic disparities in experiences with the pandemic or the CVB increase. Given documented differences in barriers to receipt of and experiences with social support programs as well as clear disparities in the effects of the COVID-19 pandemic by race and ethnicity[21,65,100,101,151], a major limitation of this research is the inability to measure or document differences in experiences or purchases by race and ethnicity. For example, more than one third of WIC participants identify as Hispanic or Latinx[15] and we know discussions about the Public Charge rule under the Trump administration led to reductions in WIC enrollment and benefit use specifically in the Hispanic or Latinx community.[100,101] It is possible that a disproportionate percentage of shoppers stopping use of WIC benefits after the pandemic were Hispanic or

Latinx, and we found worse purchasing outcomes were associated with stopping use of WIC benefits compared to continuous use during the pandemic. Understanding these differences in experiences and outcomes is critical to fully understanding the effects of the pandemic and the CVB increase on existing nutrition-related disparities. Future studies should prioritize examining differences in food purchasing behaviors during the pandemic and effects of the CVB increase by race and ethnicity using representative, high quality food purchasing or food consumption data paired with qualitative data to capture individuals' lived experiences.

Significance and Public Health Impact

This research can be used in efforts to improve and strengthen emergency preparedness and emergency food response policy. For example, our qualitative study and others have highlighted how shortages of WIC-approved items due to hoarding behavior early in the pandemic led to WIC participants being unable to redeem benefits or having to travel to many stores to find WIC-approved items.[77,78] In future public health emergencies, messaging and policies that protect this group of public health importance and widen the eligibility criteria for WIC-approved items may be important in preventing harm and exacerbating nutrition disparities. Additionally, given the substantial immediate and sustained increases in processed food purchases we observed in our quantitative study and reported in other studies[81], it may be important for public health entities to focus messaging and education about emergency preparedness on the importance of shelf-stable, nutrient-dense foods and proactively ensure the food supply can support higher volumes of purchases of these products. Finally, our work and others has highlighted the toll that miscommunication about pandemic-relief policies took on social program participants in terms of anxiety, uncertainty, and underutilization of benefits.[75,99,116] Resources should be devoted to streamlining and improving communication and implementation of emergency response policies, particularly among high risk groups.

The CVB increase was associated with increased spending on FV and a greater amount and variety of FV purchased, but participants felt they still needed more to meet

their needs. Our studies as well as others have consistently concluded that the 2021 CVB increase achieved its intended goal of increasing FV purchases and consumption among WIC families. However, given the magnitude of the changes observed, the current state of young children's FV consumption, and existing disparities in FV consumption, much more will be needed to move children's FV intake in line with recommendations. WIC is a supplemental food program and therefore does not meet 100% of families' nutrition needs by design. However, there are components of the food package, such as milk, that are given in more-than-supplemental amounts (sometimes exceeding 100% of recommended intake).[16] In our research, most families said that even the higher CVB amounts in 2021 and 2022 were insufficient to meet their family's FV needs and they use the full benefit in 1-2 weeks. In the revised food packages currently being developed by USDA,[44] it would be worthwhile to consider increasing the CVB beyond the 2022 levels to make a more meaningful impact on WIC participant FV intake.

Lower than expected increases in FV purchases may be attributable to incomplete CVB redemption or substitution of payment methods for FV. The observed increase in CVB-eligible FV expenditures of $12.40/shopper/month is less than the per person amount of the benefit increase ($15-$36 depending on participant characteristics and month). Participants in our focus groups reported barriers to using their CVB, particularly in rural communities, such as food shortages and inadequate access to appealing FV, miscommunication and uncertainty about changes in the CVB amounts over time, and difficulty identifying WIC-eligible FV in the food retail environment.[116] Some participants also reported using the higher CVB to buy FV they ordinarily would have purchased with non-WIC funds. We cannot determine the degree to which substitution of payment methods or redemption may explain our findings, but future studies using WIC administrative data and other food transaction data should prioritize these questions.

This research has been used in efforts to improve the WIC food packages beyond the CVB component. In 2023, the USDA released a proposed rule to revise the WIC food

packages[44] and held a 90-day open comment period. Using the findings from this research and other recent studies, we provided feedback on USDA's proposed revisions to the food packages, which included making the higher CVB amount a permanent food package component.[197] Our recommendations included the following:

- establish permanent, higher benefit amounts for the CVB to reach the target intake for FV,
- allow 100% juice in the food packages only as a substitution for additional CVB ($3),
- increase the CVB substitution amounts for infant FV, allow other forms of FV to be substituted than fresh fruits and vegetables, and lower the minimum age for infants to receive a CVB from 9 months to 6 months,
- build additional flexibilities into the WIC food packages, such as rolling over benefits from one month to the next and allowing more substitutions across WIC food package components,
- include seafood in the child (2-4 years) and adult food packages,
- create a pathway for plant-based dairy alternatives,
- adjust dairy issuance to promote participant choice,
- strengthen whole grain intake, and
- establish package and container size flexibility across food categories.

Healthy food incentives are effective, but likely insufficient to make notable public health nutrition impact alone and efforts focused on additional structural and commercial determinants of diet and health are needed.[202] Our studies and many others have identified that FV incentives generally increase the amount of FV purchased and consumed by participants.[34-36,118,138,177] However, depending on household composition, the shifts we observed in FV purchases could be considered small in magnitude and we also observed small increases in processed food and SSB purchases alongside the CVB increase, so the

implications for total diet and health remain unclear. The drivers of diet-related disparities in the US certainly include the cost of healthy food, but also structural determinants further upstream such as disinvestment in marginalized communities, racism, and housing, childcare, and income support policies[203,204] and commercial determinants such as food industry influence on public health research and recommendations and US political processes.[202,205] Over the last several decades, disparities in diet and diet-related chronic diseases have been intractable or gotten worse in some instances and the field of public health seems to be coalescing around the idea that traditional interventions targeting individual, interpersonal, or community-level factors alone are largely ineffective.[204] As the field moves forward, we will need a comprehensive approach to addressing diet-related disparities that provides effective policy-level supports such as the CVB increase alongside approaches that address structural and commercial determinants of disparities such as regulation of the food industry, litigation to end harmful food industry practices, affordable housing, and reparations for communities harmed by slavery and decades of disinvestment, among others.[65,202,206]

Future Directions

Our research provides preliminary evidence that, among WIC participants, the shock of the pandemic was associated with increases in the absolute calories purchased from this retailer and small reductions in purchase quality. However, as noted previously, this food transaction dataset presents a variety of limitations. Future studies should use nationally representative food purchasing datasets that include purchases from a wider variety of food groups and more than one retailer such as the Nielsen Consumer Panel or Information Resources, Inc. to better understand the relationship between the pandemic and food purchases of groups of public health interest.

Similarly, this research found preliminary evidence that longer duration of WIC benefit use during the pandemic was associated with slightly higher food purchase quality, but additional studies with datasets better suited to address this question, such as WIC

administrative data, are needed. At least one research team has been able to link WIC administrative data which includes information and enrollment and redemption to food purchasing data using unique EBT card identifiers.[207] These data would substantially reduce the likelihood of misclassification of WIC shoppers and provide more robust evidence as to whether WIC enrollment during the pandemic may have been protective. More broadly, given the evidence that longer WIC participation is associated with better diet quality[134] and so few eligible children participate in WIC beyond age one,[208] rigorous evaluations of the effects of current USDA investments to improve WIC participation and enrollment on diet and health are needed.

This research also provides evidence of the effectiveness of the CVB increase in improving WIC participant FV purchases, but a wide range of important research questions related to the 2021 CVB increase remain. Future studies should use redemption and consumption data to understand the degree of CVB redemption and the effects of payment substitutions on the total diet. Future studies should also explore how much of the FV purchased with the higher CVB was consumed, how much may have gone to waste due to lack of time or adequate storage for preparing FV, and effective strategies to increase consumption of FV once purchased.

Future research must also examine whether there were differences in WIC participants' experiences during the pandemic and with the CVB increase by race and ethnicity. Our qualitative work and other studies have uncovered differential barriers by race and ethnicity to WIC enrollment and benefit use such as discriminatory policies, miscommunication and lack of Spanish-speaking resources, and rude or racist interactions with agency staff.[21,65,100,104] In 2022 and 2023, USDA invested millions of dollars to "cultivate comprehensive and sustained solutions to increase cultural competency and culturally responsive care in WIC, in turn increasing participation in WIC and improving health of participants".[209] This is an important initiative and it will be critical for researchers to document the effects of these investments on participants' experiences and health. More broadly, future research should explore the role of

interpersonal and systemic racism and discrimination in participation in non-food related social support programs.

Additionally, this research examined the effects of one COVID-related policy change, the CVB increase, in isolation. In reality, there were a variety of changes to food and non-food related social support programs during our study periods, and families were likely enrolled in multiple social support programs. Due to the de-identified nature of our data, we are not able to assess the effects of these policies, but it will be important to understand whether and how participation in multiple programs was associated with diet-related and other health outcomes as well as potential barriers to enrollment and benefit receipt presented by the volume of program changes during this time period and communication about those changes. These research questions are also worth exploring outside of the context of a public health emergency, as understanding the benefits of and/or challenges to multiple social program participation can inform federal and state policies to streamline social program enrollment and recertification.

Finally, we need more research and public health interventions targeting structural and commercial determinants of diet if we are going to move the needle on diet-related disparities. Some scholars have suggested employing frameworks such as the National Institute on Minority Health and Health Disparities Minority Health and Health Disparity Research Framework and focusing on interventions that target the "social, physical, economic, or political environments that shape or constrain health behaviors or outcomes".[203,204] More public health interventions and subsequent evaluations should focus on factors known to be driving health disparities like poverty, economic and educational opportunities, systemic racism and discrimination, housing, and health care.[204]

In conclusion, this research provided preliminary evidence about the relationship between the shock of the COVID-19 pandemic and the 2021 CVB increase and WIC shoppers' food purchases. Future research using different, but complementary datasets will be needed to fully understand the effects of these events on WIC participants. Additionally, broader research

regarding experiences using WIC and other social support program benefits as well as the effectiveness of recent USDA investments to improve WIC participation and retention will be needed. Finally, future research should focus on the structural and commercial determinants of health as solutions to, thus far, intractable diet-related disease disparities.

APPENDIX 1. FOCUS GROUP GUIDE

Aims:

- Examine Special Supplemental Nutrition Assistance Program for Women, Infants, and Children (WIC) participant facilitators and barriers to utilizing the increased cash value benefit (CVB) for fruits and vegetables
- Assess participant awareness of the change in the increased CVB
- Examine WIC participant perceptions of how the increased CVB has affected their household's food security and dietary behaviors
- Examine how WIC participants perceive that COVID-19 affected their food security and food-related behaviors

Key:

Text that is read out loud by interviewer to participant

[Instructions to interviewer; text not read to participant]

1. *Probes for interviewer to use as needed*

Introduction

Thank you all very much for joining us today, and for being patient as we set everyone up. My name is --- and I'll be leading our discussion today. I also have my co-worker(s) here, --- and ---. They will be helping with the technology and taking notes, but they won't be participating in our discussion. We are part of a research team at The University of North Carolina at Chapel Hill. Before we get any further, are there any questions about the consent form that we sent you via email?

We are having these group discussions because we are interested in your experiences with a recent increase in the amount of WIC benefits provided to purchase fruits and vegetables.

Our discussion should last about 60 minutes, and it will be audio and video recorded. We encourage you to leave your cameras on because this will allow us to have a more meaningful discussion. If you need to turn off your video because of internet speeds or connection issues, we understand. Related to turning off your cameras, we also want to let you know this is a safe space if you need to pump or breastfeed you can certainly turn off your camera as needed.

We want to make sure we provide a welcoming space for you to participate. I will be here to listen and ask some specific questions. You all are the experts on this topic, so we want to hear from you about your experiences and ideas. There will be no judgement of your responses or answers. I want to make sure you all know that we do not work for WIC, we are employees of UNC, and your responses will not affect your participation in the WIC program in any way. Feel free to make any positive or negative comments about the things we will be discussing today. We want this to be a free-flowing discussion and there are no right or wrong answers.

To be respectful of your time, I may need to interrupt at times to move us forward. Thank you for your understanding if I need to do this.

Because I am here to listen, there may be long pauses between your responses as I hold space to make sure you have felt heard and shared all you wanted to share.

Before we start, there are some points I'd like to go over.

We want to encourage everyone to actively share in the conversation. Everyone has had different experiences that we want to hear. But also, be aware of how much you're speaking. If you are talking a lot, I may interrupt you, and if you aren't saying much, I may call on you. If I do, please don't feel bad about it. It is just my way of making sure we get through all the questions and that everyone has a chance to talk.

I also wanted to let you all know that everything that you say here will be kept anonymous. Nothing said in this group will ever be associated with any individual by name. We would also ask that you similarly not associate anything said in this group with anyone by name.

We also want to make sure you feel as comfortable as possible sharing, so if you would like to change your name to an alias you can do so by clicking on Participants, hovering over your name, clicking "Rename" and then typing in a new name. Additionally, if there is something you don't feel comfortable sharing out loud with the group you can use the chat function.

The information that you share with us today will be written up in an article to be published in a scientific journal. It will also be shared with the National WIC Association and the state WIC office so that our findings can inform improvements to the WIC program, so your input is very important. We also plan to share a summary of our results with you all in a few months when the results are ready.

As we are talking today, I also want to encourage you to show agreement or disagreement in the chat or verbally. So we can keep the conversation moving, if you agree or disagree with something another participant is saying and would like to let us know, you can type a short message in the chat window or you can say you agree or disagree.

If you accidentally exit or have connection issues, please do your best to re-enter. You can do so by clicking on the same Zoom link you used to get in the first time. If you're having trouble, you can also contact ---, who is assisting with the technology for this interview at XXX-XXX_XXXX [will use a google voice phone number].

[Put phone number in the chat for the participant]

Okay great, before we get started, let's briefly go around and introduce ourselves. Please tell us your first name, or if you do not wish to share your name you can use an alias, and your favorite time of year or season and why. I'll start. My name is --- and my favorite time of year is --- because ----. **[moderator then "calls" on people to quickly introduce themselves].**

Thanks for introducing yourselves.

Do you have any questions before we get started? Great, now we'll dive into the conversation.

[Start audio recording: zoom]

General shopping and WIC utilization behaviors:

Let's start by just talking a little bit about the WIC program, your general shopping behaviors, and how you use your WIC benefits.

1. Tell me about your process getting enrolled in the WIC program.
    a. Is there anything you would like to see changed about the enrollment process?
2. Tell me about your grocery shopping experiences with WIC over the last 30 days. For example, where did you go? What stores do you like using your WIC benefits at and why? How often did you go grocery shopping?
3. How do you decide on which items you use your WIC benefits on? [*Probe what foods parts of the food package that participants like and what parts of the food package they wish were different*]

COVID and food acquisition behaviors

Now we'd like to hear a little bit about your experiences with providing food for your family during the pandemic.

1. How, if at all, did you change how you shopped for groceries during the pandemic? [*Probes for changes in types of foods/beverages, shortages, frequency of trips, going to fewer/more stores, changes in food cost, shopping online, differences between early on in the pandemic and now, certain food categories (e.g. FV) that were easier/more difficult to buy]*

2. Similarly, think back over the course of the pandemic, how, if at all, have you changed how you used your WIC benefits throughout the month? [*Probe for things that made it easier or more difficult to use WIC benefits like shortages, flexibilities in the WIC food package*]

Awareness of and access to FV benefit changes

1. In June of 2021, the amount of WIC benefits to buy fruits and vegetables increased from about $10/person to $35/person each month. What did you know about this change, if anything? [*Probes if they say they were aware of it- How did you find out about this change?*]

    5a. In September of 2021, the benefit then decreased for one month back to $10 and then increased again in November. What did you know about this change, if anything? How did you find out about it? Did this cause you any difficulties?

2. How are you currently getting information about changes to the WIC program such as this recent change in the amount for fruits and vegetables? How would you like to get information about changes to the WIC program [*Probe/examples: via text message, on the app, from a WIC staff person]*?

3. How did you feel about the changes in the amount of money for fruits and vegetables? What did you like most about these changes? What was frustrating or what did you like the least about these changes? [*Probe: was the increase something that met their household's need or would something else have been more helpful*? *For those participating pre/post policy change- was the old amount sufficient? Do they need more than the current amount? How has the change in food prices and availability due to the pandemic affected redemption if at all?*]

Shopping experience during benefit change

[If someone in the group did not know about the program change, you can ask them about what they hypothetically would do with more money for fruits and vegetables or direct questions at participants that were aware of these changes.]

1. With the new fruit and vegetable benefit amount- about how much of the amount available for fruits and vegetables would you usually spend in a month? [*Probes Were there things that made it easy to spend the full amount? Were there things that made it hard to spend the full amount?*]

2. How, if at all, do you think having more money for fruits and vegetables affected your other purchases at the grocery store? [*Probes Were there other foods or beverages that you bought more of because you had this benefit? Were there other foods or beverages that you bought less of because you had this benefit*?]

3. How did you feel about the increased benefits only being allowed for fruits and vegetables? [*Probe about if they would have preferred the benefits be used for other foods in the WIC package or just other foods more generally and why?]*

4. If you had trouble spending your whole FV allotment, what kinds of things would make it easier for you to use all your fruit and vegetable money from WIC each month?

Food behaviors during benefit change

4. In a typical week when you had more money from WIC for fruits and vegetables, what types of meals would you and your family eat? Was this similar to or different from what you would usually eat? How? [*Probe for buying different types of fruits and vegetables, allowing children to try new fruits and vegetables, amount of food thrown away before it could be eaten or because family did not like it]*

Perception of the value of participating in WIC

5. How, if at all, did this increased FV benefit influence your decision to remain enrolled in the WIC program?

6. If the benefit amounts go back to $9-11/month/person, would that influence how likely you would be to continue to participate in WIC?

Closing

So, that brings us to the end of the discussion. Is there anything that hasn't already been raised that you think is important to include or mention?

[Turn off recording]

Thank you all very much for your time. We are grateful for your willingness to share your thoughts and feelings with us. If you have any further thoughts to share, please e-mail us at [insert study email]. We will be reaching out to you all soon with some information about local food and nutrition programs and common eating challenges among young children in case you are interested, as well as your gift card. We are trying our best to process the gifts cards as quickly as possible, but please note that it may take one to two weeks.

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