ABSTRACT

Title of Dissertation: INCARCERATION AND NUTRITIONAL HARDSHIP: CONSIDERING THE LINK TO FOOD INSECURITY AND HEALTHFUL FOOD ACCESS

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This dissertation addresses the following research questions: (1) What is the relationship between prior incarceration and food insecurity? (2) What is the relationship between prior incarceration and access to healthy food retailers? (3) Does access to healthy food retailers and factors that are considered consequences of incarceration mediate the association between prior incarceration and food insecurity? (4) Does access to healthy food retailers and food security status mediate the relationship between incarceration and (a) health and (b) nutritional behavior?

To address these questions, this project draws from two data sources. First, using the National Longitudinal Study of Adolescent to Adult Health, I assess the link between

incarceration and food insecurity, as well as health and nutritional outcomes. Second, the Center for Disease Control and Prevention (CDC) collected data for the Modified Retail Food Environment Index (mRFEI) in 2008-2009, which is linked to Add Health data using census tract codes. The mRFEI represents the percentage of retailers that sell healthy food relative to unhealthy food retailers in a census tract and the 0.5-mile buffer around the census tract. These data are used to assess the relationship between incarceration and access to healthy food retailers.

Findings suggest that when compared to respondents who did not have prior contact with the criminal justice system, formerly incarcerated individuals are more likely to be food insecure and live in census tracts with low access to healthy food retailers. The findings indicate that much of the relationship between incarceration and food insecurity is explained by financial difficulties, stress, and decreased social standing. However, when the reference category is changed to "arrested only" or "convicted only" respondents the association between incarceration and nutrition hardship outcomes are attenuated, suggesting that selection bias underlies the association. Finally, neither food insecurity or access to healthy food retailers mediate nutritional outcomes or the likelihood of having an unhealthy weight, although food insecurity was found to mediate the association between incarceration and subjective health status. Overall, the results call for further investigation of the complex relationship between incarceration, post-release nutritional hardships, and health.

INCARCERATION AND NUTRITIONAL HARDSHIP: CONSIDERING THE LINK TO FOOD INSECURITY AND HEALTHFUL FOOD ACCESS

By

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CHAPTER 1: INTRODUCTION

Approximately 7 million individuals were under the supervision of the adult correctional system in the United States in 2014, including 2.2 million individuals incarcerated in state and federal prison or in local jails (Kaeble et al., 2015).[1] The current size of the correctional population represents a four-fold increase in the incarceration rate over the last 40 years (Travis, Western, & Redburn, 2014). This expansion has also coincided with a sizeable growth in the number of ex-inmates reentering communities. Over 95 percent of inmates are eventually released (Travis, 2005) and each year approximately 600,000 inmates leave state and federal prisons and millions exit local jails (Carson, 2015; Minton & Zeng, 2015). Consequently, the high incarceration rate has resulted in a sizeable population of former inmates transitioning from custodial confinement to life in residential communities, the majority of whom are concentrated in poor urban neighborhoods (Clear, 2007; Lynch & Sabol, 2004; Sampson & Loeffler, 2010).

The large number of former inmates reentering society has prompted interest among social scientists and policymakers regarding the challenges to successful reintegration including the establishment of a conventional lifestyle and meeting basic material needs, such as access to food (Harding et al., 2014; Petersilia, 2003; Travis, 2005; Western et al., 2015). Indeed, a large body of work on prisoner reentry consistently finds that the majority of former inmates fail to avoid future rearrests (Beck & Shipley, 1989; Durose et al., 2014; Langan & Levin, 2002). Low rates of successful reentry are

[1] Adult correctional system includes individuals incarcerated in prisons or jails and those on probation or parole.

perhaps not entirely surprising given the daunting social and economic challenges facing former inmates (Nagin, Cullen, & Jonson, 2009; Petersilia, 2003; Travis, 2005).

Although much research and public policy to date has focused on recidivism, desisting from crime is only one element of successful reintegration. Another key component is whether former inmates are able to meet basic material needs in order to establish a conventional lifestyle (Harding et al., 2014; Travis, 2004). An emerging area of research examines the barriers and hardships to successful reintegration faced by former inmates. This literature establishes that incarceration is a stressful and stigmatizing experience that harms successful social and economic mobility by eroding human and social capital, generating legal restrictions, and contributing to health problems (Morenoff & Harding, 2014; Wakefield & Uggen, 2010; Western, 2006). Accordingly, incarceration has become a crucial social institution playing a role in creating and widening social inequalities by reshaping life-course trajectories for individuals and their families (Pettit & Western, 2004; Wakefield & Uggen, 2010; Wildeman & Muller, 2012).

Notably, the growth and patterning of the penal population has also produced a burgeoning interest in the micro-level association between incarceration and various health outcomes. Work in this area generally views the relationship between incarceration and health in two ways. First, any association between incarceration and poor health may be the result of a selection process in which inmates have poor health profiles because of individual, environmental, or social characteristics such as poverty or a history of substance abuse rather than incarceration itself (see Massoglia & Pridemore, 2015). Prior research demonstrates that most inmates are in poor health prior to incarceration

including high rates of infectious diseases, mental illness, injury, and heart disease (Conklin et al., 2000). Moreover, there is substantial overlap in the correlates of criminal behavior and poor health behavior. For instance, individual characteristics such as self-control are associated with both health and criminal activity (Gottfredson & Hirschi, 1990; Moffitt et al., 2011). In addition, prior research documents an association between criminal offending and poor health outcomes including serious injuries, illnesses, and hospitalization (Farrington, 1995; Shepherd, Farrington, & Potts, 2002; 2004).

Second, incarceration can affect health through two primary mechanisms: (1) increased exposure to infectious disease, and (2) stress and stigma related to incarceration that can persist even after an inmate is released. Regarding the first mechanism, high rates of infectious diseases including tuberculosis (TB), hepatitis, and HIV are well documented among incarcerated populations (Johnson & Raphael, 2009; Massoglia, 2008; Massoglia & Pridemore, 2015; NCCHC, 2002). Although inmates often enter prison with infectious diseases at higher rates than the general population (Massoglia & Schnittker, 2009), features of the prison environment such as overcrowding, shared facilities and hygiene items, amateur tattooing, and unprotected sex can contribute to the spread of infectious disease. Second, research documents that incarceration is a stressful and stigmatizing experience. Early ethnographic work of life behind bars suggests that prisons are extremely depriving and frustrating environments that result in a loss of personal autonomy and liberty, diminished social status, and a removal of elements of one's identity (Goffman, 1963; Sykes, 1958). Moreover, contemporary work on the reintegration process documents the stress and hardships that former inmates continue to face following release from incarceration (Harding et al., 2014; Visher & Travis, 2003;

Western et al., 2015). For instance, the stigma related to incarceration can isolate individuals from sources of social and human capital such as access to economic opportunities (Pager, 2003), social networks (Comfort, 2007; Rengifo & Waring, 2006), and relationships with family members and romantic partners (Hagan & Dinovitzer, 1999; Lopoo & Western, 2005). Consequently, former inmates face daily stressors and social stigma that may negatively impact health and well-being by increasing material hardship, contributing to social isolation, and diminishing social standing (Harding et al., 2014; Western et al., 2015; Schnittker & John, 2007; Schnittker & Bacak, 2013). To date, most evidence indicates that while former inmates tend to have poor health prior to incarceration, serving time behind bars contributes to a worsening of health problems among former inmates (Massoglia & Pridemore, 2015), as well as their families and those in the larger community (Johnson & Raphael, 2009; Wildeman & Muller, 2012).

Despite growing attention to the potential consequences of incarceration, relatively limited research has examined the impact of incarceration on health behavior generally, and nutritional profiles of former inmates more specifically (Porter, 2014). While recent research documents the struggle to meet basic material needs among former inmates, including how former inmates obtain minimal food needs (Harding et al., 2014), this topic remains understudied and little is known about how the experience of being incarcerated may impact important aspects of health such as diet, food insecurity, and access to healthy food retailers. This is an especially notable limitation as food insecurity and food access are viewed as severe forms of deprivation separate from measures of economic hardship (McIntyre et al., 2003; Turney, 2015).

Food insecurity (i.e. the lack of access to adequate food) is viewed as one of the most serious nutritional health issues in the United States today (Gundersen & Ziliak, 2015). At present, 12.7 percent (15.8 million) of U.S. households are food insecure (Coleman-Jensen, 2016). Like incarceration, food insecurity is not evenly distributed across the population. Rather, certain demographic groups such as those living below the poverty line and minorities are at the greatest risk for food insecurity and poor nutrition (Coleman-Jensen et al., 2016). The extent of food insecurity is particularly concerning given the widespread consequences for health and mortality. Indeed, extant research demonstrates that food insecurity is associated with a wide range of adverse health outcomes (for review see Gundersen et al., 2011; Gundersen & Ziliak, 2015). For instance, food insecurity increases risk for mental health problems and depression (Heflin & Ziliak, 2008; Hromi-Fiedler et al., 2011), increases the risk of poor physical health (Cook et al., 2006; Vozoris & Tarasuk, 2003), and increases nutrition related illness including diabetes (Seligman et al., 2007), hypertension (Stuff et al., 2004), and hyperlipidemia (Seligman, Laraia, & Kushel, 2010). Additionally, Gundersen and colleagues (2016) found household food security status is a robust predictor of mortality.

This dissertation extends previous work on the health and well-being consequences of incarceration by investigating two understudied nutritional hardships that carry major implications for health functioning: food insecurity and access to healthy food retailers. The current study draws upon longitudinal data and uses a life-course framework that views incarceration as a critical social institution that can significantly reshape pathways in both the short- and long-term (Pettit & Western, 2004).

The introductory chapter proceeds in the following manner. First, I will discuss the trends of incarceration in the United States. This discussion details the size and scope of the American penal system and variation in incarceration rates across states, regions, and demographic groups. Next, I discuss the burgeoning research on the role of incarceration as a driver of social inequality. Specifically, I focus my discussion on the lack of research on nutritional outcomes including diet, food insecurity, and access to healthful food. I then introduce research on food insecurity and nutritional access and discuss why incarceration may be related to these outcomes. Finally, I provide an overview of the rest of the dissertation.

The Rise of Incarceration in the United States

From 1925 until 1972 the incarceration rate in the United States remained relatively stable (Blumstein & Cohen, 1972). However, following nearly 50 years of stability, the incarceration rate began a period of continued growth, increasing by between 6 to 8 percent annually from 1973 through 2000 (Wakefield & Uggen, 2010). Overall, the number of inmates grew during this period from 161 inmates per 100,000 residents in 1972 to a peak of 767 inmates per 100,000 residents in 2007. This period of sustained growth has come be known as the era of mass incarceration (Garland, 2001). At present, the United States has the highest incarceration rate in the world, standing at five to seven times the size of rates in other democratic countries (Travis et al., 2014; Walmsley, 2009). Recent estimates find that by 2010 approximately 7.7 million people were classified as either current or former prison inmates (Shannon et al., 2016).

A focus solely on national rates of incarceration hides important variation across states, regions, and demographic groups. Since 1972 the incarceration rate grew the most in the South and Southwest, whereas the Midwest and Northeast saw a slower growth (Raphel & Stoll, 2013). Twelve states have incarceration rates above the U.S. national average and the state with the highest incarceration (Louisiana) has approximately seven times the incarceration rate of the state with the lowest incarceration (Maine) (Carson, 2015; Kaeble et al., 2015).[2]

Even more sizeable is the variation in the composition of the incarcerated population across demographic groups. For instance, males make up over 90 percent of the incarcerated population, although the female incarceration rate in recent years is outpacing that of males.[3] African Americans are incarcerated at more than five times the rate of whites in the U.S. and this disparity is at least ten times the overall rate in five states (Nellis, 2016). Raphael and Stoll (2013) estimate that on any given day approximately 8 percent of African American men are incarcerated in prison or jail. In comparison, 2.7 percent of Hispanics and only 1 percent of non-Hispanic white men are incarcerated. The average inmate also comes from the lower end of the socioeconomic distribution, has less than a high school education and high rates of unemployment or underemployment prior to being incarcerated (Western, 2006). By 2008, a young male high school dropout was about 20 times more likely to be incarcerated than an individual

[2] Louisiana has a prison rate of 816 per 100,000 residents and a jail incarceration rate of 870 per 100,000 residents. Maine has a prison incarceration rate of 153 per 100,000 residents and a jail incarceration rate of 160 per 100,000 residents (Carson, 2015; Kaeble et al., 2015).

[3] For instance, in 1972, the incarceration rate for males was 24 times higher than females. However, by 2010, the male incarceration rate had reduced to 11 times that of women (Travis et al., 2014).

who attended college (Western & Muller, 2013). The disparities are even starker when looking at the impact of both race and education. For example, approximately 70 percent of African American male high school dropouts have served time in a state or federal prison (Travis et al., 2014). Consequently, "large race and class inequalities combined with historically unprecedented scale of incarceration to produce extremely high rates of incarceration among very low-educated black men" (Western & Muller, 2013: p. 169).

Incarceration, Inequality, and Well-being

The correctional system has emerged as a powerful social institution that generates and reinforces social inequalities (Wakefield & Uggen, 2010). The increase in the penal population has resulted in a growth of research on the consequences of punishment. Social scientists now view contact with the criminal justice system as a powerful "engine of social inequality" (Western, 2006: p. 198) and emerging research focuses on how punishment affects the life-course of both individuals and their families.

Those incarcerated in prison or jail are often already disadvantaged by traditional markers of social status. Indeed, the correctional population is overrepresented by the "jobless, the poor, the racial minority, and the uneducated" (Wakefield & Uggen, 2010: p. 393). Still, extant research suggests that incarceration exacerbates preexisting inequalities leaving those already disadvantaged even more so upon release (Wakefield & Uggen, 2010; Wildeman & Muller, 2012). The growth of the penal population has contributed to social inequality through the stigma of having a criminal record and the legal restrictions stemming from a criminal record that create barriers to social, economic, and political reintegration. As a result of these challenges, former inmates

often have limited prospects for employment and economic mobility and struggle to make ends meet (Harding et al., 2014). As noted by Western and Pettit (2010: p. 8) "as an outcast group, the men and women in our penal institutions have little access to the social mobility available to the mainstream."

Emerging research has begun to document a key area of social inequality that sets former inmates apart: the ability to acquire basic material needs. For example, Harding and colleagues' (2014) interviews with former prisoners in Michigan documents difficulty in obtaining food and shelter. This study reveals that meeting basic food needs is a common hardship among former inmates and social welfare programs and reliance on social support through friends, family, and romantic partners are crucial to accessing food among this group. Similarly, Western and colleagues (2015) demonstrate that leaving prison presents challenges to social integration including attainment of a basic level of material well-being and obtaining a means of subsistence. Thus, evidence is now mounting that the increasing movement over recent decades of people into and out of prison and jail has increased inequality by reducing employment and lowering wages for former inmates, damaging social ties, and through laws disqualifying certain classes of former inmates from jobs and public benefits that are critical to successful social and economic reintegration (Morenoff & Harding, 2014; Pager, 2003; Western, 2002). However, only limited attention has been paid to the effect of incarceration on nutritional outcomes such as diet and ability to obtain adequate food.

Food Insecurity, Nutrition, and Health

Food insecurity is defined as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Anderson, 1990: p. 1560). An estimated 42.2 million people live in a food insecure household including 29.1 million adults and 13.1 million children (Coleman-Jensen et al., 2016). Much epidemiological research suggests that access to foods of adequate quantity and quality is necessary for optimal physiological, cognitive, and emotional functioning in both children and adults (Cook & Frank, 2008; Gundersen et al., 2011). For instance, household food insecurity has been shown to harm both current health and the development of young children, leading to hospitalizations, iron deficiency, mental health and behavioral problems such as aggression, depression, anxiety, and attention deficit disorder, as well as poor academic performance (Cook & Frank, 2008; Nord, 2009; Gundersen & Ziliak, 2014; Whitaker, et al., 2006; Yoo, et al., 2009). Food insecurity has also been linked to increased weight (Larson & Story, 2011), in what is often referred to as the "food insecurity-obesity paradox" (Dinour, Bergen & Yeh, 2007). The relationship between food insecurity and unhealthy weight is often explained though patterns of food consumption. For instance, those who experience food insecurity often alternate between a state of hunger and a state of consumption of high-calorie foods in order to avoid hunger. These individuals opt for nutrient poor high calorie or high fat foods that cost less than nutrient dense meats, fruits, and vegetables (Drewnowski, 2010).

Research also shows that the impact of food insecurity carries detrimental harm for adults as well. Food insecure adults are likely to have several physical and mental

health problems, such as hypertension, diabetes, depression, and low nutrient intake (Gunderson et al., 2011; Gundersen & Ziliak, 2015; Seligman et al., 2007). Moreover, even when children do not personally experience food insecurity or inadequate nutrition, parental food insecurity may negatively impact physical, cognitive, and emotional functioning in children by increasing stress and depression in parents (Johnson & Markowitz, 2015; Nord, 2009).

To date only a few studies have examined the impact of incarceration on food insecurity, with the major focus being on the effect of parental/paternal incarceration on food insecurity among children. Wang and colleagues (2013) recruited 100 recently released prisoners from Texas, California, and Connecticut to participate in a survey regarding food insecurity and HIV risk behaviors. Overall, the survey revealed that approximately 91 percent of former inmates were food insecure, including 37 percent who had very low food security (defined as not eating for an entire day in the past month). Turney (2015) uses data from the Fragile Families and Child Well-being Study (FFCWB) to examine the impact of paternal incarceration on children's food insecurity. The findings indicate that having a biological father incarcerated in the past 2 years is associated with an increased likelihood of food insecurity among 5-year old children who resided with a biological father before incarceration but not for those who did not reside with the father. Cox and Wallace (2016) also use data from FFCWB, finding incarceration of a parent increases household food insecurity by approximately 4-percentage points. Lombe and colleagues (2017) examine factors associated with food hardship among young people residing in public housing in Baltimore. The findings suggested that having a mother incarcerated increased food hardship, however, paternal

incarceration did not have an association with food insecurity. Finally, Jackson and Vaughn (2017) use data from the Early Childhood Longitudinal Study – Birth Cohort and find that parental history of criminal justice involvement (composite measure of arrest, conviction, or incarceration) is positively associated with childhood food insecurity.

In addition, prior criminological research has not assessed various aspects of the food environment related to incarceration. Indeed, while prior research has demonstrated that former inmates are more likely than their non-incarcerated counterparts to engage in poor health behavior such as consuming higher amounts of fast-food (Porter, 2014), there is no prior research on access to nutritional food among former inmates and how this may relate to their health outcomes. A focus on geographical food access is of particular importance given a sizeable literature showing that communities with large supermarkets have a greater supply of produce and other healthy food choices, whereas areas that rely on convenience stores or fast-food restaurants primarily have fewer healthy food choices (Cummins et al., 2010; Farley et al., 2009; Sharkey et al., 2013). Further, there are wide disparities in access to healthy foods in the U.S. and those who are most likely to be incarcerated – low-income, minority, urban neighborhoods – are most affected by poor access to supermarkets and healthy food retailers, yet have greater access to fast-food restaurants and other low nutrient, energy dense foods (Larson et al., 2009). Moreover, other research demonstrates that the density of supermarkets and other stores that provide healthful foods is associated with consumption of more fruits and vegetables and meeting recommended dietary guidelines (Greer et al., 2014; Moore et al., 2008; Morland et al., 2006; Zenk et al., 2009). However, no research has examined whether former inmates have different levels of access to healthy food retailers and if differential food access in

part explains disparities in health outcomes among ex-inmates. This dissertation aims to fill this gap.

Importance for Criminological Inquiry

Although there is limited research on nutritional hardship as a consequence of incarceration within criminological literature, this topic is important for criminologists for several reasons. For one, scholars note that a limitation within the food insecurity literature is that the causes of food insecurity beyond that of poverty are poorly understood (Gundersen & Ziliak, 2014). As incarceration is a driver of social inequality (Wakefield & Uggen, 2010; Western, 2006) and given that previous research finds parental incarceration increases the risk of food insecurity among children (Cox & Wallace, 2016; Jackson & Vaughn, 2017; Turney, 2015), it is important to further investigate the degree to which incarceration is related to food insecurity among former inmates and their households in order to understand the causes of food insecurity. Given the strides made in understanding the consequences of incarceration, criminologists are particularly well-suited to investigate this issue (Kirk & Wakefield, 2018; Travis et al., 2014). Second, several researchers contend that understanding successful reentry goes beyond whether or not an individual recidivates, but rather also includes understanding how former inmates interact with resources within communities they return to in order to meet basic material needs, including food and nutritional needs (Harding et al., 2014; Morenoff & Harding, 2014; Wallace & Papachristos, 2014; Western et al., 2015). Accordingly, the study of the relationship between incarceration and nutritional hardships has implications for those studying the reentry process generally.

Third, past research indicates that ex-inmates live in more disadvantaged communities compared to their non-incarcerated counterparts (Hipp, Turner, & Jannetta, 2010; Kubrin & Stewart, 2006; Visher & Farrell, 2005). However, less is known about what types of resources are lacking in areas where formerly incarcerated individuals live, even though it is often stated that in these communities "resources and services are stretched thin" (Harding, Morenoff, & Herbert, 2013: p. 217). Existing criminological research typically captures neighborhood disadvantage with measures such as poverty rates, unemployment rates, income levels, or public assistance rates. In contrast, only limited research assesses the degree to which communities where prisoners return lack resources necessary to meet basic needs (Wallace & Papachristos, 2014; Wallace, 2015). Kubrin and Stewart (2006) have previously drawn attention to this issue, noting that, "by providing an environment either rich or deficient in resources, place of residence tangibly affects the quality of day-to-day living and influences the range of opportunities available through the quality and extent of institutional resources" (p. 172). Therefore, this study advances criminological research by assessing the degree to which former inmates lack access to critical institutions needed to meet basic needs by profiling the local food retail environment. Finally, understanding nutritional hardship may also carry implications for understanding criminal behavior more broadly. Indeed, a series of recent studies finds evidence that food insecurity among children is a risk factor for delinquent behavior (Huang & Vaughn, 2015; Vaughn et al., 2016; Jackson & Vaughn, 2017). Accordingly, nutritional hardships may be an overlooked factor that provides insight into offending behavior.

Dissertation Overview

The purpose of this dissertation is to contribute to the incarceration-health literature by addressing the gaps previously discussed in this chapter. To examine these areas of inquiry I use two data sources. The first is the National Longitudinal Study of Adolescent to Adult Health (Add Health). Add Health is a nationally representative survey of adolescents enrolled in grades 7-12 in the United States during the 1993-94 academic year. These data contain key variables including (1) prior contact with the criminal justice system, (2) respondent's census tract location at each wave of data collection, and (3) survey items measuring food insecurity, physical health, and diet. Using geocoded census tract data, this project combines the nationally representative Add Health data with data measuring access to healthy foods from the Modified Retail Food Environment Index (mRFEI). The Center for Disease Control (CDC) Division of Nutrition, Physical Activity and Obesity collected data for the Modified Retail Food Environment Index (mRFEI) in 2008-2009. The mRFEI score represents the percentage of retailers that sell healthy food relative to unhealthy food retailers in a census tract and within a 0.5 mile buffer around the census tract. Healthy food retailers are defined as supermarkets, larger grocery stores, supercenters, and produce stores. Less healthy food retailers include fast-food restaurants, small grocery stores, and convenience stores. Table 1.1 below provides nominal definitions of key terms are used throughout the following chapters.

The remainder of this dissertation is organized as follows. The next chapter provides the literature review that informs the current research. Specifically, Chapter 2 focuses on theoretical and empirical literature regarding the link between incarceration

and social inequality and later life health outcomes, as well as prior research on food insecurity and access to food retailers in the United States. In Chapter 3 the mechanisms that underlie the link between incarceration and food insecurity are discussed. Based on theoretical and prior research I propose a series of hypotheses to be tested in this dissertation. Chapter 4 presents the data sources used to examine the association between incarceration and nutritional outcomes of interest. Add Health provides individual-level data on household food insecurity, and Add Health restricted data on residential location at the census tract level is combined with CDC data on nutritional access to food retailers from the Modified Retail Food Environment Index. Together, these two data sources enable the first examination of food insecurity among individual inmates following release from incarceration and access to healthful foods based on residential locations of former inmates. After reviewing the data sources, Chapter 5 presents the empirical tests of my hypotheses. Finally, the concluding chapter highlights the theoretical and empirical contributions of the current study for academic researchers, as well as criminal justice policy makers and practitioners. In doing so, I emphasize the limitations of the current study and note key areas of future research to expand upon my findings.

Table 1.1: Nominal Definitions of Key Terms

Term	Definition
Prior Incarceration	Whether an individual previously served time in prison or jail as an adult (after age 18).
Food Insecurity	Limited or uncertain availability of adequate foods or limited or uncertain ability to acquire adequate food.
Food Access	Available food retail stores within a defined geographic area (census tract and the 0.5 mile buffer).
Poor Health	General term that captures multiple ways of measuring poor quality health. Poor health may refer to subjective measures such as self-rated health (i.e poor or good) or objective measures such as being overweight (i.e. waist-to-height ratio).
Poor Nutrition	General term capturing unhealthy diet. For instance, high consumption of fast-food or high consumption of sugary beverages.

CHAPTER 2: LITERATURE REVIEW

Overview

Chapter 1 detailed the increase in the size and scope of incarceration in the United States, as well as the consequences of incarceration for former inmates. In recent years, there has been a growth in research on two interrelated consequences of incarceration. First, there is an increased focus on the health consequences of incarceration, including how health is affected while individuals are incarcerated, as well as whether consequences of incarceration for physical and mental health functioning continue following release. Second, while a sizeable literature documents the various barriers individuals face when reintegrating into society (Visher & Travis, 2003), recent scholarship has detailed how former inmates face a variety of material hardships and struggle to meet basic needs (Harding et al., 2014; Western et al., 2015).

However, a form of hardship that has received less attention is how former inmates navigate basic nutritional needs following release from incarceration. This is an important omission as food insecurity and inadequate access to nutritious foods are considered critical hardships (Boushey et al., 2001) that play a major role for health and well-being (Gundersen & Ziliak, 2015; Victora et al., 2008). In this chapter I begin by providing an overview of previous research documenting the consequences of incarceration for both health and material hardship. I then discuss gaps in this literature and conclude with a review of two unique forms of deprivation that have gone largely unnoticed by prior criminological work: food insecurity and access to healthy food retailers.

Incarceration and Health

Early research on incarceration and health is descriptive and highlights that current and former inmates tend to be in worse health than those in the general population (Binswanger et al., 2009; Wilper et al., 2009). Inmates often have markers of poor health including nutritional deficiencies (Nwosu et al., 2014) and high rates of chronic conditions such as hypertension, asthma, arthritis, hepatitis, and certain forms of cancer (Binswanger et al., 2009; Fazel & Baillargeon, 2011; Wang et al., 2009; Wilper et al., 2009). Additionally, formerly incarcerated persons have higher rates of premature mortality compared to the general resident population, especially in the first few weeks following release (Binswanger et al., 2007; Zlodre & Fazel, 2012).

More recent research uses longitudinal data and a variety of statistical techniques to account for factors that may confound the relationship between incarceration and health. These findings demonstrate that incarceration is associated with adverse health outcomes (Massoglia, 2008; Espositio et al., 2017; Schnittker & John, 2007). Although data limitations and difficulties associated with accounting for unobservable confounding factors make causal identification between incarceration and health challenging (Schnittker & John, 2007; Wildeman & Muller, 2012), the accumulated body of evidence suggests that "incarceration has strongly harmful effects on the health of prisoners over their life course" (Wildeman & Wang, 2017: p. 1467).

Pathways between Incarceration and Health Outcomes

Several mechanisms have been proposed to explain the adverse health consequences of incarceration. For instance, contact with the criminal justice system may

worsen health through increased financial hardship. Formal processing through the criminal justice system is also a stressful and stigmatizing event that can impact one's health through both immediate and long-term stressors, the damaging of social ties, and declines in neighborhood attainment.

Incarceration, Stress, and Psychological Well-being

Stressful life events have consequences for health and well-being (Glaser & Kiecolt-Glaser, 2005; Schneiderman, Ironson & Siegel, 2005; Thoits, 1995, 2010). Incarceration is a major life event that results in severe changes and psychological stress in both the short- and long-term (Massoglia, 2008). Both contemporary and classical research documenting life behind bars details numerous stressors that prisoners experience, such as loss of liberty, overcrowding, and witnessing and experiencing violent victimization (Goffman, 1963; Sykes, 1958; Walker, 2016).

In addition to these immediate deprivations, inmates are often socially isolated and have limited contact with friends and family members who can provide emotional and social support that can be instrumental in reducing stress and anxiety felt during incarceration (Braman, 2004; Comfort, 2008). Indeed, prisoners are typically incarcerated far away from their families in rural areas that are difficult to access from urban locations where many prisoners lived beforehand (Christian, 2005; Travis, McBride & Solomon, 2006). Accordingly, between 40% to 75% of inmates are never visited (Cochran, 2012; Mears et al., 2012; Duwe & Clark, 2013). Even when inmates do receive visitations, they occur infrequently for most inmates (Cochran, Mears & Bales, 2014), although the frequency of visitations varies among prisoners (Hickert, Tahamont, & Bushway, 2017).

A growing body of research suggests that incarceration has negative implications for psychological functioning. Massoglia (2008) finds that relative to those who have not been incarcerated, former inmates have a higher likelihood of stress related illnesses. A series of recent studies have shown that incarceration is related to the onset or worsening of psychological disorders including major depression, bipolar disorder, and dysthymia (Porter & Novisky, 2017; Schnittker et al., 2012; Sugie & Turney, 2017; Turney et al., 2012). Wildeman and colleagues (2014) finds incarceration leads to reductions in happiness and life satisfaction. Thus, extant research suggests "incarcerated persons often suffer long-term consequences from having been subjected to pain, deprivation, and extremely atypical patterns and norms of living and interacting with others" (Haney, 2002: p. 79).

These psychological ailments are problematic for successful reintegration as the psychological consequences of incarceration "work in tandem with structural barriers to reentry" (Schnittker, 2014: p. 123). In particular, psychological well-being is pertinent for understanding food insecurity and nutritional outcomes during reintegration. Indeed, an extensive body of research demonstrates that food insecurity co-occurs with adverse mental health outcomes, especially depression and anxiety (Hamelin, Beaudry & Habicht, 2002; Leung et al., 2015; Whitaker et al., 2006). Moreover, the onset of mental health conditions is also found to increase the risk of household food insecurity (Noonan et al., 2016), as well as impede the ability to become food secure by limiting employment prospects (Lent et al., 2009).

Incarceration and Social Ties

Serving time creates difficulties for maintaining relationships with family, friends, and romantic partners. Two leading perspectives suggest that fracturing of social ties is largely the result of: (1) stigma associated with incarceration, and (2) separation caused by a period of imprisonment (Massoglia, Remster, & King, 2011). According to a stigma perspective, formerly incarcerated persons are unable to detach themselves from negative stereotypes and labels suggesting they are dangerous or untrustworthy (Schwartz & Skolnick, 1962; Western, Kling & Weiman, 2001). Such stigmatizing labels can result in exclusion from social groups (Braithewaite, 1989), as well as damage relationships with family members (Hagan & Dinovitzer, 1999) and romantic partners (Massoglia et al., 2011). A separation perspective posits that the physical separation caused by imprisonment damages interpersonal relationships with those left behind.

Prior research examining the consequences of incarceration for social ties has focused largely on romantic partnerships, often estimating either the influence of incarceration on the likelihood of getting married or divorced. Generally, findings suggest incarceration is negatively associated with getting married in both the short- and long term (Apel, 2016; Bacak & Kennedy, 2015; Huebner, 2005) or that imprisonment increases the likelihood of divorce (Apel et al., 2010; Loopo & Western, 2005; Massoglia, Remster & King, 2011; Siennick, Stewart & Staff, 2014). Moreover, research on social ties more generally suggests that incarceration may reduce the size of social networks (Rengifo & Waring, 2006).

To be sure, the consequences of incarceration for social integration are important factors for understanding the risks of food insecurity as various forms of household and

community social capital are inversely associated with becoming food insecure (Dean & Sharkey, 2011a; Martin et al., 2004). For instance, interviews with former inmates during the reintegration process find that formerly incarcerated persons often rely on social ties to family members or romantic partners in order to meet basic material needs such as obtaining food and shelter (Harding et al., 2014; Western et al., 2015). Indeed, Harding and colleagues (2014: p. 461) conclude that former prisoners who had long-term stable access to food throughout the reintegration process "did so by combining multiple sources of support, including employment, social support, and public benefits."

Incarceration, Financial and Material Hardship

Incarceration harms employment and earnings, therefore increasing financial strain. While research consistently shows that formerly incarcerated individuals have poor labor market outcomes, there is less consensus regarding why. At least three mechanisms may explain poor labor market prospects for former inmates (Pager, 2007).

First, a selection perspective contends that high rates of unemployment and low wages are not a result of incarceration per se, but rather result from preexisting characteristics that make formerly incarcerated persons' undesirable job candidates. For instance, those who have been previously incarcerated tend to have low levels of human capital, including lower formal education and poor employment histories (Wakefield & Uggen, 2010; Western, 2006). Past research shows that approximately one-third to two-thirds of inmates are employed prior to their incarceration (Kling 2006; Petit & Lyons 2007; Tyler & Kling 2007; Sabol 2007). Moreover, even if former inmates obtain a job

they may have difficulty maintaining the position for a sustained period (Bushway & Reuter, 2004).

Alternatively, the experience of incarceration may harm employment prospects independent of any preexisting deficiencies. Indeed, a period of incarceration means months or years out of the labor market. During this time, job skills are eroded, individuals gain large gaps in employment histories, and social and familial relationships that can be critical networks to obtain employment may decline (Berg & Huebner, 2011; Hagan, 1993). Moreover, the adaptation to imprisonment may also be detrimental to employment prospects as inmates often adopt certain behavioral traits such as showing resistance to authority and being suspicious of their colleagues as a means of survival (Haney, 2002)

Third, a criminal record is harmful as a conviction can result in both legal and social exclusion. Formal legal restrictions are often imposed via a variety of federal and state statutes (Petersilia, 2003) and have become an increasingly difficult barrier overtime as the costs of conducting electronic background checks have declined (Lageson, 2016; Petersilia, 2003). Aside from legal restrictions, a criminal record carries a social stigma that makes gaining employment difficult. Indeed, employers often view those with a criminal past as less trustworthy and unreliable (Holzer, 1996; Stoll et al., 2004). For instance, knowledge of a criminal record is found to be negatively related to hiring ex-offenders on average (Stoll & Bushway, 2008). Notably, Pager's (2003) experimental audit study used matched pairs of individuals to apply for entry-level jobs. The findings of the study revealed that applicants with a fictitious criminal history record received

callbacks from prospective employers at substantially lower rates than those without criminal histories (see also Pager, Western & Sugie, 2009).

Other research demonstrates that incarceration also suppresses wages by approximately 10 to 30 percent (Western, 2002; 2006). Moreover, incarceration can create financial hardships in ways aside from directly impacting employment and wages. Harris and colleagues (2010) find that monetary sanctions associated with criminal conviction generates legal debt that is large relative to expected earnings. Turney and Schneider (2016) find that incarceration is negatively associated with household assets including ownership of a bank account, vehicle, and home.

The consequences of incarceration for financial hardship is relevant for understanding poor nutritional outcomes among formerly incarcerated persons. For instance, there is a strong inverse association between socioeconomic status and health behaviors, as well as poor nutrition and food security (Gundersen et al., 2011; Pampel et al., 2010). Moreover, research also finds a link between SES and dietary quality, including consumption of more whole grains, fresh fruits and vegetables, lean meats and seafood, higher intake of essential vitamins and minerals, and a lower consumption of fast-food (see Darmon & Drewnowski, 2008; Paeratakul et al., 2003). Accordingly, researchers have concluded that higher-quality diets are consumed by more affluent people, whereas individuals from more limited economic means tend to consume lower quality diets (Darmon & Drewnowski, 2008).

Material Hardship Faced by Former Inmates

The large number of individuals that are released from prisons and jails each year has generated a growing interest among both academics and policy makers in assessing

the challenges faced by formerly incarcerated persons (Visher & Travis, 2003; Petersilia, 2003; Travis, 2005). However, in light of high rates of reoffending following release from incarceration (Durose et al., 2014; Langan & Levin, 2002), much contemporary research focuses on recidivism (Harding et al., 2014). Still, successful community reintegration is a complex process that requires multiple markers of success beyond desistance from crime. For instance, Harding and colleagues (2014: p. 442) note: "another key determinant of whether returning prisoners are able to establish conventional lifestyles is meeting basic material needs." Western and colleagues (2015: p. 1515) reinforce this point noting: "successful transition from prison involves attaining a basic level of material and social well-being consistent with community membership."

To be sure, while literature documenting the consequences of incarceration recognizes that individuals typically leave prison with few resources (Travis, 2005; Visher & Travis, 2003) and face economic hardships including difficulty in obtaining employment (Pager, 2007), less is known about the range of specific material hardships faced by formerly incarcerated persons during reintegration into society, including the inability to meet basic needs (Harding et al., 2014).

Prior research documenting material hardship among formerly incarcerated persons typically takes two forms. First, empirical research uses an index of hardship that conceptualizes material hardship as a household not being able to provide basic needs such as food or shelter or missing payments on bills such as rent and utilities (see Schwartz-Soicher, Geller, & Garfinkel, 2011). Accordingly, there is an indirect focus on food hardship as indices can include a measure of difficulty in obtaining food or the use of food stamps as one component.

To date, most scholarship focuses on the effects of parental/paternal incarceration on material hardship for their families. For instance, studies using data from the Fragile Families and Child Wellbeing Survey (FFCWS) measure the impact of paternal incarceration on material hardship of families, defining hardship as not meeting a major need due to lack of financial resources (i.e. receiving free food, losing phone service, losing utility services, being evicted, not paying full utility bills, not paying full rent or mortgage, not seeing a doctor when one is needed). The findings demonstrate an association between parental incarceration and material hardship, as children are more likely to receive public assistance and face a form of material hardship following the incarceration of one's father (Geller et al., 2009; Schwartz-Soicher et al., 2011). Recently, Sykes and Pettit (2016) examine the relationship between parental incarceration and material hardship – measured as the parent finding it difficult to cover basic needs such as food and housing. The findings indicate that children exposed to parental incarceration have higher levels of material deprivation. Specifically, their descriptive analysis shows that while about one-fourth of children without an incarcerated parent experience material hardship, nearly half (46%) of those with an incarcerated parent experience some form of material hardship. Even after balancing for background characteristics, the findings suggest that children who have a parent incarcerated experience material hardship at a rate 17.9 percentage points higher than those that do not.

Second, qualitative studies and ethnographic research document that former inmates struggle to meet basic material needs, including minimal food needs. For example, Harding and colleagues (2014) interviews with former prisoners in Michigan

reveal that the majority of former inmates struggle considerably to meet even the most basic needs such as shelter and food. Western and colleagues (2015) assessment of prisoners as part of the Boston Reentry Initiative find a similar pattern, namely former prisoners experience a number of stressors and hardships during reintegration and often lack the ability to meet basic needs. In both studies, former inmates rely heavily on public assistance programs or family members and romantic partners in order to obtain basic material needs such as a place to sleep or a meal. Additionally, Fader's (2013) ethnography of young men transitioning from incarceration to the community in Philadelphia also documents a pattern of difficulties making sufficient wages and often relying on the ability of romantic partners to access public assistance as a means of survival.[4]

Incarceration and neighborhood attainment/mobility trajectories

Those who come into contact with the criminal justice system are more likely to reside in socioeconomically disadvantaged neighborhoods and experience various forms of residential instability both prior to and following release from incarceration (Harding, Morenoff & Herbert, 2013; Hipp, Turner & Janetta, 2010). Studies describing patterns of residential attainment among formerly incarcerated populations often find incarceration is

[4] Sugie (2012) documents a similar finding regarding the effect of parental incarceration on public assistance for families. Using data from the FFCWS to examine the relationship between parental incarceration and families' receipt of public assistance – TANF, food stamps, and Medicaid/SCHIP, her findings indicate that while incarceration is not related to TANF it is significantly associated with food stamps and Medicaid/SCHIP. This finding is particularly pertinent for the current study as it suggests that incarceration of a parent is associated with higher levels of material hardship for family members but also suggests that those with access to public assistance may mitigate the impact of incarceration on food insecurity.

highly concentrated in disadvantaged communities (Lynch & Sabol, 2001; 2004a, 2004b; Visher et al., 2004; Visher & Farrell, 2005). For instance, Lynch and Sabol (2004b) found just five percent of neighborhoods in Baltimore City accounted for one-quarter of all prison admissions. Moreover, incarcerated persons also experience several residential moves in the months following release. Harding and colleagues (2013) find the median returning prisoner in Michigan moved 2.6 times per year and moved once every 4.5 months. Other research finds only 20 percent of former inmates return to their pre-incarceration neighborhoods (Massoglia et al., 2013). Moreover, while incarceration has an independent effect on the likelihood of mobility, much of the impact is explained by the consequences of incarceration for other life outcomes. As Warner and Sharp (2016: 9) explain "formerly incarcerated individuals are more mobile, in part, because of post-prison struggles in relation to other correlates of mobility such as marriage and employment." This is particularly consequential as recent research finds that moving frequently carries detrimental behavioral consequences including increased delinquency (Vogel, Porter, & McCuddy, 2017) and residential mobility is related to increased risk of food insecurity and hunger (Bartfeld & Dunifon, 2006; Tapogna et al., 2004).

While these earlier studies demonstrated that formerly incarcerated persons concentrate in disadvantaged areas after release from prison, such findings could not establish whether there was a downward trend in residential attainment as this work was unable to account for where individuals were residing prior to being incarcerated. Notably, Massoglia and colleagues (2013) is the first study to control for pre-prison conditions, thus enabling an analysis of whether incarceration leads to a decline in neighborhood attainment. Using longitudinal data from the NLSY79 that tracks

individual residences over a thirty-year period prior to and after incarceration, the findings demonstrated that only whites live in more disadvantaged neighborhoods following incarceration. Recently, Warner (2016) demonstrated similar findings that incarceration leads to downward mobility from non-poor to poor neighborhoods.

The residential trajectories following release from incarceration are important in order to understand health for multiple reasons. For one, local conditions can play a role in conditioning post-release experiences of former prisoners. For instance, Sabol (2007) finds that local labor markets measured by the county unemployment rate in Ohio impact the probability of former prisoners obtaining employment following release from prison. Accordingly, it is also possible that the local food retail environment plays some role on the dietary patterns and ability to obtain food for local residents. Second, emerging research suggests local food environments play a major role in health outcomes. For instance, Pampel and colleagues (2010: p. 360) note "low-income neighborhoods have more than their share of fast-food restaurants, liquor stores, and places to buy cigarettes and have less than their share of large grocery stores with a wide selection of healthy fresh foods." Indeed, a growing body of research assessing local food environments finds that impoverished areas tend to have higher food insecurity and offer less healthy food options (Morrissey et al., 2016; Larson et al., 2009; Morland et al., 2002; Walker et al., 2010). This is particularly important for understanding health outcomes and nutritional patterns as "without access to healthy food choices, individuals cannot make positive changes to their diets" (Baker et al., 2006: p. 1). Given that many former inmates come from and return to low-income areas, examining the food environments and access to

nutritious food in these areas is an important element of understanding any link between incarceration and health outcomes.

Gaps in Research

Taken together, the discussion in chapter 2 thus far establishes that there has been an increase in research on the consequences of incarceration for health in recent years. Overall, this body of research suggests that serving time incarcerated has deleterious consequences harming both an individuals' mental and physical health functioning. However, this is still an emergent research area and many questions remain. In particular, the nexus between incarceration and food insecurity/access and in turn how these nutritional outcomes impact the health of formerly incarcerated persons is largely unexplored.

This is a notable limitation as leading causes of death in the United States often include modifiable health behaviors such as poor diet. For instance, a 2015 joint report by the National Research Council and Institute of Medicine (2015) found that up to half of premature deaths in the United States are the result of behavioral factors including tobacco use, poor diet, and lack of exercise.[5] Notably, while the percentage of early deaths linked to tobacco fell between 1990 and 2010, early deaths attributed to poor diet increased during this same period. Overall, poor diet was found to contribute to over 650,000 (14 percent) of early deaths in 2010. Given that former inmates are at a particularly high risk of premature death compared to the general public (Binswanger et

[5] Poor diet is typically characterized as low fruit and vegetable intake and consuming too much saturated fat, which is related to coronary heart disease, diabetes, and certain forms of cancer.

al., 2007; Rosen et al., 2008; 2011; Spaulding et al., 2011), and that incarceration negatively effects dietary patterns including increasing the consumption of fast-food (Porter, 2014), a deeper understanding of the nutritional consequences of incarceration is warranted. In particular, any findings of adverse nutritional consequences found in the current study are important given that the Add Health sample is still relatively young (i.e. 24 – 32 years old) and behaviors such as dietary habits that form during adolescence and young adulthood typically continue into later stages of adulthood (Gillman, 2004). The current study aims to address this gap in the literature and in doing so expand upon the burgeoning research on incarceration and health. In the remaining sections of chapter 2, I document prior research on material hardships faced by former inmates and then discuss how food insecurity and poor access to healthy food retailers are unique forms of material hardship that have consequences for health.

Food Insecurity as a Unique Form of Material Hardship

Food insecurity is a particularly salient form of hardship and a serious public health issue in the United States (Gundersen et al., 2011). Indeed, Boushey and colleagues (2001: p. 32) note, "to go without sufficient food is the *most basic critical hardship*" [emphasis added].[6] However, there is limited research examining the consequences of incarceration specific forms of hardships that have direct implications for health functioning such as food insecurity (Cox & Wallace, 2016; Jackson & Vaughn, 2017; Turney, 2015; Wang et al., 2013). This is a particularly notable limitation as "food

[6] Notably, Maslow (1943) noted that food was among the most basic needs in his five-tier model of human needs.

insecurity is an especially acute and severe form of deprivation that is distinct from other indicators of economic deprivation or hardship" (Turney, 2015: p. 354). In this section, I highlight the unique importance of food insecurity as a distinct from of material hardship and discuss why former inmates may be particularly prone to experiencing food insecurity.

There is currently no standard measure of material hardship or consensus regarding a definition of material hardship (Beverly, 2001a, 2001b). Often deprivation or hardship is conceptualized based on household income or from hardship indices that are developed by individual researchers (Mayer & Jencks, 1989; Short, 2005). The most frequently used construct is the federal poverty measure based on annual income. Such poverty thresholds are based on annual cash income from a variety of sources (earnings, pension, assets, and welfare) and change based on family size and composition (Heflin & Iceland, 2009). In 2017, the federal poverty line for a family of four (two adults and two children) was $24,600 (U.S. Department of Health and Human Services, 2017).

However, the use of poverty as a measure of deprivation is criticized, as it does not accurately reflect actual financial resources needed to be self-sufficient or indicate whether basic needs such as food or shelter are met (Heflin & Iceland, 2009; National Research Council, 1995). Indeed, there are substantial differences in the populations that are defined as poor by federal income levels and those who experience forms of material deprivation, and researchers increasingly acknowledge that understanding deprivation goes beyond just income based measures and should incorporate more direct measures of material aspects that impact a household (Iceland & Bauman 2007; Mayer & Jencks 1989; Short 2005; Sullivan, Turner & Danziger 2007). As Heflin and Iceland (2009: p.

1053) point out: “many argue that the U.S. public is or should be more concerned with meeting a basic set of needs instead of providing a basic level of income.”

Food insecurity - limited or uncertain availability or ability to acquire nutritionally adequate and safe foods (Anderson, 1990) - is often characterized as a unique form of material hardship (Boushey et al., 2001; McIntyre et al., 2003; Turney, 2015).[7] For instance, Boushey and colleagues (2001) characterize hardships into two forms: critical and serious. Critical hardships are those that arise from being unable to meet basic needs necessary for survival. Such needs include food, housing, and medical care. Serious hardships differ as these capture an inability to access goods and services needed for a safe and decent standard of living. Examples of serious hardships include the inability to afford less immediate needs such as preventative medical care, quality childcare, or safe and affordable housing. Thus, these types of hardship are distinct, as those facing critical hardships such as a lack of food “cannot support basic needs critical for survival” (Boushey et al., 2001: p. 4).

Food insecurity in particular is inversely related to income, yet food insecurity is not the same as poverty. Notably, the distinction between poverty and food insecurity can be inferred from the fact that there are high proportions of houses that are food secure and also fall below the poverty line. Conversely, households are also food insecure but have incomes above the poverty line (Gundersen et al., 2011; Gundersen, 2013). For instance,

[7] The definition of food insecurity is intended to be distinct from the concept of hunger, which is viewed as an individual-level physiological condition resulting in uneasy or painful sensations stemming from a lack of food. Hunger is a possible but not necessary consequence of food insecurity. In contrast, food insecurity is a household level condition (Anderson, 1990; Blumberg et al., 1999; Gundersen & Ziliak, 2014; National Research Council, 2006).

in 2015 28.3 percent of households below the poverty line were food insecure, compared to 5.8 percent of households at or above 185 percent of the poverty line (Coleman et al., 2016). Moreover, prior research indicates there is only a moderate correlation between food insecurity and poverty (Beverly, 2001a, 2001b; Boushey et al., 2001; Hamilton et al., 1997; Mayer and Jencks, 1989; Rector et al., 1999). Hamilton et al., (1997), for example, finds a Pearson correlation coefficient between food insecurity and poverty of 0.33. The relatively weak correlation may in part be because material-hardship (such as food insecurity) is a consumption-based measure that reflects both access to resources, as well as an individuals' ability to obtain and manage these basic resources (Iceland & Bauman, 2007).

Additionally, although income remains an important factor in understanding who experiences food insecurity, there are a number of risk factors associated with food insecurity even after accounting for income (Gundersen & Ziliak, 2014). Notably, many of these risk factors can also be considered collateral consequences of incarceration.

Mental Health

Mental health of adult caregivers within a household is a key risk factor. Kaushal and colleagues (2013) use data from the Fragile Families study and show that mothers residing in low-income households that are food secure are in better physical and mental health, relative to mothers in low-income households that are food-insecure. Similarly, research by Noonan and colleagues (2014) finds that when mothers report being depressed the risk of household food insecurity rises by between 50 and 80 percent. This is a particularly salient factor as research suggests a link between incarceration and

depression among former inmates (Esposito et al., 2017; Porter & Novisky, 2017; Schnittker, 2014; Sugie & Turney, 2017; Turney et al., 2012), as well as depressive symptoms among mothers following the incarceration of their spouse (Wildeman, Schnittker & Turney, 2012).

Physical Disability

Physical disabilities are another factor that is related to the onset of food insecurity. Balisteri (2012) finds that holding other factors constant, households with a disabled adult are nearly three times as likely to experience food insecurity compared to households without a disabled adult. Likewise, this is relevant in the contexts of formerly incarcerated populations as prior work shows that contact with prison increases the likelihood of severe physical functional limitations (Schnittker & John, 2007).

Marital Status

Research also shows that the marital status of the head of the household plays a role in household food insecurity. For instance, Balisteri (2012) shows that after controlling for other economic and household factors, households headed by a single or unmarried parent are at greater risk for food insecurity. Given the sizeable body of research suggesting that incarceration reduces the chances of marriage and increases the likelihood of divorce (Apel, 2016; Bacak & Kennedy, 2015; Loopo & Western, 2005; Massoglia et al., 2011) the consequences of incarceration for marital status is another factor suggesting that prior incarceration may increase the likelihood of becoming food insecure.

Food Insecurity & Health

Background on Food Insecurity

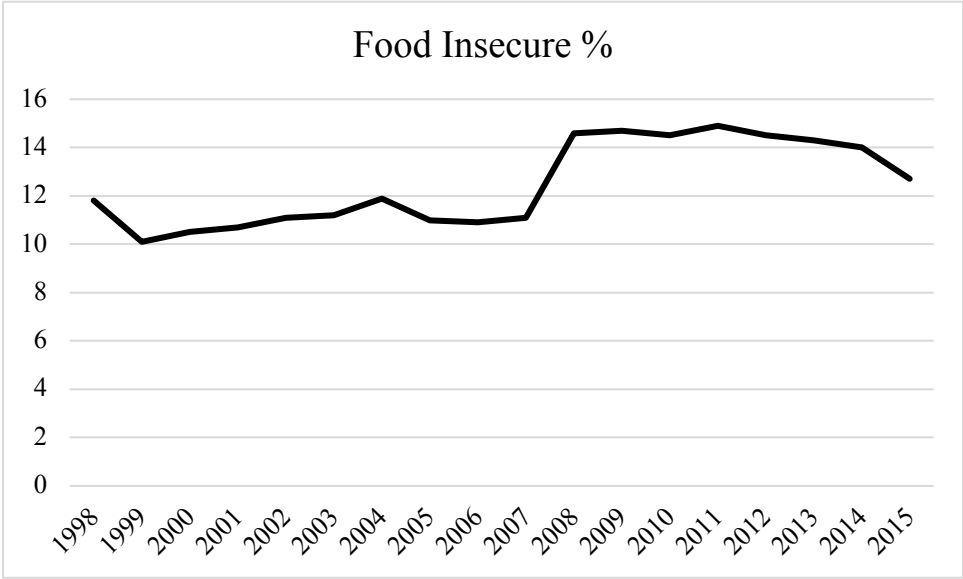
Food insecurity is a major public health issue in the United States (Coleman & Jensen et al., 2016; Gundersen et al., 2011; Gundersen & Ziliak, 2015). There are two primary reasons that food insecurity attracts attention as a key public health concern. First, millions of Americans are food insecure. In 2015, approximately, 15.8 million households were deemed to be food insecure at some point during the year (Coleman-Jensen et al., 2016). Second, there are numerous dietary, health, and developmental consequences associated with food insecurity (Gundersen & Ziliak, 2015; Rose, 1999).

The United States Department of Agriculture Economic Research Services has collected data on food insecurity annually since 1996 (Gundersen, 2013). The USDA sorts households into food insecurity categories based on the responses to the core food security measure (CFSM) questionnaire. Households are delineated into three possible categories. (1) food secure are households in which all household members had access to enough food for a healthy and active life at all times; (2) low food security are households in which some household members were uncertain of having, or unable to acquire enough food at some point during the year; and (3) very low food security are households in which one or more members were hungry at least some point during the year due to a lack of food. Households that are low food security or very low food security are classified as being food insecure.

Figure 2.1 presents the trends on food insecurity over time based on responses from the CFSM. A few trends are notable. First, food insecurity rates remained relatively steady at approximately 11% each year from the start of the survey until 2007. However,

the onset of the Great Recession in December 2007 corresponded with an increase in the food insecurity rate. Between 2007-2008 the national food insecurity rate rose from 11.1% to 14.6%. In total, this resulted in an increase in food insecure households from approximately 13 million to 17.1 million. In subsequent years, the food insecurity rate has begun to steadily decline. However, despite the official end of the Great Recession in June 2009, food insecurity rates remained elevated, staying at or above 14% from 2009-2014. The most recent data indicate that the food insecurity rate in 2015 had declined to 12.7%. Still, this remains higher than the years preceding the Great Recession. At present, an estimated 42.2 million people live in a food insecure household including 29.1 million adults and 13.1 million children (Coleman-Jensen et al., 2016).[8]

Figure 2.1: Household Food Insecurity in the United States, 1998 – 2015



Source: USDA Economic Research Service

[8] The rate of food insecurity is slightly higher for households with children. As of 2015, 16.6% of food insecure households contained children. However, only 7.8% of children were food insecure in 2015. The difference between the two trends is largely because adult caregivers often shield children from food insecurity by reducing their own nutritional intake (McIntyre et al., 2003; Nord, 2013; Radimer et al., 1990).

While these patterns above document national trends in food insecurity, there is substantial heterogeneity within the population regarding the likelihood of experiencing food insecurity (Coleman-Jensen et al., 2016). For instance, prior research has identified a number of demographic and economic factors that increase the probability of food insecurity. Notable factors consistently associated with food insecurity include lower income, households headed by African-American or Hispanic persons, being single or divorced compared to married persons, being a renter compared to home owner, younger persons, and being less educated. Households with children are also more likely to be food insecure relative to those without (Coleman-Jensen et al., 2016; Gundersen & Ziliak, 2015).

The Health Consequences of Food Insecurity

Food insecurity is viewed as a serious public health problem and a severe nutritional health issue that is associated with a wide range of adverse health outcomes (Gundersen et al., 2011; Gundersen & Ziliak, 2015; Olson, 1999).[9] In fact, the USDA began measuring household food insecurity because of the belief that food insecurity was a crucial determinant of health and is related to various negative health outcomes (Gundersen & Ziliak, 2015). Continual measurement of food insecurity is of notable importance as "understanding the existence of certain negative health outcomes that

[9] It is important to note that much of the research literature on food insecurity and adverse health outcomes focuses on correlation rather than a causal relationship. Gundersen and colleagues (2011) review of the consequences of food insecurity note there are many adverse health outcomes associated with being food insecure. However, few existing studies adequately assess the endogenous relationship of food insecurity and poor health outcomes. For an example of a study employing causal identification methods to assess the health consequences of food insecurity see (Gundersen & Kreider, 2009).

stems from food insecurity is of direct importance to healthcare professionals and to the policy makers and program administrators charged with health and well-being" (Gunderson & Ziliak, 2015: pp. 183-184). Contemporary research on the health consequences of food insecurity typically focuses on either children or adults.[10] These findings consistently demonstrate that food insecurity has deleterious consequences for the health and well-being across all stages of the life-course.

Health Consequences of Food Insecurity for Children

To date, the majority of research on the effects of food insecurity has focused on the consequences for children (Cook et al., 2004; Gundersen & Ziliak, 2014). In 2015, approximately 13 million U.S. children lived in a food insecure household (Coleman-Jensen et al., 2016). An extensive body of research demonstrates that the consequences of food insecurity for children are widespread (Gundersen & Ziliak, 2014; Kirkendall, House & Citro, 2013). As a response to the consequences for health and developmental outcomes among children experiencing food insecurity, the U.S. federal government spends over $100 billion annually on social safety net problems many of which are tasked with alleviating food insecurity among children (Gundersen & Ziliak, 2014).[11]

[10] This review will focus on non-senior adults since no senior aged adults are included in the data used in this dissertation. However, for a review of the consequences of food insecurity for seniors see (Gundersen & Ziliak, 2015; Lee & Frongillo, 2001; Ziliak, Gundersen & Haist, 2008).

[11] Programs include: Supplemental Nutrition Assistance Program (SNAP), the National School Lunch Program (NSLP), the School Breakfast Program (SBP), the Special Supplemental Nutrition Program for Women, Infants, Children (WIC), and the Child and Adult Care Food Program (CAACFP), and other programs that indirectly aid in reducing food insecurity such as the Earned Income Tax Credit.

For instance, prior research documents that food insecurity is associated with several adverse health consequences in children even after accounting for confounding factors. Generally, children living in food insecure homes are found to have lower general health based on parental reporting (Gundersen & Kreider, 2009). Regarding specific health ailments, Eicher-Miller and colleagues (2009) find children in food insecure households have iron deficiency anemia rates nearly 3 times greater than children in food secure households. Other research finds that children living in food insecure homes are over twice as likely to report being in poor health relative to their food secure counterparts (Cook et al., 2006). Kirkpatrick and colleagues (2010) finds that children in food insecure households are over 2.5 times more likely to have asthma. Chi and colleagues (2014) finds food insecure children are twice as likely to have tooth decay compared to children in food secure households.

Aside from physical health outcomes, the consequences of food insecurity also impact mental health functioning. Similarly, research has also documented that children in food insecure households have higher levels of depression, anxiety, and suicidal ideation (McIntyre et al., 2013; Melchior et al., 2009). Finally, food insecurity among children can also result in developmental shortcomings. For instance, Howard (2011) used data from the Early Childhood Longitudinal Study (ECLS) finding that elementary school students residing in food insecure households scored lower on non-cognitive performance than similarly situated children in food secure households. Moreover, other research demonstrates that food insecurity has a negative association with academic performance and psychosocial outcomes including an increased likelihood of being suspended, seeing a school psychologist, and having difficulty getting along with other

students (Alaimo, Olson & Frongillo, 2001; Jyoti, Frongillo & Jones, 2005). Whitaker and colleagues (2006) find that food insecure mothers have higher rates of mental health problems and pre-school aged children residing in these households were twice as likely as children in food secure homes to exhibit behavioral problems.

Health Consequences of Food Insecurity for Adults

Food insecurity has several adverse nutritional and health related consequences for adults as well. Moreover, in many cases the consequences and severity of food insecurity may be worse for adults as parents and guardians typically shield children in their household from food insecurity by reducing their own food consumption (McIntyre et al., 2003; Nord, 2013; Radimer et al., 1990).

A number of studies find that food insecure households have lower quality nutritional intake. Kirkpatrick and Tarasuk (2008) show that food insecure households in Canada were prone to inadequacies for crucial nutrients such as protein, vitamin A, vitamin B-6, and magnesium. Using a nationally representative survey in the United States, Bhattcharya, Currie, and Haider (2004) find that food insecure adults have less healthy diets, which was characterized as lower scores on the USDA's Healthy Eating Index (HEI). Park and Eicher-Miller (2014) assess nutrient deficiency among pregnant women finding that those residing in a food insecure household were more likely to exhibit iron deficiency.

Research among food insecurity of adults also finds evidence of adverse physical health conditions. Murhead and colleagues (2009) find that adults in food insecure households were over three times more likely to have oral health problems compared to

adults in food-secure households. Individuals in food insecure households are also at an increased risk for medical conditions such as diabetes and hypertension (Seligman et al., 2007; 2010), as well as a variety of chronic illnesses (Gregory & Coleman-Jensen, 2017). Vozoris and Tarsuk (2003) find that individuals living in food insecure households in Canada were significantly more likely to report being in poor or fair health, have poor functional health, and have restricted daily activity. Additionally, food insecurity is also associated with sleep patterns. Ding and colleagues (2015) find that food insecure adults are more likely to report inadequate sleep. Recently, Gundersen and colleagues (2016) was the first study linking food insecurity to mortality risk. This research finds that food insecurity was strongly related to premature mortality even after adjusting for confounding factors such as age, sex, education, homeownership, income, and household composition.

Finally, there is also evidence for adverse mental health outcomes associated with food insecurity status among adults, although the majority of research in this area focuses on either mothers or pregnant females. Still, this research shows a consistent pattern indicating that women residing in food insecure households exhibit higher rates of mental health problems including depression and anxiety (Casey et al., 2004; Heflin et al., 2005; Hromi-Fiedler et al., 2011; Whitaker et al., 2006). One study using a nationally representative survey of Canadians finds those experiencing food insecurity were about three times more likely to experience major depression than those who reported being food secure (Vozoris & Tarasuk, 2003).

Food Insecurity and Incarceration

Four studies have examined any links between incarceration and food insecurity, three of which assess paternal incarceration on food insecurity of children (Cox & Wallace, 2016; Jackson & Vaughn, 2017; Turney, 2015). Wang and colleagues (2013) is the only study to date that has assessed food insecurity among recently released prisoners. In this work, the authors recruited 110 recently released prisoners from Texas, California, and Connecticut to participate in a survey regarding food insecurity and HIV risk behaviors. The findings revealed very high rates of food insecurity among this group as 91% of the sample reported being food insecure. Other studies have focused on the association between paternal incarceration and the food insecurity of children. Both Turney (2015) and Cox and Wallace (2016) used data from the Fragile Families and Child Well-Being Study and found incarceration of a parent is associated with an increased risk of food insecurity for children. Finally, Jackson and Vaughn (2017) found parental involvement with the criminal justice system, including arrest, conviction, or incarceration was associated with an elevated risk of food insecurity for children.

In sum, food insecurity is a topic that has been extensively studied. As the above discussion highlights, food insecurity is associated with a wide-range of adverse health outcomes and these associations remain even after adjustment for a host of confounding factors including income. Indeed, the adverse conditions associated with food insecurity are so far-reaching that one recent commentary summarized the state of the literature as follows: "the list of outcomes associated with food insecurity is too long to even summarize here, but none of the outcomes is good" (Nord, 2014: p. 2). However, despite widespread acknowledgement of food insecurity as a risk factor for adverse health,

considerations of food insecurity have received only scant attention in the criminological literature (Cox & Wallace, 2016; Jackson & Vaughn, 2017; Turney, 2015; Wang et al., 2013).[12] This is surprising given the growing interest in the consequences of incarceration for material hardship (Harding et al., 2014; Schwartz-Soicher et al., 2011; Western et al., 2015), and the growth of research on the health consequences of incarceration (Massoglia & Pridemore, 2015). Accordingly, the current study aims to fill this gap and assesses whether incarceration carries consequences for food insecurity and whether food insecurity among former inmates is a key factor that has been overlooked in previous research examining health and incarceration.

Healthful Food Availability & Health

Defining Access to Healthy Food Retailers

Access to healthy food retailers is a measure based on a geographical unit of analysis that describes how available and accessible retail stores or food outlets (i.e. supermarkets; grocery store) that sell healthy foods (i.e. fresh fruits and vegetables; whole grains, or other healthful foods) are to residents. Because supermarkets or grocery stores are found to offer a larger variety of healthy food options at a lower cost than other types of food stores, such as small retail outlets or convenience stores (Chung & Myers, 1999; Diez Roux & Mair, 2010; Glanz et al., 2007), researchers often use supermarkets as a proxy to measure healthful food availability. Accessibility is usually defined in terms

[12] Moreover, while the above studies examine food insecurity among formerly incarcerated populations, none of the above cited research was published in criminological outlets. Rather the only existing publications on incarceration and food insecurity appear in economic (Cox & Wallace, 2016), sociological (Turney, 2015), medical (Wang et al., 2013), nutrition (Jackson & Vaughn, 2017) research outlets.

of geographic distance to healthful food retailers, often characterized as living in a geographic area (i.e. neighborhood; census-tract) within a reasonable distance to a healthful food outlet (CDC, 2014), whereas a "reasonable distance" is typically defined as within one-half or one mile from an individual's primary residence (USDA, 2009) or a census-tract boundary (CDC, 2009, 2011; Grimm et al., 2013).[13]

The current study focuses on concepts of "availability" and "accessibility" of healthy food retailers. The availability dimension measures whether healthy food retailers are available in a general geographic area based on the presence or density of food retailers in a given area. Accessibility captures whether healthy food retailers are within an accessible distance from one's residence. However, there are other important measures of the local food environment that are not included in the measurement used in the current study. For instance, affordability (i.e. price of foods), acceptability (i.e. quality of foods), and accommodation (i.e. hours local food retailers are open) are also key components of the local food retail environment (Caspi et al., 2012). However, the current study focuses on availability and accessibility as these are necessary first steps in order to access foods. That is to say, other dimensions of the food retail environment such as affordability, acceptability, and accommodation do not matter if food is not available within a geographic area.

Prior research has used several different measures to examine the "healthfulness" of neighborhood food availability and determine whether neighborhood food environments influence dietary patterns and population health (for reviews see Bell et al.,

[13] In rural areas, 10 miles is considered a reasonable distance to travel to a food outlet (Ver Ploeg et al., 2009).

2013; Lytle & Sokol, 2017; Larson et al., 2009; Walker et al., 2010). Items capturing the availability of food stores are the most frequently used measure in research on food environments (Hosler & Dharssi, 2010). The most common measurement of food availability is the characterization of areas as food deserts, which are poor urban areas, where residents do not have access to supermarkets or large grocery stores (Cummins & Macintyre, 2002).[14] Those residing in food deserts lack access to affordable healthy foods sold through retailers such as supermarkets and instead must rely on convenience stores or small neighborhood stores that have limited availability of healthy food options such as fruits or vegetables (National Research Council, 2009). Other research quantifies the proximity and density of supermarkets and food outlets that offer a variety of healthy food (Glanz et al., 2007; Chung & Myers, 1999). Researchers also characterize "unhealthy" food environments by classifying proximity to or density of fast-food restaurants or other unhealthy food retailers (i.e. convenience stores) within a geographic area (Fleischhacker et al., 2011).

Research on Neighborhood Food Environments

Social scientists have long been interested in the ways in which neighborhoods and local environments influence a variety of social outcomes including health and well-being of local residents. For instance, Shaw and McKay's (1942) theory of neighborhood social disorganization proposed a framework to understand how community processes influence various outcomes, including health. While the work of Shaw and McKay is

[14] National Research Council (2009: p. 8) adopted the following definition of food deserts: "a geographic area, particularly lower-income neighborhoods and communities, where access to affordable, quality, and nutritious foods is limited."

notable for their research on delinquency, their research on Chicago neighborhoods noted that socially disorganized communities generally had poor health outcomes such as high rates of infant mortality, low birth weights, and high rates of tuberculosis. In the subsequent decades researchers have continued to demonstrate an association between community characteristics and individual-health outcomes, often showing that residing in disadvantaged communities is generally associated with poor health outcomes (Pickett & Pearl, 2001; Sampson, 2003), as well as an association between high rates of neighborhood incarceration and adverse population health including high levels of asthma, sexually transmitted infections, and psychiatric morbidity (Frank et al., 2013; Khan et al., 2008; 2009; Rogers et al., 2012; Thomas et al., 2006). Accordingly, in recent years researchers have increased focus on ways in which aspects of the local environment such as land use, street designs and access to resources such as healthy food retailers affect the health and well-being of local residents. As Diez Roux and Mair (2010: p. 125) note: "neighborhoods (or residential areas more broadly) have emerged as potentially relevant contexts because they possess both physical and social attributes which could plausibly affect the health of individuals."

In the United States, a sizeable portion of the population lacks access to healthy foods. The Department of Agriculture estimates that approximately 30 million Americans (9% of the population) reside in an area that lacks access to affordable nutritious food (Ver Pleog et al., 2012). These rates are even higher in low-income communities, minority neighborhoods, and rural areas (Bell, et al., 2013). For instance, many poor urban communities require commutes of 20 minutes or more to access a grocery store and some rural communities are over 20 miles away from the nearest grocery store (Ver

Pleog et al., 2009). An examination of the food environment is important as individuals typically make dietary decisions based on which food outlets are available in their local neighborhoods (Furey et al., 2001).

In particular, features of the local environment such as healthful food access can affect health by placing constraints on or enhancing health related behaviors (Diez Roux & Mair, 2010; Larson et al., 2009). Prior research indicates that residents with access to healthy food retailers eat more fruits and vegetables (Bodor et al., 2007; Michimi & Wimberly, 2010; Morland, Wing & Roux, 2002; Powell, Han & Chaloupka, 2010; Robinson et al., 2013). Moore and colleagues (2008) finds residents in areas with a greater density of supermarkets have better dietary patterns. A recent systematic review of neighborhood access to healthy foods concluded that neighborhoods in which residents have better access to supermarkets and other retail stores that carry healthy food options have healthier dietary patterns (Larson, Story & Nelson, 2009). Another common theme is that neighborhoods with better residential access to healthy retail outlets have a lower prevalence of overweight and obese residents and poor access to supermarkets is generally associated with higher body mass index (BMI) (Bodor et al., 2010; Larson et al., 2009; Liu et al., 2007; Morland et al., 2006; Ingami et al., 2006; Powell et al., 2007; Wang et al., 2008). Moreover, while access to food retail stores and household food insecurity are distinct concepts, there is evidence that better neighborhood food access is associated with a lower risk of food insecurity (Mayer et al., 2014).

Research also focuses on the availability of unhealthy foods (i.e. fast-food restaurants). Indeed, several studies find strong evidence that consuming more fast-food is related to weight gain and greater obesity (Bowman & Vinyard, 2004; Duffey et al.,

2007; Niemeier et al., 2006; Pereira et al., 2005). This is challenging given that closer proximity to fast-food restaurants is generally associated with poorer diet and greater fast-food consumption (Boone-Heinonen et al., 2011; Moore et al., 2009). Moreover, within the United States, fast-food restaurants are more greatly concentrated in low-income and minority neighborhoods than in higher income and majority white neighborhoods (Block et al., 2004; Lewis et al., 2011; Morland et al., 2002; Powell et al., 2007).[15] However, studies examining the relationship between the geographic availability of fast-food restaurants and obesity have provided mixed results. For instance, a series of studies at the state and county-level in the United States find a positive association between fast-food availability and obesity (Maddock, 2004; Mehta & Chang, 2008). However, other studies using more refined units of analysis such as the zip code (Powell et al., 2006; Sturm & Datar, 2005) or within 2 miles of a person's primary residence found no association between fast-food availability and obesity (Burdette & Whitaker, 2004; Jeffery et al., 2006). Still, other research examining the proximity between fast-food restaurants and schools find an association between increased fast-food consumption and higher odds of being overweight among students (Currie et al., 2010; Davis & Carpenter, 2009).

Studies also suggest that low ratios of healthy to unhealthy food can carry consequences for health. For instance, Koh, Grady, and Vojnovic (2015) investigated

[15] Prior research also documents other disparities in the built environment of poor and minority neighborhoods. For example, low-income, minority communities often have less access to pharmacies carrying medication (Morrison et al., 2000), are more frequently exposed to advertisements for alcohol and tobacco (Alaniz, 1998; Luke et al., 2000), and have reduced access to physical activity and recreational facilities (Gordon-Larsen et al., 2006).

factors associated with obesity rates at the census tract level in Detroit. This analysis used the mRFEI to measure healthy and less healthy census tracts. The findings indicated that spatial patterns of high obesity prevalence were most similarly aligned with less healthy census tracts. Weintraub and colleagues (2016) investigated the impact of mRFEI on cardiovascular disease in Alameda County, California. The findings indicated that individuals diagnosed with cardiovascular disease were more likely to reside in neighborhoods with a lower ratio of healthy to unhealthy food options (i.e. lower mRFEI score), suggesting that nutritious food availability plays a role in cardiovascular health problems. A study of adults in New Orleans found that each additional supermarket in a person's neighborhood was associated with a reduction in the likelihood of obesity, whereas an additional fast-food or convenience store was predictive of greater odds of obesity (Bodor et al., 2010).[16]

In sum, a growing body of evidence is emerging that indicates that access to healthy food retailers has important implications for well-being of local residents. Indeed, from 2010 – 2013, over 75 studies have examined the influence of access to nutritious food on the health of local residents. One recent review of this literature concluded: "the majority of these studies find healthy eating and positive health outcomes associated with access to healthy food" (Bell et al., 2013: p. 1). However, despite a growing interest in the role of communities in prisoner reintegration (Morenoff & Harding, 2014), disparities nutritional access has gone unnoticed by prior criminological research. At present, there

[16] Notably, recent research suggests that the harmful consequences of fast-food consumption goes beyond its poor nutrient components, as packaging at many fast-food chains contains grease-repellant fluorinated chemicals that have been lined to adverse health problems including certain forms of cancer, elevated cholesterol, decreased fertility, thyroid problems, and changes in hormone functioning (Schaider et al., 2017).

are no studies assessing the association between prior incarceration and access to healthy food retailers based on residential location following release. To be sure, this is a significant gap in the research literature aimed at understanding the link between incarceration and health. For instance, recent work demonstrates prior incarceration is associated with decreased dietary quality including increased intake of fast-food (Porter, 2014). Accordingly, as former inmates often return to low-income urban environments with fewer healthful food options and a greater density of fast-food restaurants and small corner stores offering prepared and processed foods (Hendrickson et al., 2006), then dietary choices may be in part influenced by limited access to nutritious food. Additionally, disparities in food access are an important factor to consider for understanding patterning and disparities in health. Accordingly, the current study aims to contribute to the research literature documenting adverse health consequences among former inmates, and examines the extent to which formerly incarcerated persons reside in areas with poor residential access to healthy food retailers.

CHAPTER 3: THEORY AND HYPOTHESES

Overview

The introductory chapter provided an overview of the rise in the incarceration rate and the corresponding growth in research regarding the social and economic consequences of incarceration. Chapter two reviewed extant literature on consequences of incarceration to health and material hardship. Further, chapter two discussed the gaps in prior literature. Namely, this discussion focused on the lack of research on important nutritional outcomes following release from incarceration, such as food insecurity and access to healthy food retailers. Chapter three focuses on the processes that may cause incarceration to negatively impact food security and access to healthy food retailers. Moreover, this chapter discusses how these two outcomes may negatively influence health and well-being of formerly incarcerated persons.[17]

I begin this chapter with a series of figures that illustrate the theoretical associations between incarceration and nutritional hardships. First, figure 3.1 highlights the direct relationships whereby incarceration is expected to increase the risk for food insecurity and decrease access to healthy food retailers. Second, figure 3.2 illustrates factors which are anticipated to mediate part of the relationship between incarceration and nutritional hardships. Finally, figure 3.3 suggests that food insecurity and poor access to healthy food retailers mediate part of the relationship between incarceration and poor health outcomes (i.e. overweight) and poor nutrition (i.e. fast-food and sugar consumption).

[17] I discuss adverse health conditions throughout this chapter using the general term "poor health" for simplicity. However, this term refers to specific health outcomes that will be discussed further in chapter 4. These outcomes include subjective health status and waist-to-height ratio.

Figure 3.1: Direct Effects of Incarceration on Nutritional Hardship

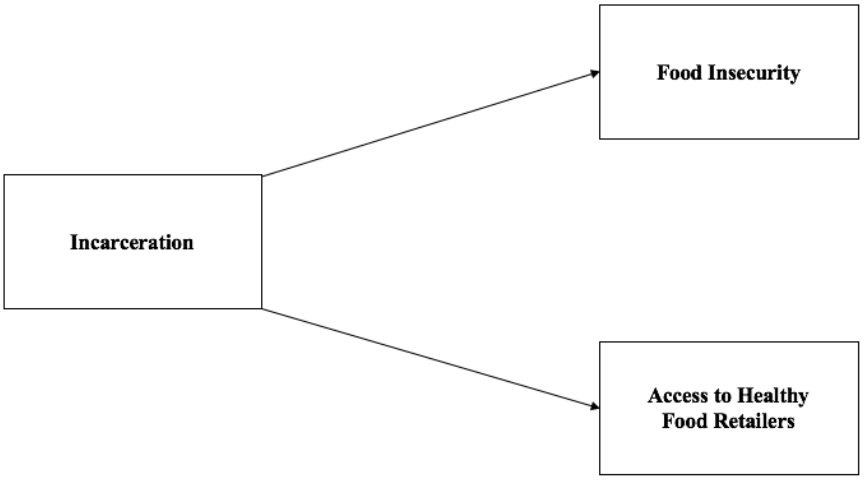


Figure 3.2: Factors Mediating the relationship between Incarceration and Nutritional Hardships

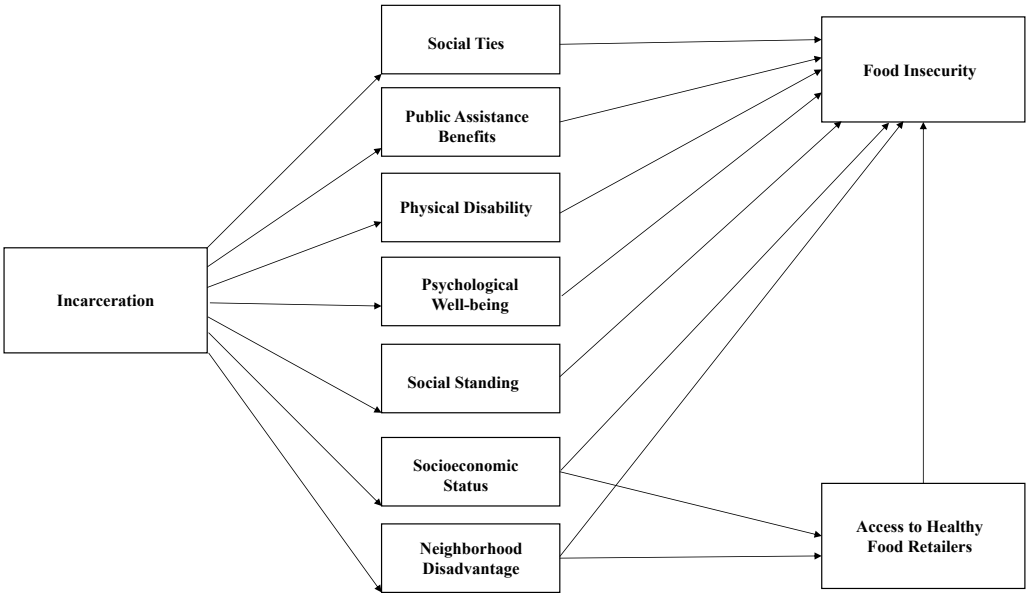
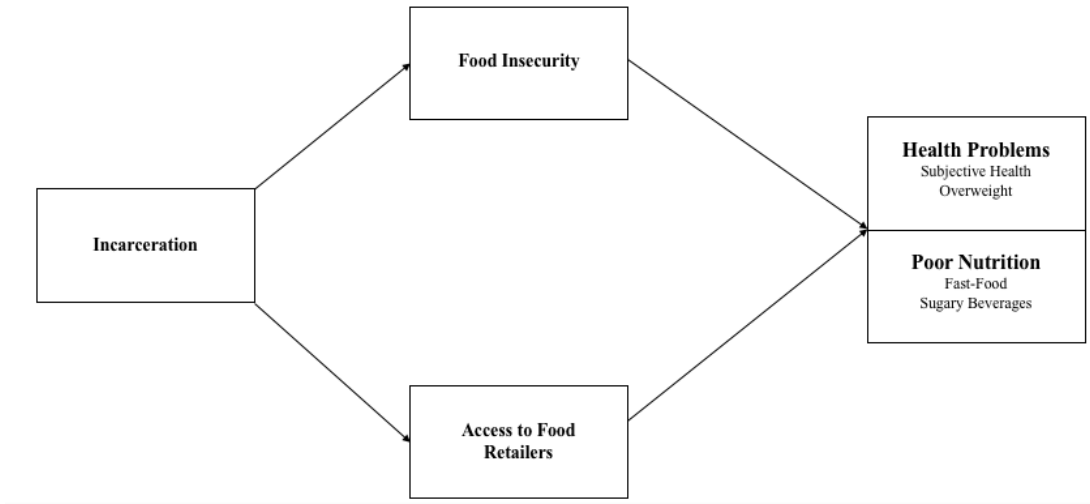


Figure 3.3: Factors Mediating the relationship between Incarceration and Health and Nutrition



Why Incarceration might increase food insecurity?

Although individuals entering into prisons and jails already exhibit a number of markers of disadvantage including low levels of human, financial, and social capital, contact with the correctional system can alter one's life course and exacerbate disadvantage (Wakefield & Uggen, 2010; Western, 2006). For instance, incarceration has been tied to declines in employment and earnings, educational attainment, the likelihood of marriage, and overall health and well-being (Dennison & Demuth, 2017; Massoglia & Pridemore, 2015; Wakefield & Uggen, 2010; Western, 2006). In regard to the likelihood of food insecurity, unexpected events that stress household budgets such as the loss of a job, loss of welfare benefits, or changing household composition can increase vulnerability to food insecurity (Gundersen and Gruber, 2001; Rose, 1999; Wolf & Morrissey, 2017). Gundersen and Gruber (2001), for instance, find that food-insufficient households are more likely than food sufficient ones to have experienced an unexpected shock to their income through the loss of employment or removal of public assistance

benefits. Additionally, these households also have less savings or liquid assets to withstand these shocks (Leete & Bania, 2010). Moreover, other factors such as declines in physical or mental health, and the weakening of social ties are also important triggers associated with entry into food insecurity (Jacknowitz, Morrisey, & Brannegan, 2015; Martin et al., 2004).

Though limited research has theorized about the implications of incarceration for food insecurity (see Turney, 2015), there are several mechanisms that may link incarceration to an increased likelihood of experiencing food insecurity. Specifically, incarceration serves as an unexpected shock that can increase the risk of food insecurity by (a) reducing socioeconomic status, (b) worsening psychological well-being and physical disability, (c) altering social networks and interpersonal relationships, (d) disrupting access to basic needs including social welfare benefits, and (e) generating stigma and reducing social standing.

Socioeconomic Status and Economic Instability

Incarceration and economic instability

Incarceration can generate financial hardship and economic instability in several ways. First, while individuals are incarcerated there are limited opportunities to earn income and current inmates who have paid positions typically make low wages (Travis & Waul, 2003; Zatz, 2008). After release, formerly incarcerated persons have limited opportunities for work, as employers are often reluctant to extend job offers to those with a criminal history (Pager, 2007; Pager et al., 2009). Additionally, former inmates who do gain employment typically earn low wages and experience slow wage growth (Western,

2002; 2006). Incarceration is also linked to a reduction in ownership of liquid assets including a bank account, vehicle, and home (Turney & Schneider, 2016). Finally, monetary sanctions levied against those convicted of crimes can generate economic instability. Harris and colleagues (2010) propose debt from legal proceedings have consequences for meeting basic material needs as "legal debt substantially reduces household income and compels people living on very tight budgets to choose between food, medicine, rent, child support, and legal debt" (p. 1786).

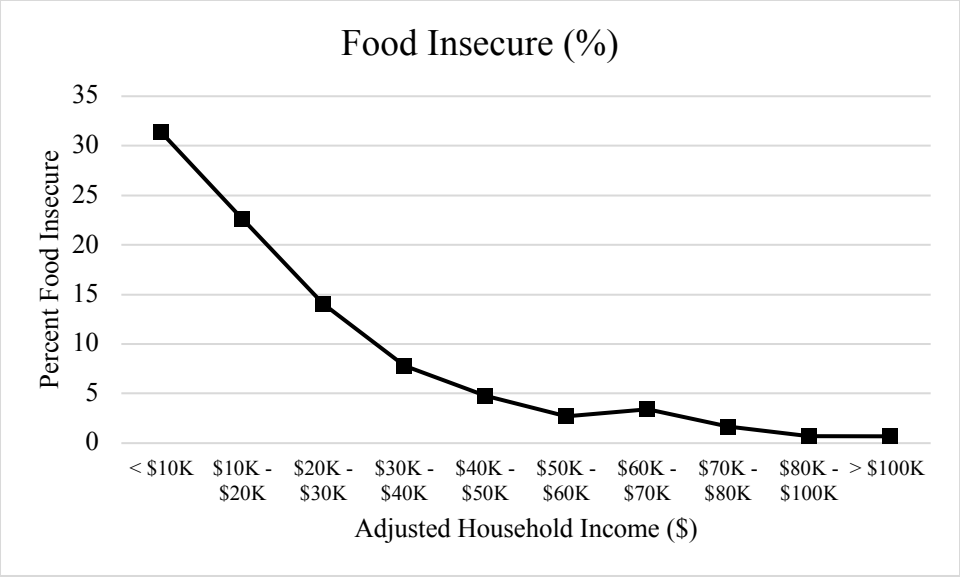
Economic Instability and Food Insecurity

Poor households experience serious constraints on how to allocate income for essential goods including basic food needs (Noonan et al., 2016). Prior research demonstrates a robust association between income levels and the likelihood of experiencing food insecurity (Coleman-Jensen et al., 2016; Cook & Frank, 2008; Gundersen et al., 2011; Nord, 2014; Rose, 1999) This association is illustrated in Figure 3.4, which shows that as household income adjusted for the number of household members increases the likelihood of food insecurity declines.[18] For example, 31.3 percent of households with incomes below $10,000 were food insecure , compared to just 4.8 of households making between $40,000 to $50,000 annually. This descriptive pattern has also been confirmed in other research that finds even after controlling other household

[18] The income-to-poverty ratio represents the ratio of a family or individual income to a given poverty threshold. Ratios below 1.00 indicate that the income for a family or individual is below the official poverty threshold. A ratio of 1.00 or greater indicates that income is above the official poverty threshold. For example, a ratio of 1.25 indicates that income is 125 percent above the official poverty threshold (U.S. Census Bureau, 2004).

and individual characteristics, those living below the poverty line are substantially more likely to be food insecure (Gundersen et al., 2011; Rose, 1999).

Figure 3.4: Food Insecurity by Household Income



Source: National Longitudinal Study of Adolescent to Adult Health

Since most inmates are economically disadvantaged prior to incarceration and continue to earn low wages, face unstable employment opportunities, and have few assets following release (Pager, 2007; Turney & Schneider, 2016; Wakefield & Uggen, 2010), formerly incarcerated individuals as a group are particularly prone to food insecurity as a result of these financial challenges. Accordingly, it is likely that incarceration will increase the likelihood of being food insecure by reducing socioeconomic status.

Risk Factors for Food Insecurity other than Income

Although it is not surprising that food insecurity is inversely associated with income, there are a considerable number of poor households that are food secure and non-poor households that are food insecure (Anderson et al., 2016; Coleman-Jensen et

al., 2016; Rose, 1999). This pattern implies that food insecurity "is related, yet distinct from poverty" (Ribar & Hamrick, 2003: p. 21). Consequently, a focus solely on static income does not account for other factors that influence the ability of an individual or household to avoid food insecurity (Anderson et al., 2016; Gundersen et al., 2011). For example, factors such as poor physical or mental health, fractured social ties, the loss of social welfare benefits, and diminished social standing are all collateral consequences of incarceration that can increase the likelihood of becoming food insecure independent of annual income levels (Anderson et al., 2016; Gundersen & Zilliak, 2014; Jacknowitz, Morrissey, & Brannegan, 2015; Rose, 1999).

Incarceration, Health Status, and Food Insecurity

Incarceration and Health Status

Having physical or mental health problems can lead to an increased risk of food insecurity primarily by reducing labor force participation and generating financial strain, as well as reducing coping skills critical to managing hardships. An emerging literature documents a negative association between incarceration and a range of physical and mental health outcomes (Massoglia & Pridemore, 2015). Upon entry to jail or prison, inmates tend to be in poor physical health (Binswanger, Krueger, & Steiner, 2009; Conklin et al., 2000) and have an assortment of mental health disorders (Bronson & Berzofsky, 2017; James & Glaze, 2006) and after release, formerly incarcerated individuals often experience further declines in health status (Esposito et al., 2017; Massoglia, 2008; Schnittker & John, 2007).

Additionally, incarceration is also related to the onset or worsening of psychological disorders. While most disorders emerge prior to incarceration, research suggests that both current and recent incarceration can increase the risk for mental health disorders including major depression, bipolar disorder, and dysthymia (Schnittker et al., 2012; Porter & Novisky, 2017; Turney et al., 2012). Moreover, there is also an important interplay between psychological well-being and material hardship among formerly incarcerated individuals. Porter and Novisky (2017) find prior incarceration is associated with a higher rate of depressive symptoms and that much of this association is explained by material hardship.[19] Therefore, it is likely that incarceration can worsen psychological well-being and in turn the psychological consequences of incarceration may be both related to, as well as can exacerbate the likelihood of experiencing forms of material hardship including food insecurity.

Health Status and Food Insecurity

Emerging research proposes that health status is a risk factor for becoming food insecure (Althoff et al., 2016; Gundersen & Ziliak, 2014; Noonan et al., 2016). A series of recent studies have provided support for this position, although this research focuses only on the health of a parent and the risk of food security among households with children. For instance, Jacknowitz and colleagues (2015) longitudinal study of triggers of food insecurity finds evidence that declines in both maternal health and the onset of maternal depression are associated with entering into household food insecurity. Similarly, Anderson and colleagues (2016) find that having a parent in either poor

general health or suffering from depression nearly triples the likelihood of the household experiencing food insecurity.

Poor physical and mental health status is theorized to increase household food insecurity in at least three ways (Heflin et al., 2007; Huang et al., 2010): (1) constrained economic resources as a result of reduced labor market participation, (2) competing financial demands resulting from medical expenses, (3) and lacking adequate coping to budget and plan for the future.

a. Less money

Individuals with physical disabilities or mental health problems are likely to have constrained economic resources due to declines in labor force participation (Babiarz & Yilmazer, 2017; Krueger, 2016; Sturm et al., 1999; U.S. Department of Labor, 2015). Moreover, even if paid employment is obtained, the number of hours worked and the type of job an individual is able to obtain are limited (Coleman-Jensen & Nord, 2013; DeNavas-Walt & Proctor, 2015). For instance, prior work finds individuals lose nearly six hours of productive work every week when they are suffering from depressive symptoms (Stewart et al., 2003) and those with depression are more likely to miss work from sick days (Adler et al., 2006; Greener & Guest, 2007). Similarly, living with someone in poor physical or mental health can diminish household income by reducing employment and earnings of other household members who may need reduced labor force participation in order to provide care for others in their household (Coleman-Jensen & Nord, 2013; Huang et al., 2010; Rogers & Hogan, 2003). In sum, as Krueger (2016: pp. 17-18) notes, "physical, emotional, and mental health-related problems… are a substantial barrier to work."

b. Competing financial demands

Health problems can create competing financial demands that strain income needed to meet basic material needs (Heflin et al., 2007). Conflicting demands may include medical care, medical equipment, prescription medications, and costs associated with transportation to see a medical professional (Batavia & Beaulaurier, 2001). The time and income spent on medical expenditures means that all else equal, an individual with physical or mental health problems will need more money to cover basic living expenses and therefore may have to sacrifice essential food consumption in order to afford health-related expenses (Huang et al., 2010; She & Livermore, 2007). For example, Huang and colleagues (2010) find health expenditures mediate the relationship between disability and food insecurity. Similarly, Nielsen and colleagues (2010) find that increasing out-of-pocket medical expenses correspond to an increased risk of food insecurity, yet find no evidence that food insecurity status is associated with out-of-pocket medical expenditures. These findings suggest that given the decision between investing in medical care or food, families with constrained budgets will often allocate resources toward medical care.

c. Coping skills

Coping strategies (i.e. techniques used to manage a crisis during times of limited resources) is a factor that explains resilience to food insecurity. For instance, selling assets, creating a tighter budget, eating foods that are less preferred, limiting portion sizes, borrowing food or money are all techniques that can be used to avoid food insecurity for those at risk (Farzana, et al., 2017; Maxwell, 1996; Maxwell & Caldwell, 2008). Individuals with physical or mental health problems may be prone to food

insecurity because of difficulties coping with the day-to-day struggles associated with these conditions, which in turn may impede the ability to properly manage constrained resources (Olson et al., 2004). For instance, those suffering from depressive symptoms can experience a diminished capacity to think about the future in a positive way and experience difficulty making decisions (O'Connor, Connery, & Cheyne, 2010), which can create challenges managing a monthly food budget (Heflin, Corcoran, & Siefert, 2007). Indeed, prior work demonstrates that those with a psychological disorder spend more income on consumer goods but less income on long-term investments (Dahal & Fertig, 2013). While this research does not directly assess food insecurity it provides some evidence that mental health disorders can result in poor budget management and potentially lead to food insecurity if the budget becomes overly constrained.

Regarding physical ailments, Huang and colleagues (2010) find that a physical disability of the head of a household is positively related to food insecurity even after controlling for family economic resources and financial expenditures. In explaining this relationship, the authors propose that issues related to budgeting could explain this association. Moreover, the burden and stress of caring for other household members in poor health may detract from budgeting and planning, therefore increasing the likelihood of becoming food insecure (Cummins, 2001; Huang et al., 2010; Power & Dell Orto, 2004).

In sum, because many inmates are in poor physical health and suffer from mental health disorders prior to incarceration and often exhibit a worsening of physical and mental health problems following release from incarceration, formerly incarcerated individuals are at an increased risk of food insecurity because of these health problems.

Thus, incarceration may increase the likelihood of being food insecure by worsening physical and mental health.

Social Ties

Incarceration and Social Ties

Strong social ties can reduce food insecurity by providing support networks to obtain food directly or resources needed to secure food, such as money or a transportation that aid in accessing groceries or a food pantry. Incarceration impacts social networks by removing members from families and communities, reducing labor force participation, and weakening social interaction among residents (Clear, 2008; Lynch & Sabol, 2004b). Given that the majority of inmates report having minor children (Glaze & Maruschak, 2010), and incarceration increases the likelihood of marital dissolution (Loopo & Western, 2005), for many "incarceration forcibly restructures household composition and kin relations" (Braman, 2004: p. 10). Additionally, because nearly all inmates are a child, sibling, or close friend of others, incarceration has a destabilizing effect on larger community social networks (Clear, 2008). As Western and colleagues (2015: p. 1516) point out: "connections to family and friends tend to erode with lengthy terms of incarceration and histories of prolonged institutionalization". Fracturing of social ties is a particularly salient consequence of incarceration for food insecurity as many formerly incarcerated individuals rely on financial and emotional support from family members, friends, and romantic partners to avoid material hardship, including food insecurity (Fader, 2013; Harding et al., 2014; Martinez & Christian, 2009; Visher et al., 2004; Western et al., 2015).

Social Ties and Food Insecurity

Stronger social ties are linked to numerous positive health outcomes including reduced risk of cardiovascular disease (Berkman,1995); mortality (Kawachi et al., 1997), better general health (Kawachi et al., 1999), and improved health behavior (Umberson et al., 2010).[20] While there are several pathways that explain why social support is beneficial for wellbeing, one major reason is the role of social networks and social support to help meet basic needs. Ethnographic research finds individuals facing material hardship often rely on social networks to meet basic daily needs (Desmond, 2012; Edin & Lein, 1997). For instance, Desmond's (2012) research of social ties in impoverished urban areas finds individuals living in poverty rely on social networks in order to pool together resources to meet basic needs such as food and housing. Henly and colleagues (2005) empirical analysis of current and former welfare recipients finds support for this position as social support was found to reduce the likelihood of living in poverty. This suggests that for low-income families, reliance on social networks is critical to survival as it can provide an economic boost that enables households to remain above poverty thresholds and meet basic material needs.

Extant literature also suggests that social ties can reduce the likelihood of becoming food insecure. Initial research has found indirect support for the benefit of social ties on reducing food insecurity. Tarasuk (2001) found Canadian women who felt

[20] Social cohesion or social capital has many definitions (for review see Kawachi & Berkman, 2000: p. 176). According to Coleman (1988: p. 302) social capital is "defined by its function. It is not a single entity, but a variety of different entities having two characteristics in common: They all consist of some aspect of social structure and they facilitate certain actions of individuals who are within the structure. Like other forms of capital, social capital is productive, making the achievement of certain ends that would not be attainable in its absence."

socially isolated were more likely to report household food insecurity. Martin and colleagues (2004) performed the first study assessing the role of social support on food insecurity. This work proposed that factors such as knowing and trusting neighbors can facilitate networks that reduce food insecurity by providing crucial support such as the borrowing of food in times of need, as well as loaning of a car, money, or child-care services in order to enable families to obtain food. Their findings provided support for the benefit of social ties as higher social capital was associated with a decrease in the likelihood of food insecurity even after controlling for household factors including income, education, and employment status.

Other research finds that individuals who feel they can rely on help from others within the community are less likely to become food insecure (Dean & Sharkey 2011a, 2011b; Garasky et al., 2006). Additionally, Bartfeld and Dunifon (2006) find support for the beneficial role of social capital in an aggregate state-level analysis. Specifically, these authors find that residential stability (people living in same home for at least 5 years) was associated with lower odds of food insecurity at the state-level. In explaining these findings, Bartfeld and Dunifon propose that stability serves as a proxy for social connection among community members through which there is greater access to information about community resources, as well as increased support from community members for those in need. More recently, a series of studies demonstrated that perceptions of instrumental social support and neighborhood social cohesion reduce the risk of food insecurity, as well as the risk of becoming or remaining food insecure among young mothers and their children (Denney et al., 2017; King, 2017)

Still, the evidence on social ties and food insecurity is not entirely conclusive. For instance, De Marco and Thronburn (2009) found no evidence between social support (measured as the strength of relationships with social networks, one's intimate partner, and one's community) and food insecurity among a sample of survey respondents from Oregon. Additionally, Chung and colleagues (2012) find that neighborhood social cohesion was not associated with risk of food insecurity. However, this study measured risk of food insecurity as "in the past 12 months, were you hungry, but did not eat because you weren't able to get out to buy food?", thus, this question conflates food insecurity with trouble leaving the home and therefore does not provide a clear measure of food insecurity risk.

For former inmates, a lack of social support and feelings of isolation can carry consequences for material hardship. Indeed, Harding and colleagues (2014: p. 461) note that social support is "especially important in the early stages of reentry, when low-cost or free housing and food helped some former prisoners transition back into the labor market or onto public benefits, buffered the shocks of loss of jobs or other resources, and protected against homelessness and hunger when relapse occurred." Similarly, research on the hardships faced during the reintegration process finds that over half of individuals received money or housing support from family members and many also relied on some form of support from friends as well (Western et al., 2015). Accordingly, without strong social support formerly incarcerated individuals will be at a higher risk of food insecurity as a result of these consequences to social ties. Therefore, I hypothesize that incarceration may lead to food insecurity by reducing social ties.

Public Assistance Benefits

Incarceration and Public Assistance Benefits

A primary goal of public assistance benefits such as the Supplemental Nutrition Assistance Program (SNAP) is to help individuals at risk avoid food insecurity. Many states restrict access to social welfare benefits for those convicted of felony crimes (Bushway, Stoll, & Weiman, 2007; Petersilia, 2003; Rubinstein & Mukamal, 2002; Travis, 2005) and often states with the highest rates of incarceration are also those with the least generous social welfare programs (Beckett & Western, 2001; Stement, Rengifo, & Wilson, 2005). Moreover, individuals can have benefits either terminated or suspended while they are incarcerated, and because the re-enrollment process is difficult and time-consuming benefits can be lost for extended periods even after release (Brucker, 2006; Harding et al., 2014). Without such benefits, formerly incarcerated individuals who are experiencing financial hardship may be at a particularly high risk of becoming food insecure (Bartfeld et al., 2015; Gundersen & Oliveria, 2001; Nord & Golla, 2009).[21] As Petersilia (2005: p. 25) suggests "ex-offenders have historically relied on public assistance to pay for food and housing." Moreover, recent research on the experiences during reentry suggests formerly incarcerated individuals often rely on public benefits to avoid food insecurity (Harding et al., 2014; Western et al., 2015). For instance, Western and colleagues (2015) research on prisoner reintegration in Boston finds that nearly half

[21] However, Sugie's (2012) study of parental incarceration on family's receipt of social welfare benefits finds evidence that parental incarceration is differentially associated with benefits based on the type of program. In particular, her research finds that families increase their receipt of food stamps suggesting that the incarceration of a father is associated with increased material hardship and specifically increased strain on access to food. However, these findings do not specifically speak to the experiences of formerly incarcerated individuals with social welfare programs such as SNAP.

of individuals were receiving food stamps and other public benefits in the first week following release from prison and nearly 70 percent were receiving benefits within the first two months.[22]

Public Assistance and Food Insecurity

Public assistance benefits are a major policy intervention targeted at reducing material hardships including food insecurity. In particular the Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp Program) is the largest food assistance program in the United States and carries the stated goal of alleviating food insecurity (USDA, 2017). Recipients of SNAP obtain benefits distributed via an Electronic Benefit Transfer (EBT) card for the purchase of food in authorized retail outlets. The level of benefits is determined based on the level of income and family size. To receive SNAP, households must meet eligibility criteria (Gundersen et al., 2011).[23] As of 2016, the average monthly food stamp benefit per participant was $127.57 and approximately 43.6 million individuals received SNAP benefits. (USDA, 2016). Moreover, one recent estimate of the prevalence of SNAP benefits found that by age 20, nearly half (49.2%) of all American children will reside in a household that received food stamps (Rank & Hirschl, 2009).

A large literature aims to assess whether SNAP achieves the central stated goal of reducing food insecurity. Among the major challenges in addressing whether SNAP

[22] The typical food stamp benefit in the Boston Reentry Initiative was $200 per month (Western et al. 2015).
[23] For further information on eligibility criteria see: https://www.fns.usda.gov/snap/eligibility

reduces food insecurity is addressing selection into SNAP (Gundersen et al., 2011). The findings regarding the net benefits provided by SNAP remain somewhat mixed. For instance, a number of studies have found no relationship between SNAP benefits and food insecurity after accounting for selection using a variety of statistical techniques including instrumental variable analysis (Gundersen & Oliveira, 2001), fixed-effects modeling (Wilde & Nord, 2005), and propensity score matching (Gibson-Davis & Foster, 2006). Yet, several studies also find evidence that SNAP is associated with reductions in food insecurity even after accounting for selection into the program (Mabli et al., 2013; Nord & Golla, 2009; Ratcliffe & McKernan, 2010; Yen et al., 2008). Most recently, Gundersen and colleagues (2017) estimated that SNAP benefits reduce food insecurity by at least six percentage points in households with children. While future research is needed to identify the impact of social welfare programs on food insecurity, there remains strong theoretical reasons to suggest these benefits can alleviate food insecurity by providing food to those who cannot otherwise afford it (Bartfeld et al., 2015; Nord & Prell, 2011).

Given the potential for SNAP benefits to alleviate food insecurity, it is potentially harmful to formerly incarcerated persons that many state laws disrupt access to SNAP benefits (Harlow, 2003; Luther, Reichert, Holloway, Roth, & Aalsma, 2011; Springer, Spaulding, Meyer & Altice, 2011). Because formerly incarcerated persons are at risk of losing social welfare benefits and prior research suggests that such assistance may be helpful to meet basic nutritional needs during the reintegration period, formerly incarcerated individuals who are not able to obtain social welfare benefits are at increased risk of food insecurity. Therefore, incarceration may increase the likelihood of being food insecure by limiting access to social welfare benefits.

Social Stigma

Incarceration, Stigma, and Social Standing

Post-release hardships of former inmates are often in part attributed to stigma. According to this perspective, spending time incarcerated has negative repercussions for an individual's identity. Ethnographic research on incarceration suggests that spending time incarcerated negatively impacts subjective views of identity (Becker, 1963; Goffman, 1963). Moreover, stigma associated with incarceration be in part driven by existing policies which put limitations on the behavior of former inmates including limits on civic participation, certain forms of employment, and housing options (Petersilia, 2003; Uggen et al., 2006). Indeed, recent qualitative research suggests that ex-felons experience feelings of diminished social status as a result of their criminal label (Uggen et al., 2004). This research is further supported by quantitative research findings that incarceration negatively impacts the subjective social standing of formerly incarcerated men (Schnittker & Bacak, 2013). Moreover, as a consequence of incarceration, diminished social status may hold implications for the health and well-being of formerly incarcerated individuals. For instance, Marmont (2004) suggests that social standing is a key source of variation in health as it is related to autonomy and opportunities individuals have for social engagement. Prior research on incarceration and health finds subjective standing often accounts for part of the relationship between incarceration and adverse outcomes such as poor health behavior (Porter, 2014) and depressive symptoms (Porter & Novisky, 2017). Accordingly, this research suggests that incarceration could increase the likelihood of experiencing food insecurity among formerly incarcerated individuals by negatively impacting social standing.

Stigma, Social Standing, and Food Insecurity

To date, there is limited research assessing the relationship between social standing and food insecurity. Existing literature suggest that being food insecure can lead to social stigma and diminished perceptions of subjective social standing (Frongillo et al., 2017; Purdam, Garratt, & Esmail, 2016). However, there are a number of reasons to believe that diminished standing can increase the risk of becoming food insecure. For one, reduced status can lead to detachment from critical institutions that might help and individual avoid food insecurity. For instance, Vozoris and Tarasuk (2003) suggest that individuals with low views of themselves may be deterred from seeking out assistance to avoid food insecurity because of the general stigma associated with food charity. On a related point, if an individual internalizes stigma of being untrustworthy they may come to believe they cannot be trusted with being loaned assets such as money or a car that can help avoid food insecurity. Finally, stigma related to incarceration may also result in detachment from the labor market, leading to diminished socioeconomic status, and an increased risk of food insecurity. For instance, a respondent in De Marco and colleagues (2009) qualitative study noted that the stigma she experiences in her community as a result of a ten-year prison stint contributed to unstable employment over several years after release. In turn, the reductions in income can lead to an inability to meet adequate food needs. Given that prior research finds that food insecurity status is associated with feelings of despair and diminished status (Frongillo et al., 2017; Purdam, Garratt, & Esmail, 2016), it is possible that the stigma of prior incarceration can exacerbate the risk of food insecurity. Accordingly, incarceration may increase the likelihood of being food insecure by reducing social standing.

Why might incarceration decrease access to healthy food retailers?

Incarceration and Residential Attainment

Following release from incarceration many people experience frequent residential mobility (Harding et al., 2013; Warner, 2015), as well as a decline in neighborhood attainment (Massoglia et al., 2013; Warner, 2016). There are several reasons that explain declines in neighborhood attainment. For one, because incarceration strains social ties and familial relationships, individuals may have limited housing options to return to upon release. Moreover, incarceration also reduces employment and educational opportunities and reduces earnings (Dennison & Demuth, 2017; Pager, 2003; Western, 2002), therefore, former inmates may lack the financial means needed to obtain housing in desirable locations. Finally, formerly incarcerated persons may have difficulty finding suitable areas to live because of being stigmatized and also because of legal restrictions that prohibit providing housing to those with a criminal history (Beckett & Herbert, 2010; Evans & Porter, 2015; Petersilia, 2003).

Neighborhoods, Health, and Food Accessibility

More desirable neighborhoods have more socioeconomic resources and access to institutional resources provides residents opportunities to continuously improve their social position (Jencks & Mayer, 1990; South et al., 2016). Disadvantaged neighborhoods often have fewer institutional resources and are less likely to have accessible healthy food retailers (Larson et al., 2009; Luan, Minaker, & Law, 2016; Morland et al., 2002; Pampel et al., 2010; Walker et al., 2010). Across the United States supermarket access is far less prevalent in black and Hispanic neighborhoods compared to white neighborhoods

(Larson et al., 2009). Similarly, high poverty neighborhoods have significantly less access to supermarkets and grocery stores (Zenk et al., 2005), yet are also more likely to contain accessible fast-food restaurants and other outlets (i.e. convenience stores) that promote an unhealthy diet (Hilmers et al., 2012; Morland et al., 2002). Accordingly, given the disparities in access to healthy and unhealthy foods, it is not entirely surprising that economically disadvantaged neighborhoods tend to have poorer health outcomes including higher rates of obesity net of individual characteristics (Black & Machinko, 2008; Deaton & Lubotsky, 2003; Sallis et al., 2009).

Although a sizeable literature documents disparities in access to healthy food retailers across communities (Walker et al., 2010), the question of why disadvantaged communities have less healthful food retailers, yet greater access to unhealthy food options remains unclear. One possibility is that economic conditions of impoverished areas constrain the ability of supermarkets to enter such communities. Indeed, fresh foods which are more commonly stocked in grocery stores are often more expensive than processed foods and fast-foods (Drewnowski & Darmon, 2005). Fresh foods also spoil more quickly than processed foods. Therefore, low-income residents risk wasting money by purchasing perishable food items (Zachary et al., 2012). For those living in poverty, losing power for a day or purchasing perishable food that their children will not consume could lead to potentially devastating consequences for the household. For instance, Daniel's (2016) study of grocery shopping patterns among low-income households documents that "many low-income respondents minimize economic risk by purchasing what their children liked - often calorie dense, nutrient-poor foods" (p. 38). Processed food also provided more energy density per dollar. Thus, households with limited budgets

may purchase cheap energy-dense foods as a means of reducing both food costs and hunger (Darmon, Briend & Drewnowski, 2004; DiSantis et al., 2013; Drewnowski, 2009; Drewnowski & Specter, 2004; Drewnowski & Eichelsdoerfer, 2010). Drewnowski and Eichelsdoerfer (2010: p. 246) note that when income levels drop, low-income families often further constrain their budget and shift their food choices toward cheaper energy-dense foods rich in starches, refined sugar, and fats, which "represent the cheapest way to fill hungry stomachs." For example, Drewnowski and Specter (2004) calculated the energy content of cookies is 1200 kilocalorie per U.S. dollar, whereas the energy content of carrots is 250 kilocalories per U.S. dollar. Accordingly, economically impoverished areas may lack the demand for grocery stores and supermarkets that typically carry large quantities of fresh food options.

Still, net of socioeconomic characteristics, other factors such as the racial composition of a neighborhood also yield a strong independent influence on the food retail environment. Bower and colleagues (2014) national study of food store availability demonstrates that while increased rates of poverty correspond to diminished access to healthy food, even at equal levels of poverty, black census tracts have the fewest supermarkets, whereas white tracts have the most (see also Morland et al., 2002). Similarly, research also finds that fast-food and carry out restaurants were more common in low-income neighborhoods compared to wealthier neighborhoods and in racially mixed communities compared to predominantly white communities (Morland et al., 2002; Powell et al., 2007). Jou (2017) contends that this relationship may stem from federal subsidies to fast-food restaurants in minority communities. Specifically, starting in the late 1960s, the Small Business Administration (SBA) and Department of Housing

and Urban Development (HUD) enacted measures to provide loan guarantees to open new fast-food restaurants in poor-minority communities as a means to spur entrepreneurship. Following a growth in black-owned and operated businesses, fast-food companies began increasing advertisement in minority communities, further increasing demand for fast-food (Harris et al., 2013; Ohri-Vachaspati et al., 2015). Over time, this strategy has ingrained nutritional preferences toward fast-food options within minority communities and diminished demand for foods typically sold in supermarket and grocery chains.

Alternatively, disparities in food access may also be tied to local crime rates. Specifically, because theft is more common in areas that are economically impoverished and have higher minority populations, higher cost food options that are typically sold at supermarkets become an attractive option. Accordingly, owners of such stores decide not to open in poor neighborhoods or if they choose to open a retail location they increase the price of food to offset any loss from theft. However, doing so puts the cost further out of reach for consumers who may already struggle to afford it (Hendrickson et al., 2006; Larson et al., 2009).

In sum, recent research suggests formerly incarcerated persons often experience declines in neighborhood attainment including an increased risk of moving from non-poor to poor neighborhoods (Massoglia et al., 2013; Warner, 2016). Such a move would correspond to reduction in resources available, including reduced access to nutritious foods. Therefore, I propose that by negatively impacting neighborhood attainment, incarceration will result in living in neighborhoods with less healthful food retailers and more unhealthy food retailers.

Is Food Access Different than Neighborhood Disadvantage?

Much research to date indicates that communities characterized by low socioeconomic status have greater access to unhealthy food retailers and lower levels of access to healthy food retailers (Chung & Myers, 1999; Larson et al., 2009; Morland et al., 2002; Moore & Diez Roux, 2006; Walker et al., 2010). This finding may lead some to conclude that poor food access is incidental to neighborhood disadvantage. However, there are two primary reasons the food retail environment deserves consideration beyond that of a supplementary characteristic of neighborhood disadvantage. For one, understanding of food access goes beyond typical assessments of neighborhood disadvantage, which are often characterized by measures of poverty or low socioeconomic status rather than the actual resources available within communities. According to the deprivation amplification perspective (see Macintyre et al., 1993; Macintyre 2007) household or individual deprivation (i.e. low income) is amplified by area level deprivation (i.e. lack of access of healthy food retailers). In other words, considering access to food retailers beyond that of traditional measures of neighborhood disadvantage (i.e. poverty) is important in order to provide a fuller picture of the mechanisms that influence well-being among disadvantaged segments of the population and to understand how access or lack of access to community resources compound individual levels of advantage or disadvantage (Macintyre, 2007).

Second, while the weight of evidence does suggest that food access is worse in poorer communities, the association between neighborhood economic status and healthy food access does remain somewhat mixed. Research finds wealthier areas often have greater access to supermarkets – which typically offer the greatest variety of healthy food

options. Yet there are often poor communities that have access to healthy food retailers and high-income communities that contain fast-food restaurants or other unhealthy retailers. For instance, Morland and colleagues (2002) finds that while supermarkets are more prevalent in high-income areas, these areas also have increased access to convenience stores that sell disproportionate amounts of unhealthy food options. Similarly, other studies find that high-income areas have greater access to chain supermarkets but lower access to grocery stores and non-chain supermarkets, which offer a lower diversity of food options but still are still considered healthy food retailers (Chung & Meyers, 1999; Lamichhane et al., 2014; Mercille et al., 2012; Powell et al., 2007). Grocery stores in lower-income communities are also found to offer lower priced, although also lower quality fresh food items than larger supermarkets in higher-income communities (Block & Kouba, 2006). Analysis of food availability in Los Angeles finds fresh fruits and vegetables are less accessible in low-income communities, however, availability of fresh meat, seafood, and poultry was similar across all neighborhoods regardless of income levels (Sloane et al., 2003). Finally, unhealthy food retailers (i.e. fast-food outlets) are also not always concentrated in poor neighborhoods but are often concentrated in areas of heavy commuting such as near central business districts, large retail shopping centers, and along arterial roads (Macintyre, 2007).

Food Access and Food Insecurity

Food insecurity and food access are distinct, yet interrelated concepts. Food insecurity is a household level economic and social condition related to being unable to meet basic nutritional needs. Food access is a community level condition related to

geographic access to food retailers. Still, both are forms of nutritional hardships and the presence of food retailers (either healthy or unhealthy) in a community is an environmental condition that makes the consumption of healthy or unhealthy food easier and therefore should influence diet, health outcomes, as well as the likelihood of being food insecure. For instance, a study of residents in Philadelphia found those who reported very difficult (compared to fair, good, or excellent) access to fruits, vegetables, and food stores was related to an increased risk of food insecurity. Yet, most food insecure individuals reported having good food store access (Mayers et al., 2014). Ma and colleagues (2016) report lower perceived access to food retailers is associated with increased likelihood of food insecurity. However, this study found no relationships between objective geographic access to food retailers and food security status. Finally, Perez and colleagues (2017) find difficulties accessing food retailers due to distance or transportation constraints is associated with food insecurity. Yet, other studies find no relationship between the proximity to food retailer and food security status (Kirkpatrick & Tarasuk, 2010; Sadler et al., 2013) and at least one study finds that food insecure individuals in Canada had greater access to nutritious food retailers and grocery stores relative to food secure residents (Carter et al., 2012).

A reason why individuals with good access to food retailers may still have high levels of food insecurity is that preferences for certain foods and dietary habits, which render improved access to healthful foods less meaningful. For instance, Cummins and colleagues (2014) assessed the impact of adding a new supermarket to a community considered a "food desert" in Philadelphia. The findings revealed that while the addition of the supermarket increased residents' perceptions of food accessibility there was no

change in fruit and vegetable intake or body mass index. Similarly, research from Glasgow, Scotland found the addition of a large chain supermarket in a poor neighborhood that did not change shopping patterns of local residents who continued to prefer small local shops (Cummins et al., 2008). Accordingly, these findings suggest that preference for existing food stores may serve as a barrier that diminishes the beneficial impact of increasing healthful food access in neighborhoods (Cummins et al., 2008, 2014).

Still, much of this research takes place in a single community (for exception see Denny et al., 2017). Thus, it is not entirely clear if in a nationally representative sample food access would influence food insecurity status. Moreover, because formerly incarcerated individuals increase their consumption of fast-food after release from incarceration (Porter, 2014), it is possible that the presence of fast-food outlets could provide some benefit in reducing food insecurity. Accordingly, I suggest the composition of available food retailers – both healthy and unhealthy - at the neighborhood level will partially mediate the relationship between incarceration and food insecurity.

Food Availability, Food Insecurity, and Health

Nutritious food is a fundamental aspect to good health (Jacobs & Tapsell, 2007) and diet quality has been linked to reduced likelihood of chronic diseases including cardiovascular disease and cancer, as well as reductions in mortality risk (McCullough et al., 2002; Reedy et al., 2014). Indeed, the connection between food and health has been so long established that over two millennia ago the Greek physician Hippocrates famously opined “let food be thy medicine and medicine be thy food.” Unfortunately,

present-day access to quality food is not equally distributed. To be sure, there is a social gradient to dietary quality, and individuals from a lower socioeconomic background typically consume less fresh fruit and vegetables (Turrell et al., 2002) and have lower quality diets (Darmon & Drewnowski, 2008). Given that healthier diets cost more than unhealthy ones (Rao et al., 2013), some contend that disparities in both dietary quality and health may stem from the high cost of healthy eating and lack of access to healthy foods in lower income areas (Darmon & Drewnowski, 2008).

While numerous factors influence both dietary patterns and overall health, not having enough food to eat (i.e. food insecurity) and living in areas that lack access to healthful foods harm overall health and well-being (Larson et al., 2009; Olson, 1999; Stuff et al., 2004). Indeed, it has long been documented that the presence of food retail outlets within communities influences residential dietary behavior (Diez-Roux et al., 1997; Morland et al., 2002) and that people tend to make choices on what to eat based on which food outlets are available in their immediate environment (Furey et al., 2001). A consequence of having poor access to healthy food retailers is that residents of these communities are overly exposed to energy-dense foods that are most commonly sold at fast-food restaurants and convenience stores (Drewnowski & Specter, 2004). Indeed, nutrition researchers document that diets filled with energy dense and processed foods, which contain high levels of fat, sugar, and sodium lead to poorer health outcomes relative to diets composed of fresh foods, including fresh fruits and vegetables, complex carbohydrates, and foods rich in fiber (Block et al., 2004; Swinburn et al., 2004).

Similarly, a long literature consistently finds evidence that food insecurity status is negatively related to health (see Gundersen & Ziliak, 2015). Food insecurity is

associated with reduced nutrient intake in adults, which can create problems for general health and well-being (Gundersen et al., 2011; Kirkpatrick & Tarasuk, 2008). Moreover, aside from depleting individuals of important nutrients, food insecurity is also a stressor which carries negative implications for health (Laraia et al., 205; Liu et al., 2014; Pearlin, 1989). According to a biological stress model, when individuals are not able to obtain sufficient food they experience stress responses that result in the body releasing hormones such as cortisol. In turn, cortisol production is harmful as it increases the body's production of glucose (sugar) in the bloodstream and restricts the functioning of nonessential biological systems such as the immune, digestive, and reproductive systems (Farrell & Simpson, 2017; Melmed et al., 2015). Accordingly, when individuals are food insecure for sustained periods of time their body undergoes a variety of stress responses that are harmful to health. Thus, it is not surprising that food insecure adults are often in worse health than their non-food insecure counter parts (Stuff et al., 2004; Vozoris & Tarasuk, 2003), and are more likely to experience stress related problems such as depression (Casey et al., 2004; Whitaker et al., 2006), hypertension (Stuff et al., 2004), and poor sleep outcomes (Ding et al., 2015). Accordingly, based on the research discussed above, I expect the prevalence of healthy food retailers and food security status will partially mediate the association between incarceration and physical health outcomes.

Food Availability, Food Insecurity, and Nutrition

Individuals of lower socioeconomic status typically have lower quality health behaviors, such as poor diet (Pampel et al., 2010). There is limited research on post-

release nutritional behavior among formerly incarcerated individuals, although existing work suggest former inmates have lower quality diet marked by increased consumption of fast-food (Porter, 2014). Moreover, nutritional hardships including both food insecurity and low access to healthy food retailers are associated with lower quality diets including less consumption of healthy food items such as fresh fruits and vegetables and increased consumption of unhealthy foods such as fast-food items (Bhattcharya et al., 2004; Bodor et al., 2007; Larson et al., 2009; Morland et al., 2002; Park & Eicher-Miller, 2014).

Individuals who are food insecure are likely to have limited economic resources to purchase food. Accordingly, food insecure persons are more likely to opt for unhealthy food options which are cheaper and provide a higher calorie to dollar ratio than healthy food options (Drewnowski & Specter, 2004). Similarly, a diet of processed, packaged food items, or fast-food items can be appealing among those with tight budgets as such non-perishable foods will not spoil quickly or because of an expected event such as a power outage. Finally, because food insecurity is a stressor, food insecure adults may consume less healthy foods during times of stress, which tend to be highly palatable as a coping mechanism (Leung et al., 2014).

Similarly, research on food environments suggest that residents' dietary behavior can be shaped by access to local food retailers. Importantly, this research suggests that residents with better access to food retailers such as supermarkets and grocery stores tend to consume healthier diets (Larson et al., 2009), whereas those with a greater availability of unhealthy food outlets such as fast-food restaurants and convenience stores tend to consume less healthy diets (Boone-Heinonen et al., 2011; Moore et al., 2009).

Accordingly, because unhealthy food items tend to be lower cost and since formerly incarcerated individuals may reside in areas with lower access to healthy food retailers relative to unhealthy food retailers, then nutritional hardships may in part explain any association between incarceration and nutritional behavior. Therefore, I propose that prevalence of healthy food retailers and food security status will partially mediate the association between incarceration and poor nutrition including fast-food consumption and sugary beverage consumption.

Summary

In summary, this chapter proposes that incarceration can lead to increased likelihood of food insecurity through a variety of pathways including declines in socioeconomic status, physical functioning and mental health, social ties, social welfare, and social standing. Additionally, I propose that incarceration can lead to declines in access to healthy food retailers primarily through declines in neighborhood attainment. In turn, these forms of nutritional hardship can lead to health problems such as being overweight or reporting poor health, and to poor nutrition including increased consumption of fast-food and sugary beverages. Table 3.1 provides a summary of research predictions proposed in this dissertation.

Table 3.1: Summary of Research Questions and Hypotheses

Q1. What is the relationship between incarceration and food insecurity?

H1. Formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to be food insecure.

Q2. Does the food retail environment mediate some of the relationship between incarceration and food insecurity?

H2. The proportion of food retailers in a tract that are healthy will partially mediate the relationship between incarceration and food insecurity.

Q3. Do consequences of incarceration mediate the relationship between incarceration and food insecurity.

H3a. The association between incarceration and food insecurity is mediated by socioeconomic status.

H3b. The association between incarceration and food insecurity is mediated by social ties.

H3c. The association between incarceration and food insecurity is mediated by social welfare.

H3d. The association between incarceration and food insecurity is mediated by physical disability.

H3e. The association between incarceration and food insecurity is mediated by psychological well-being.

H3f. The association between incarceration and food insecurity is mediated by social standing.

Q4. What is the relationship between incarceration and access to food retailers?

H4. Formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to live in census tracts with lower access to healthful food retailers.

Q5. Do consequences of incarceration mediate the relationship between incarceration and access to healthy food retailers

H5a. The association between incarceration and access to food retailers is mediated by neighborhood disadvantage.

H5b. The association between incarceration and access to food retailers is mediated by socioeconomic status.

Q6. Does the food retail environment and food security status explain some of the relationship between incarceration and (1) health, (2) nutrition?

H6a. The association between incarceration and poor nutrition is mediated by food insecurity.

H6b. The association between incarceration and poor nutrition is mediated by proportion of food retailers in a tract that are healthy.

H6c. The association between incarceration and poor health is mediated by food insecurity.

H6d. The association between incarceration and poor health is mediated by proportion of food retailers in a tract that are healthy.

Note: The general terms "poor health" and "poor nutrition" used in the hypotheses refer to specific variables discussed in chapter 4. Specifically, poor nutrition refers to the weekly consumption of fast-food and sugary beverages. Poor health encompasses healthy weight measured by waist-to-height-ratio and subjective health status.

CHAPTER 4: DATA AND METHODS

Data Overview

Two sources of data are used to test the hypotheses proposed in chapter 3. First, the primary source of data come from the National Longitudinal Study of Adolescent to Adult Health (Add Health). Second, food retail data are obtained from the Modified Retail Food Environment Index (mRFEI), which are publically available data collected by the Centers for Disease Control (CDC) Division of Nutrition, Physical Activity and Obesity. Data on the food retail environment are measured at the census tract level and are linked with census tract indicators of residence from Add Health data.

Data Sources

The National Longitudinal Study of Adolescent to Adult Health

The National Longitudinal Study of Adolescent to Adult Health is a nationally representative survey of adolescents enrolled in grades 7-12 in the United States during the 1993-94 academic year. The study design initially surveyed 90,000 students at 132 schools at Wave I. Following the initial survey, approximately 20,000 individuals were chosen for in-home interviews, covering a variety of topics regarding the respondents' health, education, family, delinquency, and other behaviors of interest (Harris et al., 2009). Since the initial survey, three follow-up surveys have been conducted: Wave II administered in 1996, Wave III administered in 2001-2002, and Wave IV conducted in 2007-2008. At the most recent interview respondents were between 24 and 32 years old. At wave IV, several key questions were asked of respondents, including a series of questions about contact with the criminal justice system and food security status.

Respondents' census tract of residence was also recorded at wave IV. Additionally, respondents were asked questions at wave IV and earlier waves about their health, delinquent behavior, employment, romantic partnerships, and other relevant questions regarding their personal life. At present Add Health data have been used in several studies to investigate the consequences of incarceration on outcomes such as health and health behaviors (Esposito et al., 2017; Porter, 2014; Porter & Novisky, 2017; Testa & Porter, 2017), divorce (Siennick, Stewart, & Staff, 2014), financial sufficiency (Siennick & Widdowson, 2017), and reducing institutional attachment (Brayne, 2014).

Finally, because reasonable distances to food retailers in non-urban areas is larger than the half mile radius from a census tract boundary that this dissertation uses, the analysis is restricted to urban areas (Dean & Sharkey, 2011b; Gordon-Larsen, 2014; Sharkey, 2009; Smith et al., 2010; Ver Pleog et al., 2009). Urban areas are identified using the Urban-Rural Community Area code (RUCA) measured at the census tract level.[24] This measure classifies whether the respondent lives in a census tract defined as a *metropolitan area, micropolitan area* (i.e. large rural city/town)*, small town,* or *rural area*.[25] Accordingly, the analysis is restricted to those who reside in metropolitan areas (81% of the sample).

For the purposes of this study, the Add Health data offer several benefits. First, the Add Health data provides a large nationally representative sample of individuals in

[24] RUCA codes are a national-wide sub-county classification system that applies metropolitan and adjacent-to-metropolitan concepts to the census tract level (Wunderlich, 2015).

[25] Metropolitan areas are census tract equivalents of urbanized areas with 50,000 or more people. Micropolitian are tract equivalents of areas with 10,000 – 49,000 people. Small towns are tract equivalents of areas including 2,500 – 9,999 people. Rural areas are tract equivalents of areas that have less than 2,500 people (Wunderlich, 2015).

the age range that is most prone to incarceration (i.e. adolescence to early adulthood). Second, these data contain a rich set of measures on economic, social, psychological, health, and nutritional related factors over multiple points in time. The large set of measures captured by the survey enables researchers to adjust for a range of confounders to provide more accurate estimations of the outcomes of interest. Finally, wave IV of the Add Health study is measured at the same time as the collection of data for the mRFEI. Therefore, this makes Add Health one of the only available datasets that contain information on incarceration and other relevant measures, which can also be merged with information on the local food retail environment from the mRFEI dataset. Accordingly, for these reasons Add Health data are particularly well suited for testing the research questions posed in this dissertation.

The Modified Retail Food Environment Index

The Centers for Disease Control (CDC) Division of Nutrition, Physical Activity and Obesity obtained data for the Modified Retail Food Environment Index (mRFEI) in 2008-2009. The mRFEI score represents the percentage of retailers that sell healthy food relative to unhealthy food retailers in a census tract and the 0.5 mile buffer around the census tract. The purpose of the mRFEI is to create a single measure that captures the ratio of healthy and unhealthy food retailers in a given geographic area (see CDC, 2011).

Food retailers are defined in correspondence with the North American Industry Classification System (NAICS). At the time of data collection there were over one million food retailers across the country included in the study. Healthy food retailers are defined as supermarkets (NAICS 445100), larger grocery stores (NAICS 445100), fruit

and vegetable markets (NAICS 445230)[26], and warehouse clubs (NAICS 452910). Data on the healthy food retailers were obtained by the CDC from the InfoUSA business database, 2009. Less healthy food retailers include fast-food restaurants (NAICS 722211), small grocery stores (NAICS 44511), and convenience stores (NAICS 445120). Convenience store data were obtained from the Homeland Security Information Program Database, 2008. Small grocery and fast-food restaurant data were obtained from the NavTeq database, 2009. Table 4.1 provides further information regarding the classifications of retailers in the mRFEI.

The mRFEI score was collected for 65,345 U.S. census tracts and was matched to a nationally representative sample of 15,696 census tracts at wave IV of the Add Health data through the ancillary studies in Add Health program.[27] The mRFEI is scored on a scale of 0 – 100 and is calculated as follows:

$$mRFEI = 100\ x\ \frac{\#\ Healthy\ Food\ Retailers}{\#\ Healthy\ Food\ Retailers + \#\ Less\ Healthy\ Food\ Retailers}$$

Accordingly, the mRFEI score represents the percentage of food retailers in a given area that sell healthy food options. For instance, a score of 10 means that 10 percent of all food retailers within a specific geographic area are healthy. Therefore, lower scores indicate that a given area has more unhealthy food retailers than healthy food retailers.

[26] Fruit and vegetable markets include retailers that sell produce and also include permeant produce stands.

[27] The original mRFEI file of 65,345 census tracts linked at a 100 percent match rate to the 15,696 census tracts available in wave IV of the Add Health data. A t-test revealed there is no statistically significant difference in the mean value mRFEI scores for food retailers in census tracts included in wave IV of Add Health and those not included in wave IV of Add Heath.

The mRFEI is a particularly useful measure of the food retail environment because it provides the ratio of geographic access to healthy food outlets (i.e. supermarkets, large grocery stores) relative to unhealthy food (i.e. fast-food, convenience stores). The use of healthy-to-unhealthy food ratios is an improvement over prior measurements (i.e. density of supermarkets) because healthy and less healthy food outlets can be positively correlated within geographical units (Mason, Bentley & Kavanah, 2013). Accordingly, neighborhood food environments are more complex than just considering how many healthy or unhealthy food retailers are within a geographic area, as there are areas with high densities of healthy and unhealthy food options, both of which influence dietary patterns of residents. Indeed, recent research also suggests measures of relative healthy food access provide a better measure of food purchasing and consumption behaviors compared to measures of absolute densities of healthy or unhealthy food outlets (Clary et al., 2015; Mason et al., 2013). While measures used by prior research often focus on only a single dimension of complex food environments (Luan, Minaker & Law, 2016), the use of indices that capture the ratio of healthy to unhealthy foods is an innovative approach that enables a more complete picture of local food environment and a better understanding of how inequities in the distribution of food access impact the nutritional choices, as well as the health and well-being of residents in these areas (Walker et al., 2010).

To date, the mRFEI has been used in a number of studies assessing the effects of food retail environments on nutritional and health outcomes (Greer et al., 2014; Koh, Grady, & Vojnovic, 2015; Luan, Law & Quick, 2015; Salinas et al., 2014; Salinas & Sexton, 2014; Weintraub et al., 2016). However, this dissertation is the first study to

assess whether formerly incarcerated persons reside in areas with less nutritional access, and whether healthy food access explains some of the relationship between incarceration and health outcomes.

Measures

Dependent Variables

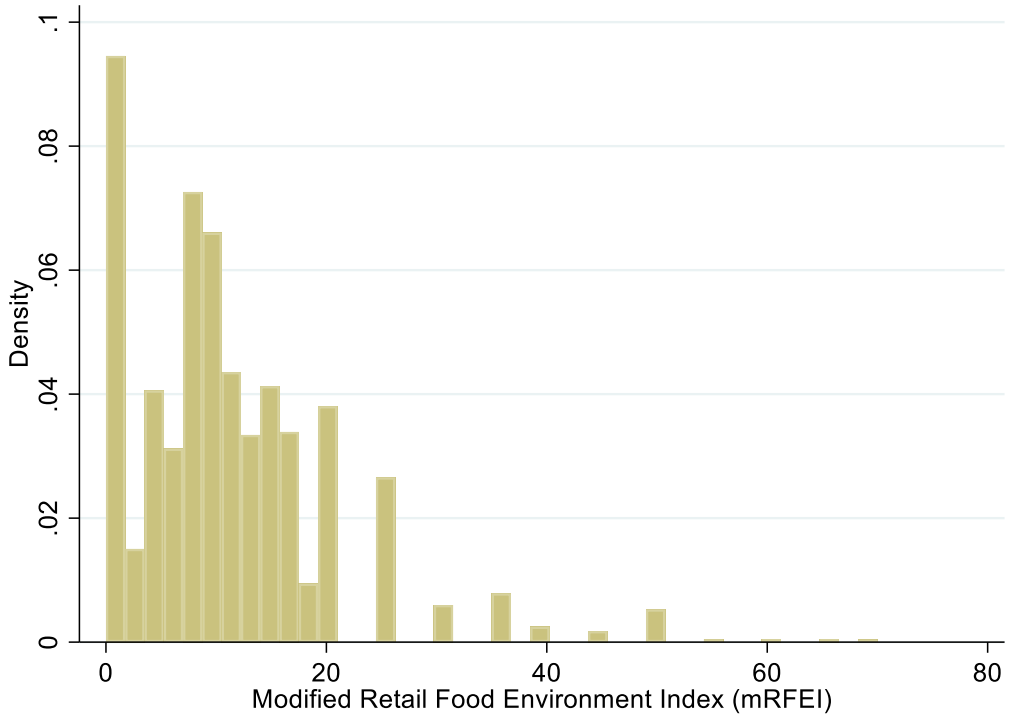
a. *Food Insecurity and Modified Retail Food Environment Index*

This dissertation uses two measures of nutritional hardship: (1) food insecurity; (2) modified food retail environment index (mRFEI). *Food insecurity* is measured as a dichotomous indicator at the wave IV interview. Participants responded yes or no to the following question: "In the past 12 months, was there a time when (you/your household) (were/was) worried whether food would run out before you would get money to buy more?" This question is the first item of the 18-item US Household Food Security Scale. A positive response indicates that individuals are either marginally food secure or food insecure (Gooding et al., 2012; Gundersen & Ziliak, 2015). Over 99% of the Add Health participants responded to this question.

Second, the *mRFEI score* is used to assess the likelihood of formerly incarcerated individuals living in areas with low access to healthy food retailers. Each point on the mRFEI scale represents the percentage of retailers within a census-tract classified as a healthy food retailer. Potential values range from 0 – 70 and the average value is 11.4, indicating that on average about 11 percent of retailers meet the definition of healthy food

retailers.[28] Approximately 23.2 percent of census tracts have a mRFEI score of 0. The distribution of the mRFEI score appears below in Figure 4.1. Consistent with prior research low access to healthy food retailers is defined as a score of less than 10, which is below the national average (CDC, 2011; Koh et al., 2015).

Figure 4.1: Histogram of mRFEI score



b. Health Outcomes

Next, for the analysis that assesses whether food insecurity or access to healthy food retailers mediates the association between incarceration and health, I use two measures of health: (1) subjective health status, and (2) waist-to-height ratio. First, a scale

[28] The original mRFEI scale ranges from 0 – 100. However, to minimize the identification of respondents, the Add Health Ancillary project top-coded the data at the 99th percentile (mRFEI = 70).

of *subjective health status* is reported at wave IV. Individuals were asked on a scale of 1-5 "in general, how is your health?" Responses include poor, fair, good, very good, and excellent. Prior work finds self-reported health to be a robust predictor of adverse health outcomes such as mortality (Benyamini & Idler, 1999; DeSalvo et al., 2006; Idler & Benyamini, 1997). Moreover, as exposure to health information has increased across the population, self-reported health has become an even stronger predictor in contemporary surveys than in the past (Schnittker & Bacak, 2014).

Waist-to-height ratio (WTHR) measures the waist circumference in centimeters divided by the height in centimeters. In a comparison against other screening tools, waist-to-height ratio is found to be the most accurate measurement of whole-body fat percentage and visceral adipose tissues (VAT) mass.[29] Additionally, other research finds WTHR to be the better predictor than BMI of outcomes such as hypertension, diabetes, dyslipidemia, and mortality (Ashwell, Gunn, & Gibson., 2012; Ashwell et al., 2014; Browning, Hsieh, & Ashwell, 2010; Lee et al., 2008). I follow prior research showing that having a WTHR above 0.5 is a risk factor for adverse health conditions and I create a dichotomous variable where 0 are individuals with a WTHR below 0.5 and 1 are those at or above this range (Ashwell & Hsieh, 2005; Browning et al., 2010).

c. Diet

I also conduct an analysis assessing whether food insecurity and access to healthy food retailers mediates the relationship between incarceration and diet. I include a

[29] VAT measures the amount of fat stored around the abdominal region, which is strongly related to several chronic medical conditions (Shuster et al., 2012).

measure of fast-food consumption as a dependent variable. *Fast-food consumption* is measured at wave IV with the following question: "How many times in the past seven days did you eat food from a fast-food restaurant, such as McDonald's, Burger King, Wendy's, Arby's, Pizza Hut, Taco Bell, or Kentucky Fried Chicken or a local fast-food restaurant?" While prior research finds that formerly incarcerated individuals consume higher amounts of fast-food (Porter, 2014), I assess nutritional hardships mediates part of the relationship between incarceration and fast-food consumption. *Sugar consumption* is measured at wave IV using the following question: "In the past 7 days, how many regular (non-diet) sweetened drinks did you have? Include regular soda, juice drinks, sweetened tea or coffee, energy drinks, flavored water, or other sweetened drinks."

Independent Variables

Prior incarceration is measured by the following question asked to respondents at Wave IV: "Have you ever spent time in jail, prison, juvenile detention center, or other correctional facility?" Further, respondents are asked how old they were at the first or only time of incarceration. Therefore, prior incarcerations will be limited to those occurring at age 18 or older. In order to reduce unobserved heterogeneity between those who have been incarcerated and those who have not, I generate comparison categories using a series of dichotomous measures that indicate whether a respondent had contact with the criminal justice system but was never incarcerated (Apel & Sweeten, 2010a; Brayne, 2014; Porter, 2014). *Arrested only* are individuals who reported having an arrest but were never convicted. *Convicted only* are individuals who reported having a criminal conviction but were never incarcerated. *No criminal justice contact* are individuals who

reported having no prior contact with the criminal justice system at any point (i.e. no arrest, conviction or incarceration).

Control Variables

The current study controls for several characteristics that may confound the relationship between incarceration and the outcomes of interest. Add Health provides a rich set of covariates measured at multiple waves. This study controls for demographic background characteristics including *age, race,* and *sex.* Age is coded as a continuous measure of the respondents age at wave IV. At this point all respondents were between the ages of 24 and 32. Race is coded as a series of dichotomous measures indicating whether the respondent identified as white, black, Hispanic, or other race. Sex is coded as a binary indicator where 1 equals male and 0 equals female. Moreover, because parents often shield their children from food insecurity therefore putting themselves at greater risk of being food insecure (McIntyre et al., 2003; Nord, 2013; Radimer et al., 1990), I control for those living with a biological child. *Child in home* is *measured* as a binary indicator to capture respondents with a child currently residing in their household. Child in home is measured by the following question asked to all respondents who identified having a biological child: does {child name} live with you? In total, 86% of respondents who have a biological child answered affirmatively to this question.

Additionally, I control for a series of measures related to the respondents' achievements and background. *High school degree* is a binary variable indicating whether or not the respondent completed high school by wave IV. *Child abuse victim* measures whether a respondent reported being hit with a fist, kicked, thrown down to the

floor, into a wall or down the stairs by a parent or adult caregiver before their 18th birthday. I include a scale for delinquency at wave I measured by involvement in vandalism, shoplifting, theft, burglary, fighting, selling drugs, robbery, and assaulting someone with a weapon. I also include a dichotomous measure for whether the respondent reported any *hard drug use* (i.e. drug use besides marijuana). *Prior healthy diet* measures the number of times a respondent ate fruit or vegetables the day before their wave I interview. *Depression* is measured at wave I based on responses to 11 questions (see Table 4.2). *Fatalism* is measured at wave I and captures respondent's perceived likelihood of living to age 35. *Food stamps* is a dichotomous indicator of whether a respondent's household received food stamps in the month prior to the interview at wave I. Because access to food retailers may be related to community disadvantage, I include a measure of *concentrated disadvantage* from wave I. Concentrated disadvantage is generated using a standardized scale that captures the proportion of residents within a respondent's census tract that are on welfare, living at or below the poverty line, are unemployed, and the proportion of female headed households (see Porter & Vogel, 2014).

I also included a series of variables that are specific to models estimating health outcomes. These models include a measure of *subjective health status* from wave I (1 = excellent, 5 = poor). *Physical activity* is measured at wave I and wave IV and measures the number of times in the previous week a respondent engaged in a variety of physical activities. *Hours of television* is measured at both wave I and wave IV and captures the number of hours a respondent reported watching television in the past week.

Mediating Variables

In chapter 3 I identified a number of mechanisms that may explain why incarceration is linked to food insecurity and poor access to healthy food retailers. To assess these relationships, I include the following mediating variables measured at wave IV. *Concentrated disadvantage* is scale of the proportion of individuals in a census tract on welfare, below the poverty line, unemployment and proportion of female headed households at wave IV. I include a series of measures for economic hardship including *income* and *employment status*. *Adjusted household income* is measured by adjusting household income levels for the number of respondents living in a household. First, household income is measured using the following question: "Thinking about your income and the income of everyone who lives in your household and contributes to the household budget, what was the total household income before taxes and deductions in {2006/2007/2008}? Include all sources of income, including non-legal sources." Income levels are reported in $5,000 intervals ranging from less than $5,000 to $150,000 or more. Following prior research, I coded household income using the mid-point of each response (Gooding et al., 2012). Next, adjusted household income is calculated using the equivalence of scale method (Garner, Ruiz-Castillo & Sastre, 2003; Short, Garner, Johnson & Doyle, 1999) defined as follows: Adjusted Household Income = Household Income / (Household Size)^{N}. Where *N* is defined as some number between 0 and 1. Following a common procedure (see Johnson, Smeeding & Torrey, 2005; Taylor et al., 2011) this study uses defines N = 0.5. Accordingly, this means that household income is

divided by the square root of household size.[30] *Employment status* is measured as a binary indictor of whether the respondent was currently employed at wave IV.

Next, I include a measure of public assistance benefits, as previous research suggests they may be beneficial in reducing food insecurity (see Bartfeld et al., 2015; Gundersen et al., 2017). *Public assistance* is measured using the following item: "between {1995/2002} and {2006/2007/2008}, did you or others in your household receive any public assistance, welfare payments, or food stamps?" Overall, 24.3 percent of individuals responded affirmatively to having receive welfare benefits.

Next, I include measures of social ties which are measured by the following variables: *close friends, married, perceived isolation, and parental financial support. Close friends* is measured using the following question: "how many close friends do you have?"[31] This measure is coded using a scale indicting the respondent had the following number of close friends: none, 1 to 2, 3 to 5, 6 to 9, 10 or more. *Married* is a binary indicator if the respondent was currently married at wave IV. *Perceived isolation* is measured by a question asking: "how often do you feel isolated from others?" The responses are coded on a scale ranging from never, rarely, sometimes, or often. *Parental financial support* measures whether a respondent's parents gave $50 or to pay living expenses at wave IV.

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[30] One common approach is to divide the total household income by the number of individuals living in a house. However, this method fails to account for the fact that there are economies of scale in multimember households that often reduce the cost of living. For instance, a two-bedroom apartment does not cost twice as much as a one-bedroom apartment. Similarly, multimember households may save costs by sharing a car or carpooling. To account for this research uses the method of equivalence scales described in the text above.

[31] Close friends are considered people whom you feel at ease with, can talk to about private matters, and can call on for help

I also include mediators for psychological well-being and physical disability. *Depression* is measured by asking respondents whether they felt depressed in the past seven days. Responses include: never or rarely, sometimes, a lot of the time, or most of the time. *Perceived stress* is a standardized scale constructed from the following four items indicating how often in the past 30 days the respondent felt the following: (1) unable to control the important things in life, (2) confident in ability to handle personal problems (reverse coded), (3) things were going your away (reverse coded), and (4) difficulties were piling up so high that they could not be overcome. *Physical disability* is measured using a binary indicator of whether a person has suffered a serious injury or a disability. This indictor includes an affirmative response to the question of "In the past 12 months, have you suffered any serious injuries? For example, broken bones, cuts or lacerations, burns, torn muscles, tendons or ligaments, or other injuries that interfered with your ability to perform daily tasks." Additionally, I include those who reported being unable to work because of a temporary or permanent disability. Table 4.2 includes a detailed description of all variables included in the study.

Finally, to capture stigma, a measure of *social standing* is included. Respondents are asked to rank where they stand relative to others in terms of money, education, and job respectability on a scale from 1-10. Prior research finds contact with the criminal justice system reduces one's subjective social standing (Schnittker & Bacak, 2013).

Analytic Strategy

Challenges to Estimating the Consequences of Incarceration

Estimating the effect of incarceration on post-release outcomes using observational data faces a number of methodological challenges (Kirk & Wakefield, 2018; Massoglia & Warner, 2011; Schnittker & John, 2007; Wildeman & Muller, 2012). The primary difficulty derives from the background characteristics of inmates. Specifically, individuals who come into contact with the criminal justice system typically have low social and human capital, disadvantaged socioeconomic status, poor mental and physical health, weak social ties, and a history of deviant behavior including involvement in crime and drug use (Wakefield & Uggen, 2010). Accordingly, it is difficult to disentangle the influence of incarceration from these pre-existing characteristics that make a given person vulnerable to adverse outcomes such as material hardship and poor health. As Wildeman and Muller (2012: p. 14) note: "concerns about selection bias suffuse social science, but they are particularly acute in this area, where there are strong theoretical and empirical reasons to believe that any effect of incarceration is solely attributable to negative endowments that increased an individual's likelihood of incarceration in the first place."

Prior research has used a variety of techniques with the aim of isolating the influence of incarceration in observational data. The most common approach is to adjust for covariates using multivariate regression. Studies on the consequences of incarceration typically adjust for a host of observable measures related to demographic background characteristics such as race and gender and other relevant characteristics such as education levels, employment and earnings, prior crime and drug use, and self-control

among others. However, this approach faces several limitations. For one, multivariate regression analyses are most suitable when correcting for small between-group differences (Murnane & Willett, 2010; Ridgeway, 2006). However, because those who experience incarceration and those who do not often differ greatly on a number of characteristics it is unclear whether the control for observables approach can fully account for the differences between these two groups. As Murnane and Willett (2010: p. 308) point out, this strategy of direct control of covariates may be flawed if "participants who do not have common support across all covariates have been included in the estimate." To overcome these between group differences, some recent research aims uses strategic comparison groups. For instance, Massoglia and colleagues (2011) assess whether the relationship between incarceration and divorce is the result of stigma or physical separation by comparing formerly incarcerated individuals to deployed military personnel. Other research compares formerly incarcerated individuals with persons who have had prior contact with the criminal justice system, although were not incarcerated (Apel & Sweeten, 2010a; Brayne, 2014; Porter, 2014).

Moreover, adjusting for observable covariates is unable to account for unobservable characteristics that are often not included in observational datasets. Even with the most detailed data currently available, the threat of omitted variable bias still remains a strong possibility. To overcome this limitation, some research uses data with repeated observations overtime and employs a fixed-effects approach that uses each individual as his or her own control and holds all time invariant characteristics constant (Massoglia et al., 2013; Schnittker & John, 2007; Sugie & Turney, 2017; Western, 2002). While assessing within person change is among the strongest approaches available for

estimating the causal effect of incarceration (Massoglia & Warner, 2011; Wildeman & Muller, 2012), many datasets including Add Health are not well-suited for fixed-effects because measurement and the collection of certain items change across waves (Porter & King, 2015).

A third approach to address selection bias is through the use of a propensity score matching (PSM; Rosenbaum & Rubin, 1983). The logic of using propensity score matching is to attempt to overcome the issues of selection bias by generating equivalence across key covariates that account for differences in the outcome of interest. Propensity score matching has become an increasingly common approach in criminological research generally (Apel & Sweeten, 2010b; Loughran et al., 2015; Shadish, 2013), as well as studies estimating the impact of incarceration on a variety of outcomes (Brayne, 2014; Massoglia, 2008; Porter, 2014; Turney, 2015). PSM offers several benefits over that of standard multivariate regression. For one, researchers can verify balance among observable covariates, rather than assuming this has occurred. Additionally, PSM can use a large number of covariates to create balance without raising issues of multicollinearity (Loughran et al., 2015). Moreover, as a non-parametric estimation strategy, it does not rely on rigid assumptions about functional forms (Brayne, 2014; Rosenbaum & Rubin, 1983; Winship & Morgan, 1999)

Methods

Given the challenges estimating the direct relationship between incarceration and the nutritional hardships of interest, I employ the following strategies. First, I use multivariate regression analysis and control for key demographic, social, and behavioral

characteristics that are related to contact with the criminal justice system, nutritional hardship, and health outcomes. Add Health is particularly well-suited for this approach as it contains a rich set of behavioral and health related measures (Brayne, 2014; Esposito et al., 2017). In order to reduce the "distance" between reference categories, I employ a similar strategy to prior research and compare formerly incarcerated individuals to those who have been previously arrested but not convicted (i.e. arrested only) and those who have been convicted but not incarcerated (i.e. convicted only). Using this strategic comparison group will help reduce any unobserved heterogeneity between comparison groups (Apel & Sweeten, 2010a; Porter, 2014).

For binary outcomes (i.e. food insecurity, low access to healthy food retailers, waist-to-height ratio) I use logistic regression. For count variables (fast-food consumption; sugary beverage consumption; subjective health status) I use negative binomial regression. All estimates use survey weights to account for the multistage cluster design. As a robustness test I also estimate the association between incarceration and nutritional hardships using propensity score matching (PSM). A description of PSM and the results are reported in Appendix F.

Next, in order to examine the indirect effects of incarceration on nutritional hardships and other outcomes of interest I perform mediation analysis for non-linear models (Karlson, Holm & Breen, 2012). The purpose of this stage of the analysis will be to test the total effect of a given outcome variable that is mediated by a given intervening variable. While estimating indirect effects using linear regression models is straightforward, comparing direct and indirect effects in nonlinear probability models is considerably more difficult (Mood, 2010; Winship & Mare, 1984). Specifically, in non-

linear models comparing the change in coefficients across models is challenging because there is a rescaling of the model that occurs whenever a mediator that has an independent effect on the dependent variable is added to a model, whether or not an individual mediator is correlated with other independent variables in the model (Kohler, Karlson, & Holm, 2011).[32] In order to account for the independent effects of multiple mediators, the current study uses KHB method (Karlson, Holm & Breen, 2012; Kohler, Karlson, & Holm, 2011). The benefit of the KHB method is that it accounts for rescaling that occurs when additional variables are included in a model and enables a decomposition of direct and indirect effects of specific mediator variables in both linear and nonlinear probability models (Breen, Karlson, & Holm, 2013; Karlson & Holm, 2011). Moreover, the KHB method indicates whether the change in the incarceration coefficient in a full model that includes mediators and the reference model without mediators is statistically significant. Given that the hypotheses propose that multiple mediators may influence the relationship between incarceration and nutritional hardships, the KHB method is particularly useful as it can decompose the indirect effects of each mediator (Kohler, Karlson, & Holm, 2011).[33]

[32] As Kohler et al., (2011: p. 421) note: "The inclusion of the mediator variable *Z* in a nonlinear probability model will alter the coefficient of *X* regardless of whether *Z* is correlated with *X;* it is a sufficient condition that *Z* is correlated with *Y*.

[33] For recent criminological applications of the KHB method to test mediation in nonlinear probability models see Haskin and Jacobsen (2017) and Widdowson, Siennick, and Hay (2016). For applications in recent food insecurity research see Gill et al., 2018.

Table 4.1: Description of Modified Food Environment Retail Index (mRFEI)

Healthy Food Retailer	Description	Corresponding Index Entries	NAICS
Supermarket/Larger Grocery Store	Establishments generally known as supermarkets or grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry. Included in this industry are delicatessen-type establishments primarily engaged in retailing a general line of food. Supermarkets are defined as stores with 50 or more payroll employees Larger grocery stores are defined as stores with 10-49 employees	• Commissaries - primarily groceries) • Delicatessens - primarily retailing a range of grocery items and meats • Grocery Stores • Supermarkets	445110
Fruit and Vegetable Market	Establishments primarily engaged in retailing fruits and vegetables	• Fruit and vegetable stands – permanent • Fruit markets • Produce markets – temporary • Produce stands – permanent • Vegetable markets	445230
Warehouse Clubs	Warehouse clubs, superstores or supercenters primarily engaged in retailing a general line of groceries in combination with general lines of new merchandise, such as apparel, furniture, and appliances.	• Superstores – food and general merchandise • Warehouse clubs – food and general merchandise	452910

Abbreviation: NAICS = North American Industry Classification System

Table 4.1 Continued

Less Healthy Food Retailer	**Description**	**Corresponding Index Entries**	**NAICS**
Fast-food Restaurants	This U.S. industry comprises establishments primarily engaged in providing food services (except snack and nonalcoholic beverage bars) where patrons generally order or select items and pay before eating. Food and drink may be consumed on premises, taken out, or delivered to the customers' location. Some establishments in this industry may provide these food services in combination with selling alcoholic beverages.	• Carryout restaurants • Delicatessen restaurants • Drive-in restaurants • Family restaurants, limited service • Fast-food restaurants • Pizza delivery shops • Pizza parlors, limited service (e.g., take-out) • Restaurants, carryout • Restaurants, fast-food • Sandwich shops, limited service • Take out eating places	722211
Small Grocery Stores	Establishments generally known as supermarkets and grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry. Included in this industry are delicatessen-type establishments primarily engaged in retailing a general line of food. Small grocery stores are defined as stores with 3 or fewer employees	• Commissaries - primarily groceries) • Delicatessens - primarily retailing a range of grocery items and meats	445110
Convenience Stores	Establishments known as convenience stores or food marts (except those with fuel pumps) primarily engaged in retailing a limited line of goods that generally includes milk, bread, soda, and snacks.	• Convenience food stores	445120

Abbreviation: NAICS = North American Industry Classification System

Table 4.2: Description of Variables

Variable	Description
Dependent Variable	
Nutritional Hardship	
Food Insecurity	Respondent indicated that in the past 12 months, there was a time when (you/your household were/was) worried whether food would run out before you would get money to buy more? (1 = Yes)
mRFEI Score	The ratio of healthy to less healthy food retailers within a census tract. Scores are the percentage of healthy food retailers in a census tract (0 – 100). Low access to healthy food retailers coded as mRFEI less than 10
Health Outcomes	
Waist-to-Height Ratio	Ratio of respondent's waist circumference (cm) to height (cm) measured at waive 4 (scale 0 – 10; binary 1 = 5 and above)
Subjective Health Status	Respondent's rating of their perceived general health (1 = excellent, 5 = poor)
Diet	
Fast-food Consumption	Respondents are asked: "How many times in the past seven days did you eat food from a fast-food restaurant, such as McDonald's, Burger King, Wendy's, Arby's, Pizza Hut, Taco Bell, or Kentucky Fried Chicken or local fast-food restaurants"
Sugar Consumption	Number of sugar beverages respondent consumed in the past 7 days at wave IV, including regular soda, juice drinks, sweetened tea or coffee, energy drinks, flavored water, or other sweetened drinks
Independent Variables	
Prior Incarceration	Respondent was incarcerated and released prior to wave IV
Arrested-only	Respondent was arrested prior to wave IV, but never convicted or incarcerated
Convicted-only	Respondent has been arrested and convicted prior to wave IV, but never incarcerated
No Criminal Justice Contact	Respondent has never been arrested, convicted, or previously incarcerated
Control Variables	
Age	Respondent's age in years at wave IV
Race	Respondents race/ethnicity: (White, Black, Hispanic, or Other Race)
Male	Respondent's sex (1 = Male)
Child in Home	Whether a respondent has children that reside in the home with them (1 = Child in home)
Parent House	A respondent currently resides in their parent's house (1 = Yes)
High School Degree	Respondent graduated from high school or obtained a GED equivalent by wave IV (1 = Yes)
Child Abuse Victim	Whether a respondent before their 18th birthday had been hit with a fist, kicked, thrown down to the floor, into a wall or down stairs by a parent or adult caregiver (1 = Yes)
Delinquency Scale	Respondent engaged in non-violent delinquency in past 12 months at wave I. Includes: graffiti, shoplifting, theft of more than $50, burglary, selling marijuana or other drugs, getting into a serious fight, hurting someone badly enough to need medical care, taking part in a group fight, robbery, pulling a knife or gun on someone, shooting or stabbing someone (1 = Yes)
Hard Drug Use	Respondent used illicit drugs other than marijuana at wave I (1 = Yes)
Healthy Diet	Number of times respondent ate fruits or vegetables the day before the wave I interview.

Table 4.2 Continued

Depression (W1)	Scale combining responses on 11 items, where respondents were asked on a scale of 0 to 3 how often they experience each of the following during the prior week • Being bothered by things that don't usually bother you • Not feeling like eating, appetite was poor • Could not shake off the blues • Feel like you were as good as other people (reverse coded) • Felt depressed • Felt too tired to do things • Felt hopeful (reverse coded) • Felt like a failure • Enjoyed life (reverse coded) • Felt sad • Felt life was not worth living
Fatalism (W1)	Respondent's perceived likelihood of living to age 35
Food Stamp (W1)	Whether any mother of a respondent's household received food stamps in the month prior to the wave I interview (1 = Yes) • Binary indicator included for missing response on receiving food stamps at wave I
Concentrated Disadvantage (W1)	Scale combining the proportion of respondent's census tract at wave I on welfare, living at or below poverty, unemployed, and proportion of female headed households at wave I
Subjective Health Status – Wave I	Respondent's rating of own perceived general health (1 = excellent, 5 = poor)
Physical Activity (W1)	Index of the number of times in the previous week a respondent engaged in the following activities at wave 1 • Exercise, such as jogging, walking, karate, jumping rope, gymnastics, or dancing (W1) • Roller-blading, roller-skating, skate-boarding, or bicycling (W1) • Play an active sport, such as baseball, softball, basketball, soccer, swimming, or football (W1)
Physical Activity (W4)	Index of the number of times in the previous week a respondent engaged in the following activities at wave IV • Bicycle, skateboard, dance, hike, hunt, or do yard work • Gymnastics, weight lifting, or strength training • Participate in individual sports such as running, wrestling, swimming, cross-country skiing, cycle racing, or martial arts • Participate in team sports such as football, soccer, basketball, lacrosse, rugby, field hockey, or ice hockey • Play golf, go fishing or bowling, or play softball or baseball • Roller blade, roller skate, downhill ski, snow board, play racquet sports, or do aerobics • Walk for exercise
Hours of Television (W1 & W4)	Number of hours a respondent watched television in the past week

Table 4.2 Continued

Mediating Variables	
Socioeconomic Mediators	
Concentrated Disadvantage (W4)	Scale combining the proportion of respondent's census tract at wave I on welfare, living at or below poverty, unemployed, and proportion of female headed households at wave IV
Adjusted Household Income ($)	Household income adjusted for household size. Adjusted Household Income = Household Income / (Household Size)^N where N = 0.05
Employed	Respondent has paid employment at wave IV
Social Welfare Mediator	
Public Assistance	Respondent or others in household received public assistance, welfare payments, or food stamps (1 = Yes)
Social Ties Mediators	
Close friends	Respondents number of close friends (1 = none, 5 = 10 or more.)
Married	Respondent is married at wave IV (1 = Yes)
Perceived Isolation	How often respondent feels isolated from others (1 = never, 4 = often)
Parental financial support	Respondent's parents paid living expenses or gave $50 or more to pay living expenses during the past 12 months? (1 = Yes)
Psychological Well-being Mediators	
Depression	Respondents felt depressed in the past seven days (0 = never or rarely, 3 = most of the time)
Anxiety	Standardized scale constructed from four items indicating how often in the past 30 days the respondent felt the following: • felt unable to control the important things in life (1 = Yes) • felt confident in ability to handle personal problems (1 = Yes) • felt things were going your away (1 = Yes) • felt that difficulties were piling up so high that they could not be overcome (1 = Yes)
Physical Disability Mediator	
Physical Disability	Respondent suffered a serious injury in the past 12 months or respondent is unable to work because of a temporary or permanent disability (1 = Yes)
Social Standing Mediator	
Social Standing	Subjective rating of respondents standing in terms of money, education, and job status relative to others in the United States (scale 1 – 10)

CHAPTER 5: RESULTS

Overview

Chapter five presents the results of the regression analyses that test the hypotheses outlined in chapter three. The results chapter begins with an overview of descriptive statistics of the Add Health sample. Next, the results from a series of models assessing the link between incarceration and nutritional hardship, as well as other outcomes of interest such as health and diet are presented.

Descriptive Statistics

Table 5.1 provides the descriptive statistics for the analytic sample. By wave IV the sample is 28 years old on average. A little less than half the sample is male (48.3%). Additionally, the sample is mostly white (68.3%). About 13.6 percent are black, 13.4 percent Hispanic, and 4.7 percent are classified as other race/ethnicity. Nearly, 93 percent report graduating high school by wave IV.

The majority of the sample (74.4%) reported having no contact with the criminal justice system. In total, 13 percent of the sample had been incarcerated as an adult by wave IV. About 9 percent of the sample had been arrested but not convicted, and 3.4 percent had been convicted but not incarcerated by wave IV.

Turning to the nutritional hardship outcomes, approximately 11.3 percent of the sample reported food insecurity at wave IV and on average respondents live in census tracts in which roughly 10.5 percent of food retailers are characterized as healthy food outlets. Next, concerning the health outcomes, respondents reported an average health of 2.31, which falls between the good and fair categories. The average waist-to-height ratio

is 5.8, which falls into the unhealthy range. Finally, in regard to dietary outcomes, respondents consume fast-food approximately twice per week on average and consumed an average of 11 sugary beverages each week.

Table 5.2 provides the descriptive statistics across different categories related to contact with the criminal justice system and the *p*-value provides the results from an ANOVA test assessing whether the four groups differ across any variables. A few interesting patterns emerge among the outcome variables. For instance, food insecurity is lowest among those with no criminal justice contact (9.6%) and approximately twice as large among those who were previously incarcerated (18.3%). The mRFEI score is lowest among formerly incarcerated respondents compared to other groups. Moreover, using the measure of composition of food retailers in an area defined as mRFEI less than 10 the results indicate that formerly incarcerated individuals are more likely to live in areas with low access to healthy food retailers relative to the other categories.

Among the dietary behavior, fast-food consumption is highest among those who were previously incarcerated relative to any other group. Similarly, consumption of sugary beverages is significantly higher among formerly incarcerated respondents as well. Next, turning to the health indicators, subjective health scale (excellent to poor) becomes progressively worse the deeper a respondent progressed in the criminal justice system. Overall, formerly incarcerated individuals report significantly worse levels of health compared to any category. Finally, the results indicate that waist-to-height ratios do not differ across the four groups.

Nutritional Hardships

The first set of analyses reported pertain to the association between incarceration and nutritional hardships. This section reports the results of logistic regression models assessing the association between incarceration and (1) food insecurity, and (2) access to healthy food retailers. Additionally, formal mediation analyses are conducted to assess the mechanisms that link incarceration to nutritional hardships.[34]

Food Insecurity

Table 5.3 presents the odds ratios from a logistic regression of food insecurity regressed on incarceration and other covariates. Model 1 presents the bivariate association using respondents with no criminal justice contact as the reference category. The results demonstrate that formerly incarcerated individuals are about twice as likely than those with no criminal justice contact to report food insecurity status (OR = 2.157; $p < .001$). Additionally, compared to those with no criminal justice contact, both those with

[34] The main analyses reported in this section consider prior incarceration as a dichotomous measure of whether or not a respondent had previously been incarcerated. However, I also conduct subsequent analyses measuring exposure as the duration of time an individual spends behind bars. Respondents who answered "yes" to the question indicating prior incarceration also indicated the total number of years and months they served incarcerated. Using these data time served is constructed as the total months served, where a score of 0 indicates that a respondent has never been incarcerated. Those who spent less than one month were coded as 0.5. Results indicate that the amount of time spent behind bars is not significantly related to either food insecurity or access to healthy food retailers. These results are consistent with findings of prior research that finds the length of incarceration on health outcomes are less important than incarceration itself (Massoglia 2008; Schnittker & John 2007). Next, a subsequent analysis was also conducted assessing the impact of how many years and months since an individual was released from incarceration on nutritional hardships. Results indicate there is no association between time since release and either food insecurity or access to healthy food retailers. The results of these models are presented in Appendix A.

a conviction only (OR = 1.651, $p = .012$) or arrest only (OR = 1.372, $p = .019$) are significantly more likely to experience food insecurity. Expressed as predicted probabilities about 19 percent of respondents with prior incarceration are predicted to be food insecure compared to 8.9 percent of those with no criminal justice contact. Next, in model 2 the control variables are included. Following the inclusion of the set of control variables, the odds ratio for the incarcerated group declines slightly (OR = 1.981, $p < .001$) and the odds ratio for the convicted only group increases (OR = 2.015, $p = .001$). In terms of predicted probabilities approximately 14.3 percent of formerly incarcerated respondents are predicted to be food insecure compared to 14.5 percent of convicted only respondents and 7.7 percent of respondents with no criminal justice contact. There is no statistically significant difference when comparing the coefficients between the formerly incarcerated group and convicted only respondents (F = 0.00, $p = .946$). Overall, after including the control variables, all respondents who had prior contact with the criminal justice system (either arrest, conviction, or incarceration) remain significantly more likely than those without criminal justice contact to report food insecurity.

Consistent with prior literature, several control variables emerge as significant predictors of food insecurity. Black respondents are at an increased likelihood of experiencing food insecurity and male respondents are less likely than females to be food insecure. Several control variables also related to food insecurity. Having a child in the home increases food insecurity and those who graduated high school are at a lower risk for food insecurity. Moreover, being a child abuse victim, having depressive symptoms in adolescence, receiving food stamps during adolescence, and tract-level concentrated disadvantage at wave I all increase the likelihood of being food insecure in young

adulthood. In contrast, consumption of fruit and vegetables in adolescence is found to reduce the likelihood of food insecurity.[35]

Next, model 3 adds in the set of mediators. After the mediators are included the prior incarceration variable retains a positive association with food insecurity, however the magnitude of the association is substantially reduced when compared to the no criminal justice contact reference category (OR = 1.305, p = .029). However, the convicted only category retains a positive and statistically significant association with food insecurity compared to respondents with no criminal justice contact (OR = 1.967, p = .003).[36] Moreover, the post-hoc Wald-Test indicates there is no statistically significant difference between the coefficient for the convicted only respondents when compared to

[35] It is possible that low access to food retailers may matter less for individuals who have reliable access to a car relative to those who do not and have to rely on walking or public transportation to access food retailers (Ver Ploeg, 2010). Unfortunately, the Add Health data do not have a direct question asking about the major form of transportation used by respondents on a daily basis. However, at wave IV respondents are asked: "how do you get to your primary place of work/school: car, bus, subway, train, walking, bicycle, none of the above." The wording of this question is not ideal as it confounds forms of transportation with characteristics that should be negatively related to food insecurity such as being employed or being a student. Still, subsequent analyses were performed using the various forms of transportation as additional control variables as well as comparing the sample that used a car as a primary form of transportation to those that did not. Across all models the results remained substantively similar and the various forms of transportation did not have a statistically significant association with either food insecurity or access to healthy food retailers. Finally, using a car as a primary form of transportation did not mediate the association between access to healthy food retailers and food insecurity.

[36] Given that food insecurity is measured over the course of the past 12 months it is possible that responses among formerly incarcerated individuals may be influenced by the time since release. Specifically, individuals who were released from incarceration within the past year may be at a lower risk of food insecurity because they were provided daily meals while incarcerated. However, a subsequent analysis that restricted the incarceration sample to those who were released less than one year before the interview date versus those released more than one year before the interview date yielded substantively similar findings.

previously incarcerated respondents (F = 2.84, p = .095). The coefficient for the convicted only respondents also does not significantly differ compared to the arrested only respondents (F = 1.82, p = .179).

Thus, the results reported in table 5.3 provides mixed support for hypothesis 1. Across all models, formerly incarcerated respondents are found to be more likely than those without criminal justice contact to be at an increased risk for food insecurity. However, a large portion of this association is explained by mediators which can be considered risk factors for food insecurity. After adjusting for these variables, the association between incarceration and food insecurity is substantially reduced. Moreover, there is no difference in the likelihood of experiencing food insecurity among formerly incarcerated respondents when the reference category is switched to either arrested only or convicted only. This suggests that there may be some unobserved factors that are related to both coming into contact with the criminal justice system and being food insecure that could not fully be accounted for using the Add Health data.

Several of the mediator variables also emerge as significant predictors of food insecurity. Specifically, concentrated disadvantage, receiving public assistance benefits, receiving parental financial support, and anxiety symptoms all have a positive and statistically significant association with food insecurity, whereas social standing and adjusted household income have a negative association with food insecurity.[37]

[37] Variance inflation factors (VIFs) were used to detect the possibility of multicollinearity. The results of the VIFs revealed no serious problems with multicollinearity as all values were below 3, which falls below standard thresholds for harmful collinearity (Kutner, Nachtsheim & Neter, 2004). For reported the VIF see Appendix B.

To formally assess the indirect effects of incarceration through mediators, the results from the KHB mediation analysis are presented in table 5.4. The results show that effect of incarceration on food insecurity operates through several of the mediators included in the analysis and overall the findings provide mixed support for the hypotheses derived from question 2 and question 3. First, in contrast to hypothesis 2 the results indicate that the proportion of retailers in a tract that are healthy does not mediate the association between incarceration and food insecurity.[38] Thus, this finding suggests that any association between incarceration and food insecurity is not explained by the composition of the local food retail environment.

Socioeconomic Mediators

Next, the third research question inquired whether factors that are consequences of incarceration would mediate the relationship between incarceration and food insecurity. First, it was expected that the relationship between incarceration and food insecurity would partially be attributed to socioeconomic status. Specifically, hypothesis 3a anticipated that socioeconomic indicators – concentrated disadvantage, household income and employment status – would mediate the association between incarceration and food insecurity. The results provide mixed support as household income reduces the effect of incarceration on food insecurity by approximately 13.8 percent (*z-score* = 4.291, $p < .001$) but there is no mediation effect for concentrated disadvantage or employment.

[38] A series of subsequent set of analyses assessed mediation effects using different coding schemes for the mRFEI measure including mRFEI = 10, mRFEI = 10-20, mRFEI = 20-30, mRFEI greater than 30, and a continuous scale of mRFEI scale. Across all models the measure of mRFEI did not yield any significant mediation effect.

Therefore, these results suggest that in explaining food insecurity, levels of household income appear more important than the employment status of a respondent.

Social Welfare Mediator

Next, turning to the role of social welfare the results provide support for hypothesis 3b as receiving public assistance leads to a 9.36 percent reduction in the association between incarceration and food insecurity (*z-score* = 3.724*, p* <.001). In part, this may be due to the fact that individuals who receive social welfare benefits experience financial strife and are at increased risk for food insecurity. Moreover, receiving public assistance benefits may also reduce the risk of food insecurity by alleviating financial hardship (Gundersen et al., 2017; Waxman, 2017).

Social Tie Mediators

Regarding the role of social ties, Hypothesis 3c anticipated that a variety of indicators - close friends, marriage, perceived isolation, and parental financial support – would mediate the association between incarceration and food insecurity. The findings from the mediation analysis provided mixed support for this hypothesis as only parental financial support emerged as a significant mediator, leading to a nearly 9.5 percent reduction in the association between incarceration and food insecurity (*z-score* = 3.746*, p* <.001). These findings suggest that the most important form of social ties for alleviating risk of food insecurity may be ties that hold the potential to reduce financial hardship. This finding is consistent with prior research that finds that one means through which stronger social ties can reduce food insecurity is by providing access to financial resources in times of need (Martin et al., 2004).

Physical Disability and Physiological Well-being Mediators

Physical disability and psychological well-being measures were also anticipated to mediate the association between incarceration and food insecurity. Hypothesis 3d predicted the association between incarceration and food insecurity would be mediated by physical disability. The results did not find support for this hypothesis as physical disability did not yield a significant mediation effect. Hypothesis 3e anticipated psychological well-being including depression and anxiety would mediate the association between incarceration and food insecurity. The results provided mixed support for the hypothesis as only anxiety symptoms emerge as a significant mediator, generating a 21.58 percent reduction in the effect of incarceration on food insecurity (*z-score* = 4.491*, p* <.001). This result is consistent with prior research that finds psychological disorders can increase the risk of experiencing food insecurity (Hamelin et al., 1999; Laraia et al., 2006; Noonan et al., 2016).

Social Standing Mediator

Finally, social standing was hypothesized to mediate any link between incarceration and food insecurity. In support of hypothesis 3f social standing is found to reduce the incarceration effect by nearly 19 percent (*z-score* = 5.055*, p* <.001). The measure of social standing is based off respondent's perceptions of their relative standing to others in society in terms of money, education, and respected jobs. Thus, the strong mediation effect of social standing may be capturing the association between incarceration and reduced standing due to experiencing economic hardship, as well as having lower quality employment or no job at all.

Overall, the results of the mediation analysis indicate that the full set of mediators reduce the association between incarceration and food insecurity by 74 percent. Much of this mediation effect is from either direct measure of financial hardship (i.e. household income) or measures that in part capture financial difficulties (i.e. public assistance benefits, financial support from parents, and social standing). These findings are largely consistent with research suggesting that economic hardship is a leading risk factor for food insecurity (Coleman-Jensen et al., 2016; Cook & Frank, 2008; Gundersen et al., 2011; Nord, 2014; Rose, 1999).

Food Retailer Access

Table 5.5 presents the results from the logistic regression analysis of healthy food retailer access (1 = mRFEI less than 10) regressed on incarceration. Model 1 presents the results of the bivariate model comparing the different forms of criminal justice contact to the no criminal justice contact reference category. The results demonstrate that prior incarceration increases the likelihood of living in a tract with low access to healthy food retailers by 1.396 times ($p < .001$). Neither of the other criminal justice contact categories (arrest only or conviction only) are found to have a statistically significant association with poor food access. Expressed in predicted probabilities, approximately 51 percent of respondents with no prior contact with the criminal justice system are predicted to reside in an area with low access to healthy food retailers, compared to 59 percent of among formerly incarcerated individuals.

Model 2 adds the control variables to the model. The inclusion of the control variables has no effect on the size of the effect of the prior incarceration measure which

still retains a positive and statistically significant association to low access to healthy food retailers (OR = 1.302, p = .003). Consistent with prior research, black respondents have lower access to healthy food retailers (Larson et al., 2009; Walker et al., 2010). Additionally, total delinquency during adolescence is also found to be associated with an increased likelihood of living in a tract with lower food access score.

Next, model 3 includes the mediator for wave IV disadvantage and adjusted household income. After accounting for the mediators, the coefficient for prior incarceration is reduced only slightly (OR = 1.244, p = .013). However, the results of the post-hoc Wald test indicates that when the reference category is changed to other forms of criminal justice contact, respondents with prior incarceration are not significantly more likely to live in a tract with poor food access compared to the arrested only respondents (F = 3.57, p = .062) or convicted only respondents (F = 1.49, p = .225). Following the inclusion of the mediators, approximately 52 percent of the respondents across each of the never incarcerated reference categories (no contact, arrested only, and convicted only) have low access to healthy food retailers compared to 57 percent of formerly incarcerated respondents.[39] These findings provide mixed support for hypothesis 4 as formerly incarcerated individuals were found to be more likely to reside in census tracts with low access to healthy food retailers compared to individuals with no prior criminal justice contact. However, in the full model this difference was not found to significantly differ for convicted only respondents.

[39] The association between incarceration and access to healthy food retailers was further assessed using a series of supplementary models with alternative coding for the mRFEI variable. These results are reported in Appendix C.

Concentrated disadvantaged wave IV is found to have a positive and statistically significant relationship with low access to healthy food retailers (OR = 2.185, p =.017). This finding is consistent with prior work finding that access to healthy food retailers is lower in economically disadvantaged communities (Morland et al., 2002; Walker et al., 2010).

The results of the mediation analysis are provided in table 5.6. Contrary to hypothesis 5a and 5b neither concentrated disadvantage or household income were found to significantly mediate the association between incarceration and access to healthy food retailers.[40] Thus, it appears other factors may better explain the composition of food retailers. For instance, healthy food retailers such as supermarkets and grocery stores often carefully seek out qualities of areas where they establish retail stores to increase the likelihood of financial success such as a consistent customer base and lower operating costs (King, Leibtag, & Behl, 2004). It may be that indicators such as higher levels of incarceration among residents of an area are indicative of an unstable supply of customers which deters healthy food retailers from establishing physical stores in these areas.

Nutritional Outcomes

This section provides the results of the regression analyses assessing the relationship between incarceration and nutritional outcomes. In particular, this section

[40] As a sensitivity analysis, I estimated an additional model including the full slate of variables used in Model 3 of Table 5.3. The coefficient for the prior incarceration variable retains a positive and statistically significant association to low access to healthy food retailers (OR = 1.257, p <.001). Moreover, none of the additional covariates are statistically significant predictors of access to healthy food retailers.

uses two nutritional behaviors as dependent variables: fast-food consumption and sugary beverage consumption. Drawing from prior research that finds food insecure individuals consume greater amounts of high calorie, nutrient poor foods (Mello et al., 2010), and research that finds residents in areas with fewer healthy food retailers relative to unhealthy food retailers consume more fast-food and high sugar products (Walker et al., 2010), hypotheses 6a and 6b anticipate that any positive association between incarceration and consumption of fast-food and sugary beverage consumption will be explained in part by food insecurity status and access to healthy food retailers.

Fast-food Consumption

Table 5.7 provides the results of the association between incarceration and fast-food consumption using a negative binomial regression model. The reported coefficients represent the incident rate ratio (IRR). Model 1 presents the bivariate association between incarceration and fast-food consumption using no criminal justice contact as the reference category. Consistent with prior research, formerly incarcerated individuals consume fast-food at a higher rate compared to their never incarcerated counterparts (IRR = 1.543; p <.001). A post-hoc Wald-Test demonstrates that formerly incarcerated individuals consume fast-food at a higher rate compared to convicted only respondents (F = 17.66, p <.001) and arrested only respondents (F = 18.80, p <.001) as well.

Next, model 2 includes a set of control variables that may confound the relationship between incarceration and fast-food consumption. After including the set of control variables, the association between fast-food consumption and prior incarceration remains positive and statistically significant, although the magnitude of the relationship

reduces (IRR = 1.180, p <.001). Importantly, there are also several other interesting patterns among the covariates. Relative to white respondents, both black and Hispanic respondents are more likely to consume fast-food. Males are also more likely than females to consume fast-food. Living in a disadvantaged tract during adolescence increases fast-food consumption in young adulthood and having a healthy diet at wave I reduces fast-food consumption at wave IV. Additionally, both fulltime employment and adjusted household income are negatively associated with fast-food consumption suggesting that higher socioeconomic status leads to lower fast-food consumption.

Finally, model 3 includes the nutritional hardship mediators. The results of the full model indicate that compared to respondents with no criminal justice contact, previously incarcerated respondents are significantly more likely to consume fast-food (IRR = 1.177, p <.001). The Wald-test indicates this difference is significantly different from the convicted only respondents (F = 7.34, p =.007) but does not significantly differ compared to the arrested only respondents (F = 2.68, p = .104). Being food insecure in adulthood is found to have a positive, but not statistically significant association with fast-food consumption (IRR = 1.105, p = .087). Additionally, there is no association between low access to healthy food retailers and fast-food consumption. Thus, these results differ from some past research that suggest food insecurity and low access to healthy food retailers increase fast-food consumption (Caspi et al., 2012)

Table 5.8 reports the results of the mediation analysis testing hypotheses 6a and 6b. In contrast to hypothesis 6a the results indicate that there is no mediation effect between food insecurity and fast-food consumption. The results also fail to provide support for hypothesis 6b as the findings indicate that access to healthy food retailers

mediates less than one percent of the relationship between incarceration and fast-food consumption. Therefore, these findings do not support the proposition that experiencing nutritional hardship will mediate the association between incarceration and increased consumption of fast-food.

Sugar Consumption

Table 5.9 provide the results of the negative binomial regression of incarceration regressed on sugary beverage consumption. Model 1 presents the bivariate association between the criminal justice contact measures and sugar consumption. Compared to those with no criminal justice contact, previously incarcerated respondents are significantly more likely to consume sugary beverages (IRR = 1.608 p <.001). Similarly, the arrested only category (IRR = 1.255, p <.001) and convicted only respondents (IRR = 1.201, p =.025) are also more likely to consume sugar products compared to those with no criminal justice contact. Using a Wald-test to compare across categories of criminal justice contact, the results show that the coefficient for the prior incarceration category is significantly larger compared to the convicted only respondents (F = 15.66, p <.001) and arrested only respondents (F = 20.69, p <.001).

Following the inclusion of the control variables in model 2, the magnitude of the relationship between incarceration and sugary beverage consumption is reduced, however, formerly incarcerated individuals remain more likely than respondents without criminal justice contact to consume more sugary beverages (IRR = 1.159, p <.001). Several other important patterns are also present. First, racial minorities are less likely than white respondents to consume sugary beverages. This contrasts from the results

from the fast-food consumption models, which found minority respondents were more likely to consume fast-food. The results also show that males consume more sugary beverages than females. Those who graduated high school and ate a healthier diet in adolescence consume less sugar in young adulthood. In contrast, those who resided in disadvantaged tracts during adolescence and had prior depressive symptoms consume more sugar in young adulthood. Additionally, having more close friends, higher social standing, and higher household income are also negatively related to sugar consumption.

Finally, model 3 includes the nutritional hardship mediators. The inclusion of mediators does not substantially change the key findings as prior incarceration still retains a positive and statistically significant relationship to sugary beverage consumption (IRR = 1.161, p <.001). Yet, following the inclusion of these measures the coefficient for prior incarceration is not statistically significant when compared to either the arrested only respondents (F = .46, p =.500) or convicted only respondents (F = 2.26, p = .135). Further, the findings indicate that food insecure respondents consume more sugary beverages (IRR = 1.129, p =.009). This finding is consistent with prior research findings that food insecurity is associated with poorer nutritional literacy and a higher consumption of low-cost, high calorie products such as sugary beverages (Drewnowski & Spector, 2004). However, access to healthy food retailers does not have an association to sugar consumption. It may be that because sugary beverages are commonly available in both healthy and unhealthy food retailers that the composition of the local food retail environment has less of an impact of sugary beverage consumption.

Finally, a mediation analysis is performed to test hypotheses 6a and 6b. In contrast, to the expectations from these hypotheses the results from the mediation

analysis indicate there is a substantively small mediation effect of the nutritional hardship variables. Overall, low access to healthy food retailers is found to have a small but not statistically significant suppression effect on the relationship between incarceration and sugar consumption, whereas food insecurity has a substantively small and non-significant mediation effect. It is possible that other factors are more important in determining sugary beverage consumption. For instance, prior research finds a strong link between income and consumption of sugar sweetened beverages in the United States (Han & Powell, 2013) and a subsequent mediation analysis finds that household income mediates approximately 5.43 percent of the association between incarceration and sugary beverage consumption (*z-score* = 2.758, $p = .006$). Moreover, other factors such as social standing may impact dietary behavior by diminishing an individual's sense of control and autonomy over dietary choices (Marmot, 2004; Porter, 2014). A subsequent analysis supports this perspective as social standing mediates about 12.4 percent of the association (*z-score* = 4.721, $p < .001$). Finally, while access to healthy food retailers did not mediate the association between incarceration and sugary beverage consumption, it is possible that other measures such as the cost of sugary beverages relative to alternative low sugar beverages within a local area might better explain this relationship (Brownell et al., 2009; Drewnowski & Darmon, 2005).[41]

[41] These mediation analyses were also conducted for the fast-food consumption models. The results indicate that household income mediates approximately 3.64 percent of the relationship between incarceration and fast-food consumption (*z-score* = 1.987, $p = .047$). Social standing was not found to have a statistically significant mediation effect.

Health Outcomes

The next section provides the results of the association between incarceration and health outcomes. The focal dependent variables used to measure health include waist-to-height ratio as a measure of healthy weight and a scale of subjective health status. Drawing upon prior research that suggests food insecurity and living in environments with low access to healthy food retailers can contribute to adverse health outcomes (Gundersen & Ziliak, 2015), hypotheses 6c and 6d proposed that food insecurity status and access to healthy food retailers would mediate any association between incarceration and (1) unhealthy weight (waist-to-height ratio) and (2) subjective health status.

Waist-to-Height Ratio

Table 5.11 displays the odds ratio from a logistic regression predicting the likelihood of having a waist-to-height ratio above 5. The results from model 1 indicate that compared to those without criminal justice contact, formerly incarcerated respondents have a negative but not statistically significant association with unhealthy weight (OR = .912, p =.311). Model 2 includes the slate of control variables to account for confounding characteristics. Following the inclusion of the control variables, the results change slightly. Specifically, the negative association between prior incarceration and unhealthy weight becomes slightly stronger (OR = .823, p = .049) when compared to the no criminal justice contact category. Among the control variables a few notable patterns emerge. In particular, Hispanic respondents have a significantly higher likelihood than white respondents of having unhealthy weight (OR = 2.064, p <.001). Additionally, living in a disadvantaged tract in adolescence, prior subjective health, and

hours watching television increase the likelihood of unhealthy weight, whereas current physical activity reduces the likelihood of having an unhealthy weight.[42]

Model 3 adds the nutritional hardship mediators. After the inclusion of these variables the negative relationship between prior incarceration and unhealthy weight gets stronger (OR = .769, p =.004). The results from the Wald-test indicate that the difference is not statistically significant when the reference category is changed to arrested only (F = 0.60, p = .442) or convicted only respondents (F = 1.33, p = .251). Among the nutritional hardship measures, the findings demonstrate that tracts with low mRFEI scores are not associated with having unhealthy weight (OR = .924, p = .228). However, food insecurity has a positive but not statistically significant relationship with unhealthy weight (OR = 1.253, p = .086). Overall, the results from model 3 suggest that food insecurity may be suppressing part of the relationship between incarceration and weight-to-height ratio.[43]

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[42]Although body mass index is one of the most widely used measures of health in past research, several recent studies have found that relying on BMI can often misclassify individuals into unhealthy weight categories (Tanamas et al., 2016; Tomiyama et al., 2016). Accordingly, this study relies on waist-to-height-ratio which is consistently shown to be a more accurate measure of unhealthy weight (Ashwell, Gunn, & Gibson, 2012). Still, a sensitivity analysis was performed using the body-mass index as the outcome variable. Overall, the results are consistent when BMI is used instead of WTHR. Specifically, the results indicate that there is a negative association between prior incarceration and BMI compared to those with no criminal justice contact (b = -0.33, p <.001). Moreover, when using BMI there is no significant mediation effect of mRFEI, however food insecurity is found to suppress the effect of incarceration on BMI by approximately 11 percent (z-*score* = 2.358, p = .018).

[43] To further assess the suppression effect, subsequent analyses were conducted using a stepwise regression model to detect changes in the coefficients. These results indicated that much of the change in coefficient size results from the inclusion of the subjective health variable collected at wave I. A further analysis was conducted that disaggregated the sample between respondents who reported either fair or poor health versus good or excellent health at wave I. The results of this model indicate that association between incarceration and WTHR is more strongly negative for those who were in fair or poor health (OR = .688, p =.342) at wave I versus those in good or excellent health (OR = .896, p = .251). However, an equality of coefficients test indicates that the difference

Finally, table 5.12 reports the results of the mediation analysis testing hypotheses 6c and 6d. The findings indicate that neither food insecurity of access to healthy food retailers has a significant mediation effect on the association between incarceration and unhealthy weight. In fact, the percent reduction reported by the mediation test for food insecurity is -7.33 percent. This negative value is indicative of a suppression effect of food insecurity on the association between incarceration and healthy weight. Therefore, the results fail to provide support for hypotheses 6c and 6d.

Subjective Health Status

Table 5.13 reports the results of the negative binomial regression assessing the relationship between incarceration and subjective health status. The dependent variable is measured on a 5-point scale ranging from excellent to poor health. The results from model 1 show that relative to those with no criminal justice contact, formerly incarcerated respondents are more likely to be in poorer health (IRR = 1.116, p <.001). Moreover, the results from the Wald-test demonstrate that formerly incarcerated individuals report significantly poorer health than arrested only respondents (F = 9.57, p =.002) and convicted only respondents (F= 7.37, p =.008).

Next, model 2 adds the control variables, including measures of subjective health from wave I and health related measures such as physical activity and dietary behavior.

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between the coefficients is not statistically significant (*z-score* = .651, p = .515). Next, to investigate the suppression effect of food insecurity the sample was disaggregated by respondents who were food insecure and those who were not. The findings demonstrated that the association between prior incarceration and WTHR is more strongly negative for the non-food insecure respondents (OR = .823, p = .061) compared to food insecure respondents (OR = .960, p = .906). The equality of coefficient test demonstrates these coefficients do not significantly differ (*z-score* = .429, p = .668).

The results indicate that formerly incarcerated individuals are significantly more likely to report poorer health compared to those without criminal justice contact (IRR = 1.049, p = .003). Regarding the patterns among the covariates, racial/ethnic minorities are more likely to report poorer health comparted to white respondents. High school graduates are less likely to be in poor health. Those with higher levels of fatalism and respondents who were child abuse victims are more likely to be in poor health. Additionally, prior heath status at wave I, neighborhood disadvantage during adolescence, as well as fruit and vegetable consumption at Wave I are significant predictors of subjective health status at wave IV. Among wave IV measures, hours of television, fast-food consumption, and sugar consumption have a positive association with subjective health, whereas wave IV physical activity has a negative association with health status.

Finally, model 3 includes the mediators for food insecurity and access to healthy food retailers. After the inclusion of these measures, formerly incarcerated respondents retain a positive and statistically significant association to subjective health status (IRR = 1.043, p = .010). However, these results do not significantly differ compared to the arrested only (F = 1.35, p = .248) or convicted only respondents (F = 1.48, p = .226). Next, the results show that access to healthy food retailers is not related to subjective health status (IRR = 1.005, p = .611). However, food insecurity increases the likelihood of being in poorer health (IRR = 1.123, p <.001).

Finally, table 5.14 reports the results of the mediation analysis testing hypotheses 6c and 6d. In support of hypothesis 6c the results reveal that food insecurity mediates approximately 14.5 percent of the relationship between incarceration and subjective health status (*z-score* = 3.053, p = .002). This finding is consistent with prior research

showing that food insecurity is negatively associated with measures of subjective well-being (Frongillo et al., 2010). However, in contrast to hypothesis 6d, having low access to healthy food retailers does not mediate the association between incarceration and subjective health status (*z-score* = .611 p = .541).

Summary

The results presented above provide mixed support for the hypotheses outlined in chapter three (for summary of findings see Table 5.15). Hypothesis 1 proposed that formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to be food insecure. The results for this hypothesis provided mixed support. On one hand, when compared to respondents without criminal justice contact the findings indicated that formerly incarcerated respondents are at an increased risk of food insecurity. However, when the reference category is changed to either the arrested only or convicted only reference categories the findings reveal no statistically significant difference in the likelihood of experiencing food insecurity between formerly incarcerated respondents and respondents who had prior contact with the criminal justice system but were not previously incarcerated.

Hypothesis 2 proposed that the composition of the local food retail environment will partially mediate the relationship between incarceration and food insecurity. However, the findings from the mediation analysis found that the availability of healthy food retailers had only a small and statistically non-significant mediation effect on the association between incarceration and food insecurity. Therefore, hypothesis 2 was not supported.

Next, a series of hypotheses suggested that a number of factors that can be considered consequences of incarceration would mediate the association between incarceration and food insecurity. A number of factors emerged as important mediators including household income, receiving public assistance benefits, parental financial support, social standing, and anxiety symptoms. Collectively, the results from this mediation analysis provide partial support for the hypotheses derived from the third research question and suggest that the association between incarceration and nutritional hardships operates through specific consequences of incarceration to other elements of one's life including socioeconomic status, social ties, receiving social welfare benefits, social standing, and psychological wellbeing.

Hypothesis 4 examined the association between incarceration and access to healthy food retailers. Specifically, hypothesis 4 anticipated that formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to live in census tracts with lower access to healthful food retailers. The results provided mixed support for hypothesis 4. In models comparing formerly incarcerated individuals to those who did not have prior contact with the criminal justice system, the results consistently found evidence that prior incarceration was associated with living in a tract with low access to healthy food retailers, net of confounding factors. However, after the reference category is changed to arrested only or convicted only respondents the results reveal a positive but not statistically significant association between incarceration and low access to healthy food retailers.[44] In regard to factors that mediate the association

[44] Notably, the difference is not statistically significant when formerly incarcerated respondents are compared to arrested only or convicted only respondents. However, when the arrested only and convicted only respondents are combined into one group the

between incarceration and healthful food access, the results indicated that both concentrated disadvantage and household income had a substantively small and statistically non-significant mediation effect. Thus, the findings of the mediation analysis failed to provide support for hypotheses 5a and 5b.[45]

Finally, the sixth research question anticipated that nutritional hardships - food insecurity and access to healthy food retailers - would mediate part of the association between incarceration and nutritional behavior - fast-food consumption and sugary beverage consumption - as well as health outcomes - waist-to-height ratio and subjective health status. The findings indicated that there was no substantive or statistically significant mediation effect of either nutritional hardship on fast-food or sugary beverage consumption. Regarding the health outcomes, there was no mediation effect between either nutritional hardship and waist-to-height-ratio. In fact, food insecurity was found to have a small suppression effect on the association between incarceration and unhealthy

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formerly incarcerated respondents are significantly more likely to reside in census tracts with low access to healthy food retailers (OR = 1.314, $p = .015$). It is likely that the finding of no significant difference when compared to arrested only or convicted only respondents is the result of a larger standard error from the reduced sample size.

[45] A series of subsequent analyses were also conducted to examine whether the association between incarceration and outcomes of interest differed by sex and race/ethnicity. In regard to sex differences the results indicate that the effect size of incarceration on both food insecurity and access to healthy food retailers was larger for female respondents compared to male respondents, however a comparison of the coefficients revealed these differences are not statistically significant (Appendix D). Next, the main difference to emerge across the race/ethnicity subsamples is that prior incarceration has a stronger impact on living in a tract with low access to healthy food retailers among white respondents (Appendix E). Moreover, the association between prior incarceration and access to healthy food retailers is significantly larger among white respondents compared to black *(z-score* = 2.603, $p = .009$*)*. However, the results do not significantly differ when white respondents are compared to Hispanic respondents (*z-score* = 1.550, $p = .121$). These results are somewhat consistent with past research suggesting that incarceration has the stronger negative effect on downward neighborhood mobility among white formerly incarcerated individuals (Massoglia et al., 2013).

weight. However, food insecurity was found to mediate approximately 14 percent of the association between incarceration and subjective health, although there was no mediation effect attributed to low access to healthy food retailers. Thus, the findings failed to provide support for hypotheses 6a, 6b, and 6d and provided only partial support for hypothesis 6c.

The models used to test the series of hypotheses adjusted for several confounding background characteristics that might influence both incarceration and the likelihood of experiencing nutritional hardship. Moreover, in order to account for potential unobserved factors the analyses used strategic comparison groups comparing the formerly incarcerated respondents to those who had contact with the criminal justice system but were not previously incarcerated. However, regression analyses are intended to account for small between group differences (Murnne & Willet, 2010; Ridgeway, 2006). It is well documented that those who experience incarceration and those who do not differ across a number of key demographic and socioeconomic characteristics (Wakefield & Uggen, 2010; Wildeman & Muller, 2012).

As a further robustness check, supplementary analyses were conducted using propensity score matching to compare the likelihood of experiencing food insecurity and having low access to healthy food retailers between respondents who had been incarcerated to those who had not but have a similar probability of experiencing incarceration (Rosenbaum & Rubin, 1983). Appendix F reports results of the propensity score analysis.

The results from the propensity score analysis provide important findings. First, the results from the matching procedure demonstrate that there is adequate overlap across

observable variables between formerly incarcerated individuals and the comparison categories. When individuals who were not previously incarcerated are used as the reference category, the findings from propensity score models do not substantively differ compared to the regression models reported above. However, when the comparison category is switched to a combined group of arrested and convicted only respondents the results reveal there is no significant effect of incarceration on either nutritional hardship using nearest neighbor matching (see Table F9). These results suggest that selection processes are driving much of the association between incarceration and nutritional hardships. In other words, these results imply certain respondents are more likely to be involved in criminal activity and to experience nutritional hardship.

Table 5.1: Descriptive Statistics of Full Sample (N = 10,598)

	Mean	SE	Min	Max
Dependent Variables				
Nutritional Hardship				
Food Insecure	.113	.006	0	1
mRFEI (continuous)	10.56	.250	0	70
mRFEI (< 10)	.522	.013	0	1
Diet Outcome				
Fast-food	2.276	.073	0	55
Sugar Consumption	11.489	.297	0	99
Diet Outcome				
WTHR	5.773	.024	2.732	10
Subjective Health	2.306	.022	1	5
Independent Variables				
No CRJ Contact	.744	.010	0	1
Arrested Only	.093	.005	0	1
Conviction Only	.034	.003	0	1
Incarceration	.130	.008	0	1
Control Variables				
Age – Wave 4	28.475	.125	24	34
White	.683	.030	0	1
Black	.136	.019	0	1
Hispanic	.134	.019	0	1
Other Race	.047	.008	0	1
Male	.496	.008	0	1
Child in Home	.179	.010	0	1
Child Abuse	.179	.007	0	1
Parent House	.125	.008	0	1
High School	.929	.007	0	1
Total Delinquency (W1)	2.483	.073	0	38
Hard Drug Use (W1)	.123	.008	0	1
Fruit & Vegetable Consumption (W1)	.911	.005	0	1
Depression (W1)	6.409	.103	0	33
Fatalism (W1)	1.551	.018	1	5
Food Stamp Recipient (W1)	.098	.012	0	1
Food Stamp Recipient Missing (W1)	.128	.008	0	1
Concentrated Disadvantage (W1)	-.110	.072	-1.199	7.864
Subjective Health (W1)	2.096	.016	1	5
Physical Activity (W1)	3.755	.057	0	9
Physical Activity (W4)	6.445	.102	0	47
Television Hours (W1)	15.312	.389	0	99
Television Hours (W4)	13.016	.231	0	150
Mediating Variables				
Concentrated Disadvantage (W4)	-.038	.017	-0.616	36.477
Adjusted Household Income ($)	40,888.92	908.29	883.88	175,000
Currently Employed	.192	.006	0	1
Public Assistance Benefits	.211	.013	0	1
Close Friends	3.179	.027	1	5
Married	.417	.013	0	1
Perceived Isolation	.968	.018	0	3
Social Standing	5.113	.050	1	10
Parental Financial Support	.417	.012	0	1
Depression	.372	.011	0	3
Anxiety	4.736	.057	0	16
Physical Disability	.142	.006	0	1

Table 5.2: Descriptive Statistics by Criminal Justice Contact

	No Contact (N = 8,985)		Arrested (1,076)		Convicted (N = 541)		Incarceration (N = 1,836)		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	*p*
Dependent Variables									
Nutritional Hardship									
Food Insecure	.096	.007	.127	.013	.144	.024	.183	.015	***
mRFEI (continuous)	10.73	.269	10.08	.377	10.56	.660	9.94	.498	
mRFEI (< 10)	.510	.014	.520	.026	.520	.040	.592	.022	***
Health Outcomes									
WTHR	5.80	.027	5.63	.041	5.73	.084	5.70	.038	
Subjective Health	2.26	.023	2.30	.044	2.28	.069	2.52	.037	***
Diet Outcome									
Fast-food	2.08	.073	2.43	.130	2.01	.163	3.23	.152	***
Sugar Consumption	10.28	.277	12.93	.567	12.20	.987	16.63	.776	***
Control Variables									
Age – Wave 4	28.48	.125	28.55	.150	28.19	.178	28.47	.159	
White	.687	.031	.686	.038	.780	.030	.633	.034	***
Black	.127	.018	.166	.033	.110	.025	.171	.027	*
Hispanic	.135	.020	.117	.022	.083	.017	.152	.022	*
Other Race	.051	.010	.030	.008	.028	.010	.043	.011	
Male	.416	.009	.638	.021	.716	.030	.759	.014	***
Child in Home	.185	.011	.167	.019	.154	.025	.167	.017	
Child Abuse	.159	.007	.197	.017	.214	.032	.268	.016	***
Parent House	.117	.009	.124	.013	.123	.023	.169	.014	**
High School	.950	.006	.933	.013	.955	.015	.811	.019	***
Total Delinquency (W1)	1.81	.062	3.82	.256	3.82	.469	4.68	.198	***
Hard Drug Use (W1)	.097	.007	.179	.018	.154	.029	.216	.017	***
Healthy Diet (W1)	.916	.005	.903	.014	.905	.019	.895	.011	
Depression (W1)	6.27	.111	6.79	.205	5.53	.289	7.10	.202	***
Fatalism (W1)	1.52	.018	1.62	.042	1.50	.061	1.65	.044	**
Food Stamp Recipient (W1)	.086	.010	.092	.018	.099	.030	.162	.022	***
Food Stamp Recipient Missing (W1)	.127	.009	.129	.015	.098	.020	.144	.014	
Subjective Health (W1)	2.06	.019	2.09	.042	2.10	.061	2.28	.038	***
Physical Activity (W1)	3.68	.062	3.82	.095	4.06	.162	3.97	.099	**
Physical Activity (W4)	6.26	.113	6.96	.274	7.11	.424	6.84	.235	**
Television Hours (W1)	14.97	.390	14.83	.723	14.69	.811	17.60	.647	***
Television Hours (W4)	12.36	.224	13.08	.530	14.75	1.20	15.91	.641	***
Concentrated Disadvantage (W1)	-.133	.072	-.133	.078	-.154	.106	.041	.095	**
Mediating Variables									
Concentrate Disadvantage (W4)	-.050	.017	-.058	.022	-.057	.026	.050	.028	***
Adjusted Household Income ($)	42,366	938	42,650	1,442	40,442	2,014	31,933	1,102	***
Currently Employed	.195	.008	.186	.017	.203	.026	.178	.014	
Public Assistance Benefits	.183	.013	.216	.027	.225	.033	.353	.019	***
Close Friends	3.18	.027	3.28	.072	3.18	.071	3.05	.041	**
Married	.461	.013	.343	.026	.334	.039	.258	.017	***
Perceived Isolation	.947	.017	.976	.053	.994	.074	1.07	.031	**
Social Standing	5.26	.054	5.00	.089	5.14	.118	4.39	.070	***
Parental Financial Support	.397	.013	.409	.021	.439	.030	.523	.019	***
Depression	.341	.010	.375	.032	.375	.044	.536	.029	***
Anxiety	4.58	.062	4.78	.122	4.51	.189	5.56	.130	***
Physical Disability	.117	.006	.179	.016	.146	.027	.242	.015	***

*** $p < .001$, ** $p < .01$, * $p < .05$ (two-tailed)

Table 5.3: Logistic Regression of Food Insecurity on Incarceration and Other Covariates

VARIABLES	Model 1 No Controls Odds Ratio	Model 2 Controls Odds Ratio	Model 3 Mediators Odds Ratio
Arrested Only	1.372*	1.478**	1.433*
	(0.183)	(0.201)	(0.207)
Convicted Only	1.651*	2.015**	1.967**
	(0.325)	(0.427)	(0.436)
Prior Incarceration	2.157***	1.984***	1.305*
	(0.250)	(0.263)	(0.184)
Age (W4)		1.001	1.041
		(0.029)	(0.026)
Black		1.681***	1.189
		(0.234)	(0.202)
Hispanic		0.887	0.898
		(0.152)	(0.153)
Other Race		0.825	0.755
		(0.213)	(0.225)
Male		0.626***	0.784*
		(0.065)	(0.091)
Child in Home		1.437**	1.253
		(0.168)	(0.156)
Parent House		0.780	0.459***
		(0.152)	(0.081)
High School Grad		0.501***	0.987
		(0.064)	(0.181)
Child Abuse		1.461**	1.217
		(0.173)	(0.155)
Delinquency Scale (W1)		0.992	0.997
		(0.012)	(0.014)
Hard Drug Use (W1)		1.182	1.186
		(0.151)	(0.169)
Healthy Diet (W1)		0.637**	0.652**
		(0.091)	(0.102)
Depression (W1)		1.066***	1.024**
		(0.008)	(0.009)
Fatalism (W1)		0.963	0.930
		(0.055)	(0.060)
Food Stamps (W1)		1.521**	1.216
		(0.224)	(0.206)
Food Stamp Missing (W1)		1.162	1.138
		(0.143)	(0.161)
Concentrated Disadvantage (W1)		1.150*	1.056

		(0.074)	(0.097)
Concentrated Disadvantage (W4)			1.115*
			(0.050)
mRFEI < 10			0.995
			(0.104)
Household Income (Ln)			0.638***
			(0.051)
Employed			1.049
			(0.121)
Public Assistance (W4)			1.674***
			(0.154)
Friends			0.997
			(0.060)
Married			0.931
			(0.120)
Perceived Isolation			1.091
			(0.073)
Social Standing			0.807***
			(0.029)
Parental Financial Support			2.059***
			(0.224)
Depression (W4)			0.920
			(0.073)
Anxiety			1.236***
			(0.029)
Physical Disability			1.013
			(0.137)
State FE	No	Yes	Yes
Constant	0.106***	0.134*	1.626
	(0.008)	(0.119)	(1.867)
Observations	10,601	10,592	10,592

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)
Standard errors in parentheses

Table 5.4: KHB Test of Mediators between Incarceration and Food Insecurity

Variable	% of Total Effect Mediated	Z-Score
Food Environment Mediator		
mRFEI < 10	-0.66	-0.637
Socioeconomic Mediators		
Concentrated Disadvantage (W4)	0.69	1.723
Household Income (Ln)	13.79	4.291***
Employed	0.02	0.160
Social Welfare Mediator		
Public Assistance Benefits	9.36	3.724***
Social Ties Mediators		
Friends	0.09	0.178
Married	1.9	0.875
Perceived Isolation	0.75	1.031
Parental Financial Support	9.48	3.746***
Psychological Wellbeing Mediators		
Depression	-1.67	-1.079
Anxiety	21.58	4.941***
Physical Disability Mediator		
Physical Disability	0.2	0.121
Social Standing Mediator		
Social Standing	19.2	5.055***

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.5: Logistic Regression of Food Access on Incarceration and Other Covariates

VARIABLES	**Model 1 No Controls Odds Ratio**	**Model 2 Controls Odds Ratio**	**Model 3 Mediators Odds Ratio**
Arrested Only	1.047	0.970	0.979
	(0.104)	(0.096)	(0.099)
Convicted Only	1.032	0.992	0.993
	(0.165)	(0.175)	(0.179)
Prior Incarceration	1.396***	1.302**	1.244*
	(0.126)	(0.127)	(0.122)
Age (W4)		0.985	0.990
		(0.019)	(0.020)
Black		1.236	1.064
		(0.135)	(0.124)
Hispanic		1.007	0.973
		(0.106)	(0.100)
Other Race		0.931	0.905
		(0.134)	(0.133)
Male		0.989	1.000
		(0.055)	(0.056)
Child in Home		0.981	0.978
		(0.071)	(0.074)
Parent House		1.065	1.055
		(0.099)	(0.099)
High School Grad		0.933	1.036
		(0.098)	(0.109)
Child Abuse		0.908	0.905
		(0.077)	(0.078)
Delinquency Scale (W1)		1.016*	1.014
		(0.008)	(0.008)
Hard Drug Use (W1)		0.914	0.923
		(0.084)	(0.084)
Healthy Diet (W1)		1.091	1.079
		(0.111)	(0.107)
Depression (W1)		0.995	0.994
		(0.006)	(0.006)
Fatalism (W1)		1.033	1.026
		(0.041)	(0.042)
Food Stamps (W1)		1.069	1.000
		(0.107)	(0.102)
Food Stamp Missing (W1)		1.185	1.184
		(0.111)	(0.111)
Concentrated Disadvantage (W1)		1.020	0.941

		(0.043)	(0.047)
Concentrated Disadvantage (W4)			2.185*
			(0.709)
Adjusted Income (Ln)			0.983
			(0.049)
State FE	No	Yes	Yes
Constant	1.038	4.178**	3.963
	(0.059)	(2.272)	(2.895)
Observations	10,601	10,598	10,598

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.6: KHB Test of Mediators between Incarceration and mRFEI

Variable	% of Total Effect Mediated	T-statistic
Concentrated Disadvantage	3.36	1.106
Adjusted Income (Ln)	4.14	1.319

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.7: Negative Binomial Regression of Fast-food on Incarceration and Other Covariates

VARIABLES	**Model 1 No Controls Incidence Rate Ratio**	**Model 2 Controls Incidence Rate Ratio**	**Model 3 Mediators Incidence Rate Ratio**
Arrested Only	1.160**	1.078	1.075
	(0.056)	(0.050)	(0.049)
Convicted Only	0.970	0.921	0.915
	(0.082)	(0.075)	(0.074)
Prior Incarceration	1.543***	1.180***	1.177***
	(0.075)	(0.051)	(0.050)
Age (W4)		0.996	0.996
		(0.010)	(0.010)
Black		1.225***	1.226***
		(0.067)	(0.067)
Hispanic		1.154*	1.158*
		(0.068)	(0.068)
Other Race		0.997	1.000
		(0.090)	(0.090)
Male		1.351***	1.355***
		(0.046)	(0.047)
High School Grad		0.934	0.934
		(0.061)	(0.060)
Depression (W1)		1.012**	1.012**
		(0.004)	(0.004)
Concentrated Disadvantage (W1)		1.122***	1.121***
		(0.020)	(0.019)
Healthy Diet (W1)		0.887**	0.892**
		(0.039)	(0.039)
Delinquency Scale (W1)		1.002	1.002
		(0.005)	(0.005)
Employed		0.879**	0.877**
		(0.039)	(0.038)
Household Income (Ln)		0.936*	0.942*
		(0.025)	(0.026)
Married		0.924*	0.924*
		(0.031)	(0.031)
Friends		0.989	0.989
		(0.017)	(0.017)
Perceived Isolation		0.951*	0.950*
		(0.020)	(0.020)
Social Standing		0.985	0.987
		(0.011)	(0.010)
Anxiety		1.023**	1.021**

		(0.008)	(0.008)
Depression (W4)		1.032	1.030
		(0.034)	(0.033)
Fatalism		1.036	1.038
		(0.023)	(0.023)
mRFEI < 10			0.994
			(0.032)
Food Insecure			1.105
			(0.064)
Concentrated Disadvantage (W4)		1.016	1.013
		(0.047)	(0.046)
State FE	No	Yes	Yes
Constant	2.094***	6.294***	5.956***
	(0.073)	(2.473)	(2.416)
Observations	10,597	10,569	10,569

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.8: KHB Test of Mediators between Incarceration and Fast-food

Variable	% of Total Effect Mediated	T-statistic
mRFEI	0.13	.184
Food Insecurity	0.98	1.120

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.9: Negative Binomial Regression of Sugar Consumption on Incarceration and Other Covariates

VARIABLES	**Model 1 No Controls Incidence Rate Ratio**	**Model 2 Controls Incidence Rate Ratio**	**Model 3 Mediators Incidence Rate Ratio**
Arrested Only	1.255***	1.120*	1.117*
	(0.062)	(0.057)	(0.057)
Convicted Only	1.201*	1.034	1.031
	(0.097)	(0.082)	(0.082)
Prior Incarceration	1.608***	1.159***	1.161***
	(0.075)	(0.047)	(0.047)
Age (W4)		1.005	1.005
		(0.008)	(0.008)
Black		0.894*	0.893*
		(0.040)	(0.040)
Hispanic		0.790***	0.794***
		(0.033)	(0.033)
Other Race		0.884	0.882
		(0.057)	(0.057)
Male		1.426***	1.428***
		(0.046)	(0.046)
High School Grad		0.756***	0.759***
		(0.047)	(0.047)
Depression (W1)		1.011**	1.010*
		(0.004)	(0.004)
Concentrated Disadvantage (W1)		1.066***	1.066***
		(0.020)	(0.020)
Healthy Diet (W1)		0.924	0.927
		(0.041)	(0.042)
Delinquency Scale (W1)		1.008	1.008*
		(0.004)	(0.004)
Employed		0.993	0.994
		(0.039)	(0.039)
Household Income (Ln)		0.889***	0.896***
		(0.020)	(0.020)
Married		1.004	1.004
		(0.034)	(0.034)
Friends		0.971*	0.970*
		(0.014)	(0.014)
Perceived Isolation		0.964*	0.962*
		(0.018)	(0.018)
Social Standing		0.936***	0.938***
		(0.008)	(0.008)
Anxiety		1.013	1.011

		(0.007)	(0.007)
Depression (W4)		1.036	1.036
		(0.031)	(0.031)
Fatalism (W1)		1.028	1.029
		(0.020)	(0.020)
Concentrated Disadvantage (W$)		1.012	1.015
		(0.066)	(0.068)
mRFEI < 10			0.957
			(0.029)
Food Insecurity			1.129**
			(0.052)
State FE	No	Yes	Yes
Constant	10.326***	65.674***	62.238***
	(0.275)	(21.248)	(20.267)
Observations	10,587	10,559	10,559

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.10: KHB Test of Mediators between Incarceration and Sugar Consumption

Variable	% of Total Effect Mediated	T-statistic
mRFEI	-1.07	1.101
Food Insecurity	1.89	1.369

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.11: Logistic Regression of Waist-to-Height Ratio on Incarceration and Other Covariates

VARIABLES	**Model 1 No Controls Odds Ratio**	**Model 2 Controls Odds Ratio**	**Model 3 Mediators Odds Ratio**
Arrested Only	0.896	0.911	0.905
	(0.088)	(0.089)	(0.089)
Convicted Only	0.986	1.042	1.030
	(0.204)	(0.215)	(0.215)
Prior Incarceration	0.912	0.823*	0.816*
	(0.083)	(0.081)	(0.080)
Age (W4)		1.076***	1.075***
		(0.021)	(0.021)
Black		1.032	1.022
		(0.106)	(0.107)
Hispanic		2.064***	2.065***
		(0.272)	(0.273)
Other Race		0.832	0.832
		(0.132)	(0.132)
Male		1.041	1.055
		(0.076)	(0.078)
High School Grad		1.097	1.119
		(0.171)	(0.171)
Fatalism (W1)		0.933	0.934
		(0.039)	(0.039)
Child Abuse		1.104	1.092
		(0.094)	(0.093)
Delinquency Scale (W1)		0.991	0.992
		(0.008)	(0.008)
Hard Drug Use (W1)		1.039	1.034
		(0.113)	(0.111)
Concentrated Disadvantage (W1)		1.149**	1.145**
		(0.057)	(0.057)
Subjective Health (W1)		1.269***	1.265***
		(0.051)	(0.051)
Healthy Diet (W1)		0.841	0.852
		(0.109)	(0.111)
Physical Activity (W1)		1.000	1.001
		(0.018)	(0.018)
Physical Activity (W4)		0.983**	0.982**
		(0.005)	(0.005)
Television Hours (W1)		1.006*	1.006*
		(0.002)	(0.002)
Television Hours (W4)		1.005	1.005
		(0.003)	(0.003)

Fast-food (W4)		0.998	0.997
		(0.011)	(0.011)
Sugar (W4)		0.999	0.999
		(0.003)	(0.003)
mRFEI < 10			0.924
			(0.060)
Food Insecurity			1.253
			(0.163)
State FE	No	Yes	Yes
Constant	3.544***	0.362	0.382
	(0.186)	(0.215)	(0.225)
Observations	10,601	10,534	10,534

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.12: KHB Test of Mediators between Incarceration and WTHR

Variable	% of Total Effect Mediated	T-statistic
mRFEI	4.11	1.439
Food Insecurity	-7.33	1.777

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.13: Negative Binomial Regression of Subjective Health Status on Incarceration and Other Covariates

VARIABLES	Model 1 No Controls Odds Ratio	Model 2 Controls Odds Ratio	Model 3 Mediators Odds Ratio
Arrested Only	1.015	1.019	1.015
	(0.019)	(0.016)	(0.016)
Convicted Only	1.011	1.013	1.006
	(0.027)	(0.024)	(0.023)
Prior Incarceration	1.116***	1.050**	1.043*
	(0.018)	(0.017)	(0.017)
Age (W4)		0.998	0.998
		(0.003)	(0.003)
Black		1.028	1.020
		(0.015)	(0.015)
Hispanic		1.079***	1.079***
		(0.020)	(0.020)
Other Race		1.064*	1.066*
		(0.029)	(0.030)
Male		0.978	0.986
		(0.011)	(0.011)
High School Grad		0.942*	0.951*
		(0.022)	(0.022)
Fatalism (W1)		1.015*	1.015*
		(0.006)	(0.006)
Child Abuse		1.045***	1.040**
		(0.013)	(0.013)
Delinquency Scale (W1)		0.999	0.999
		(0.001)	(0.001)
Hard Drug Use (W1)		1.030	1.028
		(0.017)	(0.017)
Concentrated Disadvantage (W1)		1.032***	1.030***
		(0.006)	(0.006)
Subjective Health (W1)		1.104***	1.101***
		(0.008)	(0.007)
Healthy Diet (W1)		0.972	0.978
		(0.016)	(0.016)
Physical Activity (W1)		0.999	0.998
		(0.002)	(0.002)
Physical Activity (W4)		0.991***	0.991***
		(0.001)	(0.001)
Television Hours (W1)		1.001	1.000
		(0.000)	(0.000)
Television Hours (W4)		1.002***	1.002***
		(0.000)	(0.000)

Fast-food (W4)		1.004	1.003
		(0.002)	(0.002)
Sugar (W4)		1.002***	1.002***
		(0.000)	(0.000)
mRFEI < 10			1.005
			(0.010)
Food Insecurity			1.123***
			(0.016)
State FE	No	Yes	Yes
Constant	2.267***	2.012***	1.993***
	(0.023)	(0.173)	(0.162)
Observations	10,601	10,545	10,545

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.14: KHB Test of Mediators between Incarceration and Subjective Health Status

Variable	% of Total Effect Mediated	T-statistic
mRFEI	.86	.611
Food Insecurity	14.17	3.053**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table 5.15: Summary of Support for Hypotheses

Hypothesis	Prediction	Support
H1	Formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to be food insecure	?
H2	The proportion of food retailers in a tract that are healthy will partially mediate the relationship between incarceration and food insecurity.	X
H3a	The association between incarceration and food insecurity is mediated by socioeconomic status.	?
H3b	The association between incarceration and food insecurity is mediated by social ties.	?
H3c	The association between incarceration and food insecurity is mediated by social welfare.	✓
H3d	The association between incarceration and food insecurity is mediated by physical disability.	X
H3e	The association between incarceration and food insecurity is mediated by psychological wellbeing.	?
H3f	The association between incarceration and food insecurity is mediated by social standing.	✓
H4	Formerly incarcerated individuals will be more likely than those who have not been previously incarcerated to live in census tracts with lower access to healthful food retailers.	?
H5a	The association between incarceration and access to food retailers is mediated by neighborhood disadvantage.	X
H5b	The association between incarceration and access to food retailers is mediated by socioeconomic status.	X
H6a	H6a. The association between incarceration and poor nutrition is mediated by food insecurity.	X
H6b	H6b. The association between incarceration and poor nutrition is mediated by proportion of food retailers in a tract that are healthy.	X
H6c	H6c. The association between incarceration and poor health is mediated by food insecurity.	?
H6d	H6d. The association between incarceration and poor health is mediated by proportion of food retailers in a tract that are healthy.	X

Key: ✓ = hypothesis supported; X = hypothesis not supported; ? = hypothesis partially supported.

CHAPTER 6: CONCLUSIONS

Overview of Findings

In the coming years, hundreds of thousands of individuals will be released from prison and millions will continue to cycle through local jails. Formerly incarcerated individuals will face a number of stressors and hardships during the reintegration process and many will reside in disadvantaged communities with limited access to resources necessary to meet basic daily needs. However, despite the importance of this body of research, there is limited attention to the association between incarceration and post-release nutritional hardships. This dissertation aimed to fill this gap.

In this concluding chapter, I begin by reviewing the major conclusions reached from the analyses presented in chapter 5. I then highlight how these findings extend prior literature on the consequences of contact with the criminal justice system, as well as the field of criminology more broadly. I also discuss the implications of the findings for policy purposes. Finally, I conclude with a discussion of the limitations of the current study and directions for future research.

Food Insecurity

The first research question addressed whether formerly incarcerated individuals would be more likely than those who have not been previously incarcerated to be food insecure. The results provided mixed support for the association between incarceration and food insecurity. In a bivariate model, formerly incarcerated individuals are found to be approximately twice as likely as those who never experienced contact with the criminal justice system to be food insecure. Further analysis revealed much of this

difference was accounted for by characteristics that are considered risk or protective factors for food insecurity rather than incarceration itself. Still, even after controlling for confounding characteristics, formerly incarcerated respondents were significantly more likely than those without prior contact with the criminal justice system to be food insecure. These results provide the first set of evidence that food insecurity is a form of hardship that formerly incarcerated individuals experience at higher rates than their non-incarcerated counterparts.

Next, additional analyses were conducted where the reference category was changed from those with no contact with the criminal justice system to arrested only or convicted only respondents. These analyses sought to account for unobserved characteristics that may bias the association between incarceration and food insecurity by narrowing the reference category to those who had prior contact with the criminal justice system but were not previously incarcerated. Thus, by narrowing the reference category these models should better control for any factors that might bias the link between incarceration and nutritional hardships. The results indicate that there was no statistically significant difference in the likelihood of experiencing food insecurity when formerly incarcerated individuals were compared to either convicted only or arrested only respondents. These models suggest that selection processes underlie much of the relationship between incarceration and food insecurity. Therefore, these results indicate there is no independent effect of incarceration on food insecurity when using a more rigorous comparison group that accounts for unobservable characteristics that may be related to both criminal offending and experiencing hardship.

Interestingly, when compared to convicted only respondents, the relationship between incarceration and food insecurity became negative, although this relationship was not statistically significant. The finding of a negative association between incarceration and food insecurity when convicted only respondents were used as a reference category was unanticipated. It may be that incarceration is in some ways protective against food insecurity relative to those who obtain a criminal conviction but are not incarcerated. For instance, a criminal conviction can lead to stigma, financial sanctions, as well as collateral consequences such as the loss of employment or public assistance benefits (Harris, Evans & Beckett, 2010; Olivares, Burton & Cullen, 1996; Sugie & Turney, 2017). While there has been a growth in reentry services to safeguard against the consequences of incarceration, such as job training, assistance finding affordable housing, and reestablishing public assistance benefits, these resources tend to be less available for those with a criminal conviction only (Chin, 2017). Therefore, one explanation is that formerly incarcerated individuals receive specific types of services that can protect against becoming food insecure upon release, whereas those who receive a criminal conviction but do not serve time behind bars receive the consequence of a criminal conviction without ample services to protect against the risk of food insecurity.

The second research question sought to address whether the composition of the food retail environment at the census-tract level mediated part of the association between incarceration and food insecurity. In contrast to hypothesis 2, there was no mediation effect of the proportion of retailers in a census tract that are considered healthy on the association between incarceration and food insecurity. This finding stands in contrast to literature suggesting that living in areas with lower access to food retailers is related to

food insecurity (Garasky et al., 2006; Ma et al., 2016; Pérez et al., 2017). Still, the result is consistent with other literature that finds food insecurity is not mitigated by proximity to food retailers and high rates of food insecurity are also found in neighborhoods with good geographic access to healthy food retailers (Kirkpatrick & Tarasuk, 2010).

It is possible that the lack of a mediation effect is a result of the way the local food retail environment was measured. The CDC's modified retail food environment index characterizes the food retail environment by providing the ratio of healthy to unhealthy food retailers. However, the variable does not measure the lack of access to food retailers. Rather the measure is intended to capture the absence of healthy food retailers or an imbalance of unhealthy food retailers to healthy food retailers within a geographic area. This may explain the finding of no mediation effect as an area that lacks healthy food retailers but contains unhealthy food retailers may reduce the likelihood of food insecurity by providing local residents access to low cost, high calorie foods options.

Alternatively, a measure that captures the absence of any food retailers – both healthy and unhealthy – may produce different results. In other words, having no access to any type of food retailer could be a greater risk factor for food insecurity rather than having low access to healthy food retailers. Future research should investigate this question using different measures of the local food retail environment and specifically address whether living in an area that does not have access to any food retailers mediates the association between incarceration and food insecurity. Another explanation is that other features of communities such as food pricing, accessibility to transposition, or local housing cost may matter more than the distance to local food retailers, especially among

economically disadvantage households (Bartfeld, Ryu, & Wang, 2010; Morrissey, Jacknowitz, & Vinopal, 2014; Rose, 2010).

The third research question assessed whether several factors considered consequences of incarceration would mediate the association between prior incarceration and food insecurity. In total, the mediators reduced the effect of incarceration on food insecurity by over 70 percent and several mediator variables demonstrated substantive and statistically significant mediation effects.

First, this dissertation assessed the mediating role of socioeconomic characteristics. In regard to socioeconomic status, only household income emerged as a significant mediator, reducing the relationship between incarceration and food insecurity by 13.79 percent. This finding is consistent with prior literature that demonstrates food insecurity is largely a condition of economic hardship (Coleman-Jensen, 2016; Gundersen et al., 2011; Nord, 2014; Rose, 1999). Thus, the results of the mediation analysis suggest that formerly incarcerated individuals – who have lower levels of household income compared to their non-incarcerated counterparts (see Table 5.2) – are at heightened risk for food insecurity in part because of financial hardship. Accordingly, a key area for intervention to alleviate the risk of food insecurity among former inmates is policies and programs that can improve economic opportunities among formerly incarcerated individuals and their households.

Next, the mediating role of receiving social welfare was also assessed. Receiving public assistance mediated the association between incarceration and food insecurity by 9.36 percent. This result is consistent with past research that finds access to public assistance benefits can reduce the likelihood of food insecurity (Gundersen et al., 2017;

Waxman, 2017). The measure used in the current study captured receiving any form of public assistance benefits at wave VI and therefore could not isolate the impact of receiving benefits specifically intended to reduce food insecurity such as food stamps (Coleman-Jensen, 2016; Gundersen et al., 2017). However, public assistance programs in any form can be beneficial in reducing food insecurity by alleviating economic hardship (Waxman, 2017). For instance, low income households often choose how to allocate limited resources between competing demands such as housing and food. Therefore, providing benefits that reduce the burden of housing costs can increase available money to purchase food (JCHS, 2013; Waxman, 2017).

Social ties were also hypothesized to mediate the association between incarceration and food insecurity. Among the measures of social ties, parental financial support mediated the link between incarceration and food insecurity by 9.48 percent. An explanation for this finding is that individuals who have low economic status and rely on financial support from their parents in young adulthood are at an increased likelihood of food insecurity.[46] On the other hand, this result suggests that the ability to tap into social support networks for financial assistance can potentially alleviate hardships. Accordingly, individuals who have stronger ties to their families, and come from families with financial means to provide support may be shielded against food insecurity.

This finding is relevant when evaluated in the context of literature on the consequences of incarceration. For example, prior research finds incarceration can harm relationships with family members (Comfort, 2008; Massoglia et al., 2011). Therefore,

[46] A subsequent analysis demonstrates this point as there is a negative correlation between adjusted household income and receiving parental financial support (r = -.232, p < .001).

incarceration could increase the risk of food insecurity by weakening social ties to family members and cutting off avenues of financial support. Moreover, recent work finds that formerly incarcerated individuals have greater financial dependency on their parents in young adulthood (Siennick & Widdowson, 2017). Thus, the finding that parental financial support mediates the association between incarceration and food insecurity is consistent with research that suggests incarceration can hinder both financial stability and age-appropriate development leading formerly incarcerated individuals to rely more heavily on support from their immediate family in order to avoid hardships (Western et al., 2015).

Still, the measure of parental financial assistance is limited as it only indicates whether a respondent had received financial support of $50 or more in the past year. Future work in this area should seek alternative sources of data that provide the actual amount of financial assistance or the reasons why financial assistance was received (i.e. to buy food or pay bills) in order to further understand this relationship. It would also be beneficial to understand whether family members provide any other forms of support aside from financial assistance. One possibility is that parents only provide financial support, which alleviates food insecurity in the short term but withhold other types of support that can help formerly incarcerated individuals gain financial independence and sustained food security status. In other words, "it may be that parents are willing to provide former inmates with certain forms of support (e.g., instrumental support), but unwilling or unable to provide other forms (e.g., vouching for their reputation in a job reference), which might keep young adults financially dependent" (Siennick & Widdowson, 2017: p. 413).

Psychological well-being was anticipated to mediate the association between incarceration and food insecurity. Among the measures of psychological well-being only anxiety symptoms emerged as a significant mediator providing partial support for hypothesis 3e. Overall, anxiety reduced the association of incarceration and food insecurity by 21.58 percent. Understanding the relationship between anxiety and food insecurity is complex as food insecurity often co-occurs with anxiety symptoms (Hamelin, Beaudry & Habicht, 2002; Leung et al., 2015; Whitaker et al., 2006). One possibility is that experiencing food insecurity can lead to emotional distress because of constant worrying about where to obtain future meals (Whitaker et al., 2006). Alternatively, experiencing anxiety can increase the risk of becoming food insecure by reducing coping skills needed during times of limited resources. As anxiety symptoms and food insecurity are measured concurrently in Add Health it is not possible to assess the temporal order. However, future research using data that includes measures of both food insecurity and anxiety at multiple time points should further investigate the complex association between anxiety and food insecurity.

Finally, there were theoretical reasons to expect that diminished social standing would yield a mediation effect. In support of this prediction the measure of social standing was found to mediate the relationship between incarceration and food insecurity by 19.2 percent. Consistent with prior research formerly incarcerated individuals were found to report lower subjective status than those who have not been previously incarcerated (Schnittker & Bacak, 2013). The mediation effect exhibited by social standing suggests a few possibilities. First, declines in social status could reflect a detachment from social institutions that can help an individual avoid food insecurity. For

instance, a loss of status is often associated with an internalization of stigma that manifest in feelings that an individual is untrustworthy (Schnittker & Bacak, 2013). If an individual believes that they cannot be trusted with being loaned money or the use of a car they may be less likely to seek out specific types of assistance that would help to avoid food insecurity. Alternatively, just as incarceration or a criminal conviction can reduce one's social standing, food insecurity may also be linked with diminished social standing. Some research suggests that experiencing food insecurity is associated with individual perceptions of struggling or suffering (Frongillo et al., 2017). Therefore, experiencing the stigma of incarceration combined with being unable to obtain adequate food can both be stigmatizing experiences that reduce subjective standing.[47] Finally, the wording of the item used to assess social standing in Add Health asks respondents to compare themselves to others in terms of money, education, and job status. Based on the wording of the question, subjective social standing may also be capturing financial strain (i.e. lack of money or quality employment). Therefore, the observed mediation effect could be the result of financial strain experienced by formerly incarcerated respondents. Because the Add Health data measures social standing, criminal justice contact, and food insecurity concurrently at wave IV, this study is unable to disentangle the temporal ordering. Future research that continues to address the interplay of criminal justice contact, subjective social standing, and food insecurity status would be valuable.

[47] A subsequent analysis indicates that formerly incarcerated individuals who are also food insecure report a social standing score of 3.669. In comparison, formerly incarcerated individuals who are not food insecure have a social standing score of 4.562. Results, from a t-test indicate that these differences are statistically significant (*t-statistic* = 8.574, $p < .001$).

Food Access

The fourth research question addressed whether formerly incarcerated individuals would have less access to healthy food retailers. The goal of this question was to unite criminological literature on the consequences of incarceration with growing public health literature on local food retail environments (Lytle & Sokol, 2017; Walker et al., 2010). To address this question the current study incorporated a novel measure of food access that provides a ratio of healthy to unhealthy food retailers in a census tract and the half mile buffer surrounding the census tract (CDC, 2011).

The results demonstrated that compared to those with no prior criminal justice contact there is a strong association between incarceration and living in an area with low access to healthy food retailers. This association remained even after accounting for confounding characteristics relevant to living in economically disadvantaged neighborhoods such as household income and concentrated disadvantage.

However, when the reference category was changed to either arrested only or convicted only respondents, formerly incarcerated individuals have a positive but not statistically significant association with living in a tract with low access to healthy food retailers. These results indicate that when using a more rigorous reference category there appears to be no direct effect of incarceration on low access to healthy food retailers. Rather the results suggest that respondents who are more likely to commit crime are also more likely to reside in communities that are devoid for resources such as healthy food retailers.

Overall, the null results for both nutritional hardship outcomes when changing the reference category suggest that there is no direct link between incarceration and

nutritional hardship when unobservable are accounted for through the use of strategic comparison groups. Accordingly, these results suggest that future research aiming to isolate the impact of incarceration on outcomes of interest by accounting for unobservable factors should utilize more rigorous reference categories such as those who had prior contact with the criminal justice system but were not previously incarcerated (see Apel & Sweeten, 2010; Porter, 2014). Indeed, controlling for observable variables is limited by items and quality of measures available in a given dataset. Often research using survey data may be unable to account for factors related to criminal offending and outcomes of interest, such as low motivation, impulsive behavior, or latent personality characteristics that predispose an individual to engage in deviant activity rather than conforming behaviors. It is likely that changing the reference category to those who are involved in criminal activity but not previously incarcerated begins to partially account for some of these factors and therefore explains the reduction in the association between incarceration and nutritional hardships.

Still, the results begin to provide a deeper understanding into the resource deprivation that exists within communities where formerly incarcerated individuals reside. Prior criminological work finds that formerly incarcerated individuals live in areas marked by greater concentrated disadvantage (Hipp, Petersilia, & Turner, 2010; Kubrin & Stewart, 2006), and that incarcerations itself can further exacerbate downward neighborhood mobility (Massoglia et al., 2013; Warner, 2016). Although prior research notes that these communities are underserved by critical resources and services, there is little investigation into what specific types of resources are lacking in these communities (Harding et al., 2013). Therefore, a key contribution of this study was to draw attention to

the lack of access to specific types of retailers that provide basic daily needs to local residents. In particular, healthy food retailers were identified as one type of critical resource that is stretched thin within communities where formerly incarcerated individuals live.

There are a few reasons why formerly incarcerated individuals have less access to healthy food retailers when compared to those without criminal justice contact. First, the association may be in part explained by economic deprivation. Healthy food retailers sell food items that are generally more expensive, and since formerly incarcerated individuals reside in more disadvantaged communities, economic hardship could partially explain why healthy food retailers are less likely to open stores in these areas. However, even after controlling for household income and concentrated disadvantage, the negative association between incarceration and access to healthy food retailers remains. Moreover, this study did not find a significant mediation effect of either household income or neighborhood disadvantage on the association between incarceration and access to healthy food retailers.

A second possibility is that the presence of formerly incarcerated individuals may create a stigma of local areas and deter businesses from locating there (Fagan et al., 2003). For example, businesses including food retailers are reluctant to locate in areas that will not attract a profitable clientele that would be necessary for success (Pothukuchi, 2005). In contrast, fast-food restaurants are more often found in poor urban communities that are also more likely to have higher rates of incarceration. As explained in chapter 2, millions of dollars in federal grants have been provided to poor urban communities since the 1960s with the purpose of starting fast-food chain restaurants as means to spur

entrepreneurship and alleviate poverty (Jou, 2017). However, an unintended consequence of this program was that the grants generated a large growth of fast-food restaurants within these communities and altered dietary preferences among local residents from fresh fruits and vegetables to fast-food items (Freeman, 2007).

Finally, another potential explanation is the composition of the food retail environment is a response to the demand for specific types of foods from local residents. Results from this study found formerly incarcerated individuals consume fast-food and sugary beverages at higher rates than their non-incarcerated counterparts (see also Porter, 2014). Accordingly, food retailers may recognize that there is higher demand for unhealthy foods (i.e. fast-food and sugary beverages) and less demand for healthy food retailers in certain communities. Therefore, the disparities in accessibility to healthy food retailers could be reflective of demands for specific types of food items from residents in local communities.

Nutritional Hardship Health and Nutrition

This dissertation also examined whether nutritional hardships mediated part of the relationship between incarceration and (1) nutritional behavior – fast-food consumption and sugar consumption – and (2) health outcomes – waist-to-height ratio and subjective health status. The mediation analyses provided little support for the proposed hypotheses. Access to healthy food retailers was found to have statistically non-significant mediation effect across all four outcomes, while food insecurity was only found to have a significant mediation on the association between incarceration and subjective health status.

One explanation for the absence of a mediation effect between access to healthy food retailers and nutritional behavior is that because ex-inmates face large financial and social hardships they may be constrained to eating cheaper food regardless of what types of food retailers are available in their communities. For instance, Porter (2014) finds that former inmates consume more fast-food in part because of financial instability and low social status. It is therefore possible that regardless of whether healthy food retailers are available, formerly incarcerated individuals will consume less healthy food as a result of these hardships. Indeed, subsequent analyses reported in chapter 5 demonstrated that both household income and social standing had significant mediation effects on fast-food and sugar consumption. Thus, adding healthier food retailers to underserved communities on its own may not be enough to change the nutritional behavior of formerly incarcerated individuals. Rather altering nutritional behavior may also require efforts that improve the financial situation of former inmates.

Regarding health outcomes, formerly incarcerated individuals were found to be significantly less likely than those without criminal justice contract to have an unhealthy weight but did report significantly worse subjective health status. The finding that formerly incarcerated individuals are less likely to be overweight than those without criminal justice contract is not entirely surprising.[48] Past research notes that engaging in

[48] Additionally, because the relationship between food insecurity and obesity varies by sex (Gooding et al., 2012), I conducted additional analyses estimating the predicted probability of having a waist-to-height ratio above 0.5 by food insecurity status for males and females separately. The results show that among males the probability of having a WTHR greater than 0.5 is .775 for insecure respondents and .783 for non-food insecure respondents. For females, the probability of having a WTHR above 0.5 is .854 for food insecure respondents compared to .790 for non-food insecure respondents. This result is consistent with prior research showing that food insecurity is a more salient risk factor for obesity for females than males.

criminal offending is physically demanding and individuals often enter prison with a healthier weight status than the general population (Farrington, 1995; Maddan, Walker & Miller, 2008). Moreover, the finding that formerly incarcerated individuals report lower subjective health status than their non-incarcerated counterparts is consistent with prior research (Esposito et al., 2017; Massoglia, 2008).

This study also assessed whether nutritional hardships explained part of the association between incarceration and subjective health status. The findings indicated that relative to those without criminal justice contact, formerly incarcerated individuals reported worse health, although these results did not significantly differ when compared to the arrested only or convicted only respondents. Food insecurity status was found to have a positive and statistically significant association with poor subjective health, as well as mediate the association between incarceration and health status by approximately 14 percent. This finding is consistent with prior literature that demonstrates food insecurity can lead to declines in subjective health (Stuff et al., 2004; Vozoris & Tarasuk, 2003).

There are a few possible explanations for the link between food insecurity and poor health. For one, food insecurity is likely associated with malnutrition and nutrient deficiency which should lower overall health functioning (Dixon, Winkleby & Radimer, 2001; Kirkpatrick & Tarasuk, 2008). Second, facing food insecurity can raise stress and anxiety which can produce hormonal imbalances and compromise overall health (Herrmann et al., 2001; Stuff et al., 2004). Third, food insecurity can reduce physical activity as food insecure individuals are more likely to feel too tired to exercise (Fram et al., 2015). Finally, food insecure individuals are at risk of overeating at times when food

is available. This is problematic as chronic fluctuations between times of low calorie intake and overeating can contribute to metabolic changes that promote fat storage (Bove & Olson, 2006; Finney Rutten et al., 2010; Laraia et al., 2015). This risk may be even greater in low-income communities where cheap, energy-dense foods are more readily available.

Limitations and Future Directions

Limits of Criminal Justice Contact Measures

As with any research there are limitations with the current study that should be expanded upon in future research. First, a common limitation among research on the consequences of incarceration is that there may be important unobserved differences between those who were previously incarcerated and those who were not. While Add Health provides a rich set of variables that capture relevant background characteristics there remain relevant factors that could not be accounted for. For example, characteristics that are related to criminal behavior such as the offense severity or offense history, as well as other measures related to the decision to sentence to incarceration are unavailable. Second, the binary measure of incarceration in the Add Health data misses potentially important information on whether an individual was incarcerated in jail, state or federal prison, or some other type of correctional facility. Moreover, information on experiences while incarcerated that may be related to post-release outcomes such as nutritional hardships and health are also unavailable. In light of these unobserved factors it should be noted that the analysis is limited by the inherent difficulty in identifying causal

relationships using observational data (Kirk & Wakefield, 2018). While this study sought to control for a host background characteristics, as well as use strategic comparison groups such as respondents who were arrested only or convicted only to limit the influence of selection effects, it remains possible that differences found are driven by unobserved heterogeneity.

Third, the current study uses a self-reported measure of prior incarceration and involvement with the criminal justice system (i.e. arrest or conviction). Although self-report data on prior incarceration is used commonly in research (Brayne, 2014; Porter, 2014; Siennick et al., 2014; Saperstein, Penner, & Kizer, 2014; Sugie & Turney, 2017), there may be misreporting among respondents about previous contact with the criminal justice system (Kirk & Wakefield, 2018). For instance, Kirk (2006) finds substantial differences in juvenile arrests when comparing self-report arrest to administrative records from the Project on Human Development in Chicago Neighborhoods (PHDCN). Geller and colleagues (2016) linked a subsample of data from the Fragile Families and Child Wellbeing Study with administrative criminal history records and found that questions regarding the prevalence of father's incarceration was underestimated by approximately 20 percent in the survey compared to administrative records. While no research to date examines underreporting related to incarceration in the Add Health dataset, it remains possible that individuals who were previously incarcerated failed to report this information during interviews.

To overcome these limitations discussed above, future research should investigate the association between incarceration and nutritional hardships using alternative sources of data, such as administrative records that provide greater detail of prior criminal justice

system involvement and experiences while incarcerated. Research that assesses whether the results of the current study are similar when using administrative data would be valuable.

Limits with Add Health Sample

Another potential limitation of the Add Health data is the age range of respondents at wave IV (24 – 32 years old). On one hand, using a sample of young adults can be considered a strength of the study as the findings of this study can be generalized to the segment of the population in the age range most prone to incarceration (Carson & Sabol, 2016). However, in regard to the health outcomes measured, it is possible that any harmful effects of nutritional hardships on health have not manifested given the age of the Add Health sample. Prior work finds that both subjective well-being and a number of medical conditions are closely related to age (Steptoe, Deaton, & Stone, 2015). For instance, in the United States, 41 percent of middle-age adults (40-59 years old) are obese compared to 34 percent of young adults (20-39 years old) (Segal, Rayburn, & Martin, 2016). Therefore, nutritional hardships could translate into poor health outcomes such as obesity, chronic disease, and premature morality in the future as respondents grow older (Gundersen et al., 2011, 2017).

Future research should assess questions such as whether nutritional hardship mediates part of the relationship between incarceration and negative health outcomes with alternative data that offer a broader age range beyond young adulthood. This would be a particularly important question given that the age of the incarcerated population has increased overtime (Carson & Sabol, 2016; Porter et al., 2016) suggesting that future

cohorts of individuals released from prison will be older in age and potentially more prone to negative health effects of nutritional hardships. One possibility in the near future is for research to update the current study using data from wave V of the Add Health study, which is slated to be released after 2018. In wave V, respondents will be aged 34 to 42 years old. It may be that as individuals progress from young adulthood to middle adulthood the harmful effects from experiencing food insecurity and low access to healthy food retailers could begin to result in health problems.

Second, some research on the consequences of incarceration employs fixed-effects analysis that uses each respondent s their own control and holds all time invariant factors constant (Massoglia et al., 2013; Schnittker & John, 2007; Sugie & Turney, 2017; Western, 2002). While within person change models are an empirically strong approach to the causal effect of incarceration (Massoglia & Warner, 2011; Wildeman & Muller, 2012), datasets such as Add Health are not suitable for fixed-effects analysis because certain measures are only collected at one wave and the wording of specific certain items change across waves (Porter & King, 2015). As data that contain relevant measures such as incarceration, food insecurity, and access to healthy food retailers overtime become available, future research should examine the association between incarceration and nutritional hardships using fixed-effects methods.

Third, the measure of census tract of residence is captured at one point in time in the Add Health data. Prior research finds that residential mobility is common among formerly incarcerated individuals (Harding et al., 2013; Warner & Sharp, 2016) and residential mobility is also related to an increased risk of food insecurity (Bartfeld & Dunifon, 2006; Tapogna et al., 2004). However, the current study was unable to capture

the impact of residential mobility. Future research should seek to assess whether residential mobility among formerly incarcerated individuals impacts the likelihood of becoming food insecure.

Additionally, key variables used in this study, including food insecurity, access to healthy food retailers, and several mediator variables were measured concurrently at wave IV in the Add Health Study. Accordingly, it is not possible to establish temporal ordering between the independent variable and several mediators. Therefore, it remains possible that any differences resulting from these mediators may be the result of pre-existing differences that are also associated with the likelihood of being incarcerated (i.e. economic hardship). Future research should assess the association between incarceration and nutritional hardships using alternative sources of data that include these relevant measures at multiple time points.

Finally, social and economic conditions and criminal justice policies will vary across states and localities (Harding et al., 2013). One strength of the current study is that it drew from a diverse nationally representative sample. Still, future research can assess the questions posed by this dissertation using data from specific states or localities. Doing so can provide more detailed information about the nutritional hardships faced by specific populations and how these challenges vary across localities. Moreover, this research could also uncover unique challenges that are faced in certain areas, as well as specific policy solutions that can be implemented at the state or local level to help alleviate nutritional hardships among formerly incarcerated populations.

Limits with Nutritional Hardship Measures

There are also limitations with the measures of nutritional hardship used in the current study. In regard to the measure of food insecurity, this current study is only able to draw from one question of a more detailed 18-item survey that is used by the USDA to measure food insecurity.[49] The recommended criterion to measure household food insecurity is to code households as food insecure if they answer affirmatively to at least 3 of the 18 questions in the USDA food security survey. Although past research using Add Health data has used this single item to classify respondents as food insecure (Gooding et al., 2012), relying on a single item has limitations. For example, this procedure prevents the ability to capture heterogeneity within levels of food insecurity, such as cases where respondents report very low food security (where household members reported experiencing hunger because they could not afford to purchase food).[50] Additionally, it is also possible that reliance on only one item may misclassify some respondents as food insecure compared to the more detailed measure.

However, there are at least three reasons why the measure of food insecurity used in this dissertation should be considered valid. First, the USDA standard is that an affirmative response to the question used in this study indicates that a respondent is food insecure (Gooding et al., 2012). Second, there is a high correlation with the question of food insecurity used in this study and other items in the full 18-item USDA scale. One recent study found that the single item used in this dissertation correctly classifies 83% of

[49] The official USDA Core Food Security Module contains 18 questions for households with children and a subset of 10 of the 18 questions for households without children (Gundersen et al., 2011).

[50] Households without children that answer affirmatively to six or more questions are defined as very low food secure.

respondents as food insecure when compared with the full 18-item survey (Gitterman et al., 2015). Third, the food insecurity rate in the Add Health data is similar to the rate in the national sample collected by the USDA in 2008. Specifically, the USDA measures household food insecurity using a national sample of about 50,000 households from the Current Population Survey, which is conducted annually in December of each year (Coleman-Jensen et al., 2016). In 2008, the USDA reported a national food insecurity rate of 14.6 percent. In contrast, respondents in the Add Health sample who were interviewed in the month of December reported only a slightly higher food insecurity rate of 15.9 percent.[51] Still, future research should investigate the association between incarceration and food insecurity using alternative data sources that contain multiple items from the full USDA food security survey. Doing so will enable researchers to look beyond the question of whether or not formerly incarcerated individuals are at risk of food insecurity examine but also heterogeneity within the measure and assess whether formerly incarcerated individuals are at a greater risk for severe levels of food insecurity (i.e. very low food insecurity).

Next, there are also limitations with the measure of access to food retailers. Some research raises concerns with the accuracy of geocoding commercial food retailers potentially leading to over or undercounting of retailers in a given area (Liese et al.,

[51] It is important to note that because of the recession in 2008, the food insecurity rate grew throughout the year and therefore differed based on which month respondents were interviewed. For example, the food insecurity rate was in the Add Health Sample was 11.1 percent in January 2008 but had risen to 15.9 percent by December 2008 when the economic effects of the recession had taken a more pronounced effect. A subsequent analysis re-estimated all models including a series of dummy variables for the month of interview and these results remained substantively similar to the main results reported in chapter 5.

2010; Sharkey & Horel, 2008). In order to account for this, the CDC combined data from several different sources to improve the accuracy of geocoding. Second, commercial datasets provide information on the type of retailers (i.e. healthy or unhealthy) but cannot verify that specific retail outlets sell healthy food options. That is to say, researchers did not verify which food products were sold by small grocery stores and convenience stores but rather relied on general information such as the classification of the food retailer by the NAICS code. Notably, prior research has found that the amount of healthy food items sold in unhealthy retailers can vary across communities. Horowitz and colleagues (2004) study of food retailers in New York City finds that only 18 percent of small grocery stores in predominately minority neighborhoods carried healthy food options compared to 58 percent in predominately white areas. Therefore, a more detailed assessment of the actual food offered in particular retailers could show even greater differences in the local food environment (Moore & Diez, 2006).

Additionally, the mRFEI captures geographic access to food retailers. This aspect of the food retail environment was selected because having access to food retailers is a necessary first step in being able to obtain food at all and because past research links low access to healthy food retailers and high access to unhealthy food retailers with a number of adverse outcomes for development, health, and overall well-being (Lytle & Sokol, 2017; Walker et al., 2010). However, food environments are complex and multidimensional. While the current study represents the first analysis of disparities in geographic access to healthy food retailers among formerly incarcerated individuals, future research should consider other dimensions of the food retail environment. For example, future work can examine the cost of foods within local retail environments. The

term “food mirage” is coined to explain the phenomenon in which a community has geographic access to full-service grocery stores, yet food prices are high and therefore food is inaccessible to many local residents (Everett, 2011; Short et al., 2007). Accordingly, future research should draw on food pricing data to assess the association between incarceration and food affordability (Breyer & Voss-Andreae, 2013; Drewnowski et al., 2012). Moreover, future research could also capture other important dimensions of the local food retail environment such as accommodation (hours local retailers are open) or the quality of food sold by local retailers (Caspi et al., 2012). For example, prior work finds that even when healthy foods such as fresh produce are available lower income communities, they are often of lower quality, which reduces the appeal of purchasing the items (Andreyeva et al., 2008; Evans et al., 2015).

This study also used a measure of food retailers at one specific point in time. However, future research can look at alternative measures that captures changes in the presence of food retailers overtime. This could provide insight on whether areas where formerly incarcerated individuals reside are getting better or worse in terms of their food access. For example, Wang and colleagues (2008) find that increases in the number and density of unhealthy food retailers over a 9-year period was associated with less healthy diet and increasing obesity rates. Thus, future research can examine changes over time in the composition of the local food retail environment in communities where formerly incarcerated individuals reside.

Finally, the mRFEI measures food retailers that are available in a census tract and half mile buffer around the census tract. Although the use of buffer distances to define local retail food environments is a common, there remains debate regarding appropriate

geographic boundaries (Caspi et al., 2012). Charreire and colleagues (2010) systematic review of measurement and the food retail environment details multiple spatial approaches and buffer distances used in past research. Buffer zones were found to range from as small as 500 meters to as large as 5 kilometers. Additionally, the USDA uses a separate definition, defining food deserts in metropolitan areas as a census tract in which at least 500 people and/or 33 percent of the tract population resides more than 1 mile from a supermarket or large grocery (Dutko, Ver Ploeg, & Farrigan, 2012). Nevertheless, at this point there is no agreed upon standard of how large of a buffer zone should be used, although prior work suggest the CDC definition serves as a reasonable measure for food access in urban areas. Indeed, Santorelli and Okeke (2017: p. 997) compared to the USDA definition to the CDC classification of a food retailers in New Jersey, finding that the CDC definition "appears to be a more appropriate method of classifying urban areas with low-access to fruits and vegetables."

Still, it remains possible that the size of the local food retail environment in the current study is too large given that social isolation within one's home neighborhood is common among economically disadvantaged individuals (Krivo et al., 2013). Yet, it is also possible that individuals living in an area with low access to healthy food retailers may travel beyond the half-mile buffer zone to access healthy food retailers. If this is the case, accounting for the composition of food retail environments in surrounding areas will be important for understanding the consequences for health and nutritional behavior. As Diez Roux and Mair (2010: p. 134) note: "resource poor areas surrounded by other resource poor areas in highly segregated contexts may have very different implications for health than resource poor areas situated close to resource rich area." While the data

used in the current study could not assess this possibility, future research can potentially draw from alternative data sources that allow buffer zones to be changed to smaller and larger radiuses and take into account the influence of food access in neighboring communities.

Implications for Criminology

The results of this dissertation carry several implications for criminology. First, recent qualitative research finds that material hardships faced by formerly incarcerated individuals creates a number of stressors that often hinders successful community reintegration (Harding et al., 2014; Western et al., 2015). This dissertation aimed to extend this work by providing a detailed focus on a specific type of hardship that has gone largely unstudied in criminological literature – difficulty obtaining and accessing food. In doing so, a goal of this dissertation is to contribute to a broader literature and further the understanding of the specific challenges that formerly incarcerated individuals face. Additional research that focuses on hardships such as food insecurity and the lack of resources within communities where formerly incarcerated individuals return can extend knowledge about the stressors and hardships faced by formerly incarcerated individuals.

Future work can extend this dissertation by considering whether nutritional hardships are related to other criminological outcomes such as offending and recidivism. For example, to be without adequate food could lead to feelings of strain and potentially increase the likelihood of offending (Agnew, 2011). Recent research has found an association between household food insecurity and adolescent misconduct (Jackson &

Vaughn, 2017; Slopen et al., 2010; Zilanawala & Pilkauskas, 2012). Although this research does not speak to food insecurity and criminal offending in adulthood, some research finds that food insecurity in childhood can increase the likelihood of violent behavior in adulthood (Vaughn et al., 2016). Therefore, as this dissertation finds that individuals involved with the criminal justice system experience nutritional hardships at high rates, it is possible that food insecurity or residing in areas with low access to healthy food retailers could be strains that are associated with criminal offending in adulthood, as well as higher risk of criminal offending for children in households experiencing nutritional hardships. If so, alleviating food insecurity could be one way to reduce future offending.

Additionally, this dissertation provides the first assessment of the lack of healthy food retailers as a form of resource deprivation in communities where formerly incarcerated individuals reside. The finding that formerly incarcerated individuals were more likely to live in areas with less access to healthy food retailers when compared to those without prior criminal justice contact is an important finding as it speaks to the lack of resources needed to meet basic daily needs. This finding adds to a growing literature that assesses whether areas with high rates of incarceration and reentry lack critical resources (Wallace et al., 2015). Moreover, understanding community resources holds implications for broader questions about offender reentry as scholars have previously suggested that the richness or deficiency of resources in communities where former inmates reside may influence the quality of life and array of opportunities available (Kubrin & Stewart, 2006). Thus, this dissertation begins to fill this gap by drawing

attention to the deficiencies of nutritional resources in communities where formerly incarcerated individuals reside.

At present, more research is needed to understand how lack of resources in communities is related to criminal offending. Recently, some research has begun to investigate the relationship between specific neighborhood-level resources and recidivism. Hipp and colleagues (2009) find that physical proximity to health service providers reduced recidivism among parolees in California. Wallace and Papachristos (2014) examined the relationship between the availability of health care organizations (HCO) and neighborhood recidivism, finding that the loss of HCOs is associated with increased recidivism. Finally, Wallace (2015) finds the loss of educational organizations is found to increase neighborhood recidivism in Chicago.[52] However, no research to date has addressed the relationship between access to food retailers or nutritional hardships such as neighborhood level rates of food insecurity on recidivism. Thus, a contribution of this dissertation is to link criminological research with public health literature on nutritional hardships. In turn, future work should expand on this topic and assess whether these nutritional hardships are associated with criminal offending, as well as the consequences of nutritional hardship for households and children of former inmates.

Implications for Public Policy

The findings of this dissertation suggest that formerly incarcerated individuals are a vulnerable population who experience nutritional hardship at high rates, especially

[52] Educational resources included: junior colleges, business and secretarial schools, computer training, professional management development training, cosmetology and barber schools, flight training, apprenticeship training, language schools, and other technical and trade schools.

when compared to those who have not previously reported contact with the criminal justice system. While ex-inmates often come from disadvantaged backgrounds that increase the risk for nutritional hardship, there are a number of policy implications based on the results that could potentially alleviate the risk for nutritional hardships among formerly incarcerated individuals.

First, the results suggest that financial hardship is strongly related to food insecurity. Accordingly, policy solutions which focus on expanding labor market opportunities for formerly incarcerated individuals and members of their household may be beneficial in alleviating nutritional hardship. For example, expanding job training or work programs among incarcerated individuals, as well as those who receive a criminal conviction could be beneficial since such programs are associated with increased earnings (Bloom, 2006; Jacobs & Western, 2007).

Second, correctional agencies and offender reentry organizations could provide a list of food providers including inexpensive grocery stores, soup kitchens, and food banks to help alleviate food insecurity. Additionally, criminal justice agencies can provide returning inmates and convicted offenders who are not incarcerated with information on how to apply for public assistance benefits, as well as obtain proper identification that is needed to file applications for public assistance programs (La Vigne et al., 2008).

States and localities can also consider policies in order to make public assistance programs more accessible for criminal justice involved populations. Such a policy could have a meaningful effect as this dissertation finds that receiving public assistance benefits had a significant mediation effect on experiencing food insecurity. Currently, several states ban individuals with certain felony convictions from obtaining food stamps

(Samuels & Mukamai, 2004). Additionally, in some states eligibility for public assistance benefits expire while individuals are incarcerated. However, certain localities have taken steps to broaden access to food stamps for former inmates. For instance, the Oregon Department of Corrections has a partnered with the Oregon Department of Health and Human Services to provide inmates with the Oregon Trail Card (OTC). This card enables individuals to access money from food stamps and other forms of public assistance immediately upon release and thus provides resources necessary to purchase food from a wide variety of retailers. The Texas Department of Criminal Justice provides mentorship for discharged prisoners that includes developing a plan for at least one month's supply of food and the completion of a food stamp application (La Vigne et al., 2008). This is perhaps part of the reason why one study has found the use of food stamp benefits in Texas increases after release from prison (Mueller-Smith, 2014).

Expanding access to public assistance programs for former inmates may be also be a beneficial policy since food insecurity can be caused by sudden shocks to income or unexpected loss in wages which former inmates are especially prone to (Pager, 2003; Western, 2002). While the current study could not assess shocks to income, household income did have a significant mediation effect between incarceration and food insecurity. Thus, programs that buffer against the negative economic consequences of incarceration could potentially reduce the risk for food insecurity among former inmates. As Iceland and Bauman (2007: p. 391) explain "because food insecurity is sensitive to shorter-term income flows, a program such as food stamps, which in essence is meant to increase income through near-cash transfers in a particular time period, is indeed appropriate."

Formerly incarcerated individuals could potentially benefit from efforts to include more healthy food options sold at existing food retailers or to attract grocery stores to areas with higher rates of incarceration or reentry (Gittelsohn et al., 2012). One option could be to extend policy initiatives such as the Healthy Food Financing Initiative (HFFI) to areas with high rates of incarceration (Flournoy et al., 2011; Treuhaft & Karpyn, 2010). The HFFI is a federal program that works through the Department of Health and Human Services (HHS), U.S. Department of Agriculture (USDA), and Treasury Department to award loans and grants targeted at developing and equipping food retailers to sell healthy foods in underserved communities across the United States. To date, the HFFI has provided areas over $500 million in one-time financing and evaluations of the program have found that the addition of healthy food retailers changes residents' perceptions of healthy food access (Cummins et al., 2014; Dubowitz et al., 2015).

Still, it should be noted that just because new food retailers become available does not necessarily mean that local residents will change dietary behavior. Often there is a strong familiarity between residents and owners of local stores. This loyalty can lead local residents to continue to shop in these outlets even if affordable food retailers that offer a greater variety of healthy food options open in their community. Additionally, residents may even oppose the opening of large scale grocery stores out of fear that their presence would harm smaller stores that are respected within the community (Walker et al., 2010). Finally, in the context of urban environments it could be more beneficial to improve the selection of healthy food options at small local stores rather than opening large grocery retailers. As Moore and Diez Roux (2006: p. 330) notes: "it is perfectly possible that a multiplicity of varied small stores could offer the range of food products

necessary for a healthy diet. There are also important trade-offs between large supermarkets (which often require large parking lots) and small stores in terms of automobile traffic and consequences for neighborhood walkability and street life (including social interactions between neighborhoods), all of which may have health consequences. In the US context, the presence of a supermarket may be an adequate marker for the availability of affordable healthy foods. However, it does not necessarily follow that improving the food environment of disadvantaged communities requires only increasing the number of large supermarkets." Thus, it may be more beneficial to increase the supply for healthy food options at existing locations, as well as to educate local residents about the benefits of a healthy diet.

Conclusion

In conclusion, this dissertation aimed to expand upon knowledge regarding the hardships faced by formerly incarcerated individuals, as well as to extend the literature on the consequences of incarceration for health and well-being. To do so, this study integrated public health research on food insecurity and local food retail environments with criminological literature on the consequences of incarceration. Uniting these two literatures is an important endeavor as large body of literature suggests that these nutritional hardships carry consequences for individual wellbeing. Thus, alleviating nutritional hardships may carry benefits for improving health and reducing stressors faced during the community reintegration process. Social scientists and criminal justice practitioners should continue to focus attention on understanding nutritional hardships as one means of creating more successful community reintegration. Still, this dissertation

should be taken as a first step to understanding the nutritional hardships formerly incarcerated individuals face. Future research that continues to explore how former inmates navigate nutritional hardships, and how these hardships influence their health and well-being would further extend knowledge about the challenges faced by formerly incarcerated individuals.

APPENDIX

Appendix A: Variation by Time Served and Time Since Release

Appendix A1: Nutritional Hardships Regressed on Time Served and Other Covariates

Variable	Food Insecure	mRFEI
Time Served (months)	.994	1.023
	(.012)	(.012)
Time Served (0 vs. <0)	1.419	.934
	(.348)	(.183)
Time Served – 0 Months	-	-
(Reference)	-	-
Time Served – .5 – 11	1.574	.835
Months	(.456)	(.174)
Time Served – 12 – 23	1.657	1.359
Months	(.767)	(.665)
Time Served – 24+ Months	.968	1.090
	(.498)	(.471)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix A2: Nutritional Hardships Regressed on Time Served and Other Covariates

Variable	Food Insecure	mRFEI
Time Since Release (months)	.999	.998
	(.003)	(.002)
Time Since Release (Ln)	1.012	.879
	(.124)	(.085)
Time Release - <12 Months	1.125	.808
	(.421)	(.258)
Time Release - <12 Months	-	-
(Reference	-	-
Time Release – 12 Months –	.962	1.284
23 Months	(.479)	(.534)
Time Release – 24+ Months	1.176	.733
	(.436)	(.233)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix B: Variance Inflation Factor

Appendix B1: VIF for Nutritional Hardship Models

VARIABLES	Table 5.3 Model 3 Food Insecurity	Table 5.5 Model 3 mRFEI < 10
Arrested Only	1.09	1.08
Convicted Only	1.04	1.03
Prior Incarceration	1.22	1.20
Age (W4)	1.09	1.07
Black	1.50	1.42
Hispanic	1.19	1.17
Other Race	1.12	1.11
Male	1.24	1.19
Child in Home	1.08	1.04
Parent House	1.14	1.04
High School Grad	1.13	1.12
Child Abuse	1.05	1.03
Delinquency Scale (W1)	1.29	1.29
Hard Drug Use (W1)	1.19	1.19
Healthy Diet (W1)	1.02	1.02
Depression (W1)	1.29	1.23
Fatalism (W1)	1.13	1.13
Food Stamps (W1)	1.18	1.17
Food Stamp Missing (W1)	1.07	1.07
Concentrated Disadvantage (W1)	1.42	1.37
Concentrated Disadvantage (W4)	1.17	1.04
Adjusted Income (Ln)	1.60	1.24
mRFEI < 10	1.01	-
Employed	1.07	-
Public Assistance (W4)	1.35	-
Friends	1.13	-
Married	1.22	-
Perceived Isolation	1.31	-
Social Standing	1.27	-
Parental Financial Support	1.17	-
Depression (W4)	1.48	-
Anxiety	1.69	-
Physical Disability	1.04	-
Mean VIF	**1.21**	**1.15**

Appendix C – Sensitivity Analysis of mRFEI Coding

Appendix C1: Criminal Justice Contact regressed on Alternative mRFEI Coding

Variable	mRFEI = 0	mRFEI = 10 (no 0's)	mRFEI = 10 - 20	mRFEI = 20 - 30	WTHR = 30+	mRFEI (Scale)	Log mRFEI (No 0's)
Arrest	1.125	.941	1.129	.834	.912	-.049	-.119
	(.139)	(.100)	(.123)	(.131)	(.227)	(.036)	(.128)
Convict	.979	.919	.107	1.203	.924	-.011	.019
	(.199)	(.189)	(.196)	(.274)	(.379)	(.065)	(.219)
Incarceration	1.156	1.229*	.938	.885	.922	-.064	-.171
	(.150)	(.119)	(.089)	(.132)	(.297)	(.048)	(.141)
Concentrated Disadvantage (W4)	1.059	2.509*	.557***	.946	.382	-.032	-.125
	(.053)	(.954)	(.074)	(.341)	(.199)	(.026)	(.122)
Household Income	.859	.981	1.051	.996	.895	.027	.151**
	(.039)	(.051)	(.043)	(.056)	(.092)	(.016)	(.051)
N	**10,592**	**9,316**	**10,592**	**10,592**	**10,592**	**10,592**	**10,592**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix D – Sex Specific Analysis

Appendix D1: Male Only Sample

	Food Insecurity	mRFEI	Fast-food	Sugar	WTHR	Health
Arrest	1.238	0.952	1.007	1.070	0.759	0.998
	(0.289)	(0.123)	(0.055)	(0.076)	(0.110)	(0.021)
Convict	2.723**	1.011	0.943	0.941	1.078	0.996
	(0.919)	(0.201)	(0.098)	(0.084)	(0.301)	(0.030)
Incarceration	1.241	1.175	1.166**	1.128*	0.804	1.026
	(0.239)	0.952	(0.056)	(0.062)	(0.107)	(0.020)
mRFEI	-	-	1.002	0.904*	0.936	1.000
	-	-	(0.041)	(0.038)	(0.093)	(0.016)
Food	-	-	1.174*	1.234***	0.954	1.130***
Insecure	-	-	(0.088)	(0.077)	(0.163)	(0.027)
N	**4,778**	**4,840**	**4,838**	**4,834**	**4,818**	**4,831**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix D2: Female Only Sample

	Food Insecurity	mRFEI	Fast-food	Sugar	WTHR	Health
Arrest	1.631**	1.021	1.230**	1.168*	1.149	1.036
	(0.300)	(0.143)	(0.093)	(0.080)	(0.206)	(0.024)
Convict	1.333	0.992	0.824	1.199	0.740	1.039
	(0.482)	(0.270)	(0.097)	(0.167)	(0.247)	(0.046)
Incarceration	1.479	1.503**	1.236*	1.252**	0.980	1.093***
	(0.302)	(0.232)	(0.101)	(0.091)	(0.207)	(0.026)
mRFEI	-	-	0.976	1.013	0.882	1.006
	-	-	(0.041)	(0.039)	(0.095)	(0.011)
Food	-	-	1.022	1.042	1.549*	1.110***
Insecure	-	-	(0.086)	(0.059)	(0.260)	(0.020)
N	**5,660**	**5,746**	**5,731**	**5,725**	**5,705**	**5,714**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix E – Race Specific Analysis

Appendix E1: White Only Sample

	Food Insecurity	mRFEI	Fast-food	Sugar	WTHR	Health
Arrest	1.666**	1.009	1.098	1.095	0.857	1.012
	(0.324)	(0.129)	(0.060)	(0.077)	(0.105)	(0.019)
Convict	2.093**	0.945	0.968	1.013	1.057	1.010
	(0.548)	(0.186)	(0.089)	(0.102)	(0.272)	(0.031)
Incarceration	1.303	1.562***	1.100	1.129*	0.798	1.055**
	(0.280)	(0.195)	(0.062)	(0.057)	(0.109)	(0.020)
mRFEI	-	-	0.950	0.967	0.917	0.999
	-	-	(0.037)	(0.036)	(0.074)	(0.011)
Food	-	-	1.165*	1.117	1.255	1.129***
Insecure	-	-	(0.085)	(0.071)	(0.216)	(0.020)
N	**5,724**	**5,772**	**5,763**	**5,759**	**5,733**	**5,749**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix E2: Black Only Sample

	Food Insecurity	mRFEI	Fast-food	Sugar	WTHR	Health
Arrest	1.242	0.994	1.159	1.146	0.892	1.060
	(0.360)	(0.232)	(0.117)	(0.132)	(0.250)	(0.040)
Convict	2.306	1.163	0.973	1.310	0.551	1.011
	(1.082)	(0.512)	(0.140)	(0.219)	(0.212)	(0.088)
Incarceration	1.724	0.908	1.518***	1.165	0.783	1.023
	(0.473)	(0.151)	(0.164)	(0.122)	(0.178)	(0.033)
mRFEI	-	-	1.012	0.941	1.206	1.024
	-	-	(0.069)	(0.062)	(0.201)	(0.022)
Food	-	-	0.984	1.135	1.252	1.077*
Insecure	-	-	(0.087)	(0.110)	(0.357)	(0.034)
N	**2,000**	**2,006**	**2,013**	**2,009**	**1,985**	**2,007**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix E3: Hispanic Only Sample

	Food Insecurity	mRFEI	Fast-food	Sugar	WTHR	Health
Arrest	0.787	0.841	0.942	1.191	1.338	0.970
	(0.576)	(0.260)	(0.122)	(0.128)	(0.485)	(0.034)
Convict	1.175	1.312	0.475**	1.124	0.607	0.968
	(0.921)	(0.817)	(0.116)	(0.239)	(0.354)	(0.078)
Incarceration	1.261	1.039	1.126	1.121	0.734	1.045
	(0.487)	(0.240)	(0.123)	(0.116)	(0.214)	(0.037)
mRFEI	-	-	1.147	1.055	0.783	1.004
	-	-	(0.087)	(0.059)	(0.156)	(0.028)
Food	-	-	0.964	0.966	1.250	1.142***
Insecure	-	-	(0.110)	(0.108)	(0.486)	(0.037)
N	**1,891**	**1,941**	**1,953**	**1,951**	**1,884**	**1,950**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Appendix F: Propensity Score Analysis

Since prior incarceration is not randomly assigned, isolating the effect of incarceration on food insecurity or access to healthy food retailers is challenging. One approach to reduce the differences between formerly incarcerated individuals and those who were never incarcerated is through propensity score matching.

Propensity score matching (PSM) is a non-parametric method that uses observable variables to estimate the probability of experiencing a treatment (i.e. incarceration) conditional on a set of observed covariates (Rosenbaum & Rubin, 1983; Rosenbaum, 2002). While multivariate regression models adjust for differences between covariates, PSM uses these observed characteristics to generate a control group that is equivalent on observable measures to the treatment group. To do so, PSM uses observed variables to estimate the likelihood of experiencing a treatment. Thus, in the current study, the propensity of being incarcerated is predicted using a vector of covariates. Then each case is assigned a propensity score based on the conditional probability of being incarcerated using on the observable covariates. Finally, the treated (incarcerated) and untreated (never incarcerated) cases are matched based on some predefined proximity of the propensity scores. Therefore, propensity score matching should generate a treatment and control group that appear equivalent on relevant background characteristics.

In the first step, the propensity of incarceration is estimated using a set of predictors. This model includes additional covariates that are not included in the main regression models reported in chapter 5. These additional measures include parental education, parental incarceration, attachment to parents, attachment to school, whether a respondent was suspended or expelled from school, whether a respondent was born in the

U.S, and future orientation. Table F1 reports the summary statistics for the additional variables used in the propensity score analysis.

Table F2, reports the results of the logistic regression model estimating the propensity to be incarcerated. Several measures emerge as significant predictors of incarceration including being male, high school graduate, child abuse victim, total delinquency, hard drug use, parental incarceration, and being suspended or expelled from school. Following the regression, propensity scores were predicted, which represent the predicted probability of a given respondent experiencing incarceration. Each formerly incarcerated individual is then matched with a respondent who has never been incarcerated but has a similar propensity score. Matching was done with 1-to-1 nearest neighbor matching.[53] Moreover, matching was completed using caliper of .01, which restricted the distance of the propensity score of formerly incarcerated individuals and matched controls by no more than .01.[54]

[53] Nearest neighbor matching is beneficial as it reduces the likelihood of biased estimates as each treated incarcerated respondent is matched to one unique untreated non-incarcerated respondent, where each case has a similar propensity score within the predefined caliper. However, given that relatively low percentages of the sample experience contact with the criminal justice system, the one-to-one matching comes at the cost of potentially reducing the efficiency of the estimate. In contrast, one-to-many matching leads to a larger sample size and more efficient estimates, but increases the potential for bias (Augustyn & Loughran, 2017; Garrido et al., 2014). Accordingly, I following procedures outlined in prior research and test multiple matching procedures (Augustyn & Loughran, 2017; Ho et al., 2007; Luo et al., 2010). Specifically, I perform three additional matching routines including, 1-to-1 nearest neighborhood matching with replacement, 2-to-1 nearest neighborhood matching with replacement, and 3-to-1 nearest neighbor matching with replacement. The results did not differ across these models.

[54] The analysis is performed with a caliper that equals .25 times the standard deviation of the logit of the propensity score, per the recommendation of Rosenbaum and Rubin (1985).

In order to check for balance across covariates the following two procedures were used. First, I perform a *t*-test to compare the matched and unmatched sample and assess whether any statistically significant differences exist across the two groups. I consider any covariate to be out of balance if the reported t-statistic is greater than 1.96 ($\alpha = .05$). Second, I use the standardized bias statistic (SBS) as outlined by Rosenbaum and Rubin (1985). The SBS assesses the differences in means across the treatment and control groups. A covariate is considered out of balance if the absolute value of the SBS exceeds 20. Formally, the standardized difference is expressed as:

$$sbs = 100 * \frac{\bar{x}_t - \bar{x}_c}{\sqrt{\frac{s_t^2 + s_c^2}{2}}}$$

Where $\bar{x}_t$ and $\bar{x}_c$ denotes the sample means for a given covariate in the treatment and control groups respectively and s_t^2 and s_c^2 signify the sample variance for a particular covariate in the treatment and control groups respectively. Table F3 presents the results for the balance diagnostics before and after matching. The results indicate of the 26 pretreatment covariates, 21 were out of balance using the *t*-test ($p < .05$). After the matching procedure imbalance between groups is substantially reduced and no variables remain out of balance using either the *t*-test or SBS metric.

Moreover, the validity of estimates from propensity score models is in part determined by the overlap of the distribution of the propensity score across the treatment and control groups (i.e. region of common support). Thus, any cases where the propensity score value is beyond the region of common support is omitted. In total, 52 cases were found to be off common support and removed following the nearest neighbor matching. Figure F1 presents the propensity score distributions for former inmates and never

incarcerated respondents. The figure illustrates that never incarcerated respondents differ substantially in their likelihood of experiencing incarceration compared to formerly incarcerated respondents. Next, figure F2 shows the propensity score distribution for former inmates and never incarcerated respondents following 1-to-1 matching. This figure highlights that the propensity to be incarcerated is substantially more balanced after matching.

Finally, because PSM creates balance across observable covariates, the presence of unobserved heterogeneity and omitted variables remain limitations that threaten the ability of PSM to generate unbiased estimates. To address this issue, I perform a sensitivity analysis assessing the magnitude that any unobserved covariate would need to alter the treatment effect (Rosenbaum, 2002). This procedure is conducted using the "rbounds" program in Stata (Diprete & Gangl, 2004). The results indicate that all else equal, an unobserved covariate would have to increase the odds of imprisonment by 19 percent to change the results of the food insecurity model and 11 percent to alter the outcome of the access to healthy food retailers model.

Table F4 presents the results of the 1-to-1 nearest neighbor matching. The results show that both before and after matching formerly incarcerated individuals have a higher probability of being food insecure and a higher likelihood of residing in census tracts with low access to healthy food retailers. On average, respondents who have been previously incarcerated are about 4.6 percent more likely to be food insecure (*t-statistic* = 2.99, $p = .002$) and 6.5 percent more likely to reside in a census tract with low access to healthy food retailers (*t-statistic* = 2.88, $p = .004$).

Table F5 presents the results of the logistic regression of incarceration regressed on food insecurity controlling for both the propensity of respondents to be incarcerated and the slate of mediators. In these analyses, the sample is restricted to the region where the propensity scores of the treatment and control cases are within the minimum and maximum bounds of the predefined caliper (i.e. region of common support). Model 1 compares formerly incarcerated individuals to never incarcerated respondents before including the mediators. The results indicate that when using the matched sample formerly incarcerated respondents are approximately 1.4 times (p = .033) more likely to be food insecure compared to respondents who have not been previously incarcerated. Next, model 2 presents the regression results after including the set of mediators. The results show that after controlling for the mediators there is no difference in the likelihood of formerly incarcerated respondents experiencing food insecurity (OR = .959, p = .835).

Table F6 presents the logistics regression results of incarceration on mRFEI using the matched sample and controlling for mediators. Model 1 demonstrates the bivariate relationship using the matched sample. These results indicate that formerly incarcerated respondents are approximately 1.5 times more (p = .003) likely to reside in a census tract with low access to healthy food retailers. Next, model 2 includes the mediators. These results indicate that compared to all never incarcerated respondents formerly incarcerated respondents are significantly more likely to live in tracts with low access to healthy food retailers (OR = 1.457, p = .013).

Next, a subsequent analysis is conducted where all respondents who have no prior contact with the criminal justice system are omitted from the sample. Therefore,

propensity score matching is used to compare previously incarcerated respondents to those who were either arrested or convicted but never incarcerated. Table F7 presents the logistic regression model predicting the likelihood of experiencing incarceration. The model reports that being male, a high school graduate, being a child abuse victim, parental education – college graduate and some post-graduate education -, parental incarceration, and being suspended or expelled are significantly related to incarceration.

Table F8 presents the balance diagnostics. Prior to the matching procedure 15 out of 26 covariates were out of balance ($p < .05$). However, after the matching procedure no covariates remained out of balance according to either the *t*-test or SBS. Table F9 demonstrates that following the matching procedure there is no longer any statistically significant difference in either the food insecurity or access to healthy food retailer outcomes when formerly incarcerated respondents are compared to the never incarcerated respondents. Finally, Table F10 presents the logistic regression of food insecurity on incarceration using the matched sample and including the mediator variables. Model 1 indicates that only controlling for the propensity score there is no relationship between prior incarceration and food insecurity (OR = 1.079, $p = 694$). Next, model 2 includes the slate of mediators. After including these variables, the association between incarceration and food insecurity becomes negative but not statistically significant (OR = .679, $p = .083$). Next, table F11 presents the logistic regression of food insecurity on incarceration using the matched sample. The results demonstrate that prior to controlling for the mediators there is a positive and statistically significant association between prior incarceration and access to healthy food retailers (OR = 1.272, $p = .049$). Model 2

demonstrates that after including the mediators the association between incarceration and low access to healthy food retailers gets slightly stronger (OR = 1.324, $p = .023$).[55]

[55] These results are consistent with logistic regression analyses on an unmatched sample that finds that formerly incarcerated respondents are significantly more likely to reside in a census tract with low access to healthy food retailers when compared to a combined group of arrested only and convicted only respondents.

Table F1: Summary Statistics for Additional Covariates for Propensity Score Analysis

Variable	Mean	SE	Min	Max
Parent Education – Less than High School	.125	.012	0	1
Parent Education – High School Graduate	.265	.012	0	1
Parent Education – Vocational	.091	.006	0	1
Parent Education – Some College	.170	.008	0	1
Parent Education – College Graduate	.135	.007	0	1
Parent Education – Some Post Graduate	.089	.009	0	1
Parental Incarceration	.155	.009	0	1
Parental Attachment	4.816	.008	0	1
School Attachment	2.139	.020	1	5
Suspended or Expelled	.246	.014	0	1
U.S. Born	.740	.012	0	1
Future Orientation	3.061	.025	1	5

Table F2: Logistic Regression of Incarceration on Predictor Variables

Variable	Model 1
Age	0.958
	(0.030)
Male	3.622***
	(0.422)
Black	1.114
	(0.150)
Hispanic	0.990
	(0.139)
Other Race	1.013
	(0.322)
High School Grad	0.394***
	(0.067)
Child Abuse	1.443**
	(0.173)
Delinquency Scale	1.076***
	(0.015)
Hard Drug Use	1.518**
	(0.211)
Healthy Diet	1.129
	(0.179)
Depression	1.012
	(0.011)
Fatalism	0.922
	(0.069)
Food Stamps	1.370
	(0.234)
Food Stamps Missing	1.710
	(0.604)
Concentrated Disadvantage	0.996
	(0.057)
Parent Education – High School Graduate	1.100
	(0.196)
Parent Education – Vocational	1.166
	(0.293)
Parent Education – Some College	0.931
	(0.194)
Parent Education – College Graduate	0.633
	(0.150)
Parent Education – Some Post Graduate	0.644
	(0.165)
Parental Incarceration	2.206***
	(0.280)
Parental Attachment	1.072
	(0.108)

School Attachment	1.017
	(0.052)
Suspended or Expelled	2.173***
	(0.231)
U.S. Born	1.051
	(0.149)
Future Orientation	0.952
	(0.041)
Constant	0.096**
	(0.074)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F3: Covariate Balance Diagnostics

Variable	Matched	Treated	Control	Standardized Bias	t-statistic
Age	Unmatched	15.532	15.534	-.10	-.040
	Matched	15.552	15.461	5.40	1.210
Male	Unmatched	.720	.426	62.30	18.160***
	Matched	.706	.703	.60	.150
Black	Unmatched	.223	.179	10.90	3.390**
	Matched	.220	.205	3.80	.820
Hispanic	Unmatched	.193	.179	3.70	1.120
	Matched	.190	.208	-4.70	-1.010
Other Race	Unmatched	.045	.067	-9.50	-2.690**
	Matched	.045	.054	-3.50	-.830
High School Grad	Unmatched	.848	.960	-38.80	-15.24***
	Matched	.877	.867	3.50	.670
Child Abuse	Unmatched	.271	.161	27.00	8.790***
	Matched	.259	.273	-3.50	-.710
Delinquency Scale	Unmatched	4.665	2.060	62.20	22.43***
	Matched	4.367	4.061	7.30	1.450
Hard Drug Use	Unmatched	.226	.101	34.30	11.87***
	Matched	.214	.198	4.40	.890
Healthy Diet	Unmatched	.904	.916	-4.10	-1.280
	Matched	.904	.907	-1.10	-.230
Depression	Unmatched	6.958	6.410	11.30	3.48**
	Matched	6.877	7.140	-5.50	-1.160
Fatalism	Unmatched	1.657	1.559	11.90	3.69***
	Matched	1.652	1.636	1.80	.390
Food Stamps	Unmatched	.148	.089	18.30	6.05***
	Matched	.137	.156	-5.70	-1.140
Food Stamps Missing	Unmatched	.017	-.130	16.40	4.95***
	Matched	-.002	-.021	2.10	.460
Concentrated Disadvantage	Unmatched	.204	.150	14.30	4.54***
	Matched	.195	.197	-.50	-.110
Parent Education – High School Graduate	Unmatched	.302	.271	7.00	2.15*
	Matched	.300	.308	-1.80	-.390

Parent Education – Vocational	Unmatched	.103	.090	4.30	1.340
	Matched	.105	.124	-6.50	-1.340
Parent Education – Some College	Unmatched	.221	.202	4.60	1.400
	Matched	.223	.205	4.50	.990
Parent Education – College Graduate	Unmatched	.108	.174	-18.90	-5.34***
	Matched	.112	.109	.90	.210
Parent Education – Some Post Graduate	Unmatched	.061	.114	-18.50	-5.10***
	Matched	.065	.057	2.90	.750
Parental Incarceration	Unmatched	.323	.137	45.40	15.56***
	Matched	.300	.303	-.70	-.150
Parental Attachment	Unmatched	4.779	4.826	-8.60	-2.71**
	Matched	4.784	4.783	.20	.040
School Attachment	Unmatched	2.285	2.125	15.50	4.83***
	Matched	2.267	2.281	-1.40	-.300
Suspended or Expelled	Unmatched	.516	.202	69.20	22.82***
	Matched	.493	.482	2.40	.490
U.S. Born	Unmatched	.786	.716	16.20	4.73***
	Matched	.781	.772	2.10	.490
Future Orientation	Unmatched	2.783	3.121	-29.70	-9.09***
	Matched	2.806	2.789	1.50	.330

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F4: Effect of Incarceration on Nutritional Hardship Using Nearest Neighbor Matching (*N* = 2,086)

Variable	Sample	Prior Incarceration	Never Incarcerated	Difference	SE	*t-statistic*
Food Insecurity	Unmatched	.167	.089	.078	.009	7.93***
	Matched	.163	.116	.046	.015	2.99**
mRFEI < 10	Unmatched	.537	.494	.049	.017	2.65**
	Matched	.538	.474	.065	.022	2.88**

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F5: Logistic Regression of Food Insecurity on Incarceration and Mediators (Matched Sample)

Variable	Model 1	Model 2
Prior Incarceration	1.464*	0.959
	(0.259)	(0.191)
Propensity Score	2.273	0.919
	(1.181)	(0.553)
Concentrated Disadvantage		1.852
		(0.595)
mRFEI < 10		0.897
		(0.221)
Household Income (Ln)		0.566***
		(0.077)
Employed		1.304
		(0.296)
Public Assistance (W4)		1.485
		(0.317)
Friends		0.955
		(0.107)
Married		1.242
		(0.281)
Perceived Isolation		1.310*
		(0.146)
Social Standing		0.862*
		(0.063)
Parental Financial Support		1.920***
		(0.371)
Depression (W4)		0.914
		(0.146)
Anxiety		1.225***
		(0.048)
Physical Disability		0.858
		(0.263)
Constant	0.108	23.667*
	(0.022)	(36.114)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F6: Logistic Regression of Access to Healthy Food Retailers on Incarceration and Mediators (Matched Sample)

Variable	Model 1	Model 2
Prior Incarceration	1.521**	1.457*
	(0.212)	(0.217)
Propensity Score	1.517	1.036
	(.492)	(0.338)
Concentrated Disadvantaged		1.470*
		(0.245)
Household Income (Ln)		0.962
		(0.086)
Constant	0.849	2.540
	(0.114)	(2.418)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F7: Logistic Regression of Incarceration on Predictor Variables

Variable	Model 1
Age	0.971
	(0.039)
Male	1.735***
	(0.246)
Black	0.896
	(0.184)
Hispanic	1.216
	(0.226)
Other Race	1.357
	(0.550)
High School Grad	0.415***
	(0.100)
Child Abuse	1.401*
	(0.216)
Delinquency Scale	1.025
	(0.019)
Hard Drug Use	1.281
	(0.235)
Healthy Diet	0.969
	(0.208)
Depression	1.014
	(0.013)
Fatalism	0.877
	(0.076)
Food Stamps	1.406
	(0.299)
Food Stamps Missing	2.327
	(1.191)
Concentrated Disadvantage	1.034
	(0.086)
Parent Education – High School Graduate	0.784
	(0.174)
Parent Education – Vocational	0.886
	(0.265)
Parent Education – Some College	0.710
	(0.188)
Parent Education – College Graduate	0.486*
	(0.139)
Parent Education – Some	0.503*

Post Graduate	
	(0.162)
Parental Incarceration	2.124***
	(0.320)
Parental Attachment	1.029
	(0.117)
School Attachment	1.061
	(0.063)
Suspended or Expelled	1.459**
	(0.197)
U.S. Born	0.859
	(0.131)
Future Orientation	0.985
	(0.051)
Constant	1.668
	(1.329)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F8: Covariate Balance Diagnostics

Variable	Matched	Treated	Control	Standardized Bias	t-statistic
Age	Unmatched	15.532	15.472	3.60	.810
	Matched	15.523	15.529	-.40	-.080
Male	Unmatched	.720	.645	16.20	3.700***
	Matched	.681	.679	.30	.050
Black	Unmatched	.223	.207	3.80	.880
	Matched	.231	.207	5.70	1.110
Hispanic	Unmatched	.193	.151	11.00	2.520*
	Matched	.163	.177	-3.80	-.750
Other Race	Unmatched	.045	.036	4.40	1.010
	Matched	.040	.038	1.30	.260
High School Grad	Unmatched	.848	.938	-29.20	-6.670***
	Matched	.937	.917	6.80	1.570
Child Abuse	Unmatched	.271	.214	13.30	3.050
	Matched	.231	.248	-4.00	-.780
Delinquency Scale	Unmatched	4.665	3.553	24.20	5.530***
	Matched	4.097	3.995	2.20	.440
Hard Drug Use	Unmatched	.226	.162	16.40	3.740***
	Matched	.190	.193	-.70	-.130
Healthy Diet	Unmatched	.904	.913	-3.10	-.700
	Matched	.911	.911	.00	.000
Depression	Unmatched	6.958	6.491	9.50	2.160*
	Matched	6.529	6.798	-5.40	-1.080
Fatalism	Unmatched	1.657	1.646	1.40	.310
	Matched	1.657	1.656	.10	.030
Food Stamps	Unmatched	.148	.091	17.60	4.010***
	Matched	.099	.113	-4.40	-.910
Food Stamps Missing	Unmatched	.017	-.099	12.50	2.860**
	Matched	-.079	-.044	-3.80	-.770
Concentrated Disadvantage	Unmatched	.204	.115	24.60	5.620***
	Matched	.140	.143	-1.10	-.220
Parent Education – High School Graduate	Unmatched	.302	.287	3.30	.750
	Matched	.309	.299	2.30	.440
Parent Education – Vocational	Unmatched	.103	.107	-1.50	-.340
	Matched	.108	.117	-3.00	-.560

Parent Education – Some College	Unmatched	.221	.215	1.50	.340
	Matched	.235	.216	4.40	.850
Parent Education – College Graduate	Unmatched	.108	.169	-17.50	-3.990***
	Matched	.134	.130	1.10	.230
Parent Education – Some Post Graduate	Unmatched	.061	.107	-16.50	-3.780***
	Matched	.074	.094	-7.10	-1.380
Parental Incarceration	Unmatched	.323	.160	38.90	8.880***
	Matched	.213	.201	2.80	.570
Parental Attachment	Unmatched	4.779	4.811	-5.90	-1.360
	Matched	4.795	4.802	-1.20	-.240
School Attachment	Unmatched	2.285	2.207	7.30	1.670
	Matched	2.241	2.266	-2.30	-.450
Suspended or Expelled	Unmatched	.516	.356	32.70	7.460***
	Matched	.434	.421	2.70	.520
U.S. Born	Unmatched	.786	.782	1.10	.240
	Matched	.781	.777	.90	.180
Future Orientation	Unmatched	2.783	2.932	-12.90	-2.940**
	Matched	2.842	2.867	-2.10	-.420

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F9: Effect of Incarceration on Nutritional Hardship Using Nearest Neighbor Matching (*N* = 1,534)

Variable	Sample	Prior Incarceration	Never Incarcerated	Difference	SE	*t-statistic*
Food Insecurity	Unmatched	.167	.128	.039	.016	.249**
	Matched	.156	.136	.021	.018	1.16
mRFEI < 10	Unmatched	.537	.515	.022	.022	1.01
	Matched	.519	.515	.004	.026	.15

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F10: Logistic Regression of Food Insecurity on Incarceration and Mediators (Matched Sample)

Variable	Model 1	Model 2
Prior Incarceration	1.079	0.679
	(0.209)	(0.150)
Propensity Score	1.755	0.526
	(1.098)	(0.364)
Concentrated Disadvantage		1.590
		(0.482)
mRFEI < 10		0.898
		(0.230)
Household Income (Ln)		0.572***
		(0.089)
Employed		1.356
		(0.304)
Public Assistance (W4)		1.757*
		(0.433)
Friends		1.110
		(0.114)
Married		1.091
		(0.302)
Perceived Isolation		1.184
		(0.138)
Social Standing		0.923
		(0.069)
Parental Financial Support		1.978**
		(0.470)
Depression (W4)		0.725
		(0.124)
Anxiety		1.260***
		(0.060)
Physical Disability		0.967
		(0.262)
Constant	0.122***	20.237
	(0.040)	(36.112)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Table F11: Logistic Regression of Access to Healthy Food Retailers on Incarceration and Mediators (Matched Sample)

Variable	Model 1	Model 2
Prior Incarceration	1.272*	1.324*
	(0.154)	(0.161)
Propensity Score	1.167	0.758
	(0.561)	(0.381)
Concentrated Disadvantaged		1.955**
		(0.426)
Household Income (Ln)		1.055
		(0.116)
Constant	0.953	1.402
	(0.229)	(1.747)

*** p<0.001, ** p<0.01, * p<0.05 (two-tailed)

Figure F1: Propensity to be Incarcerated before Matching

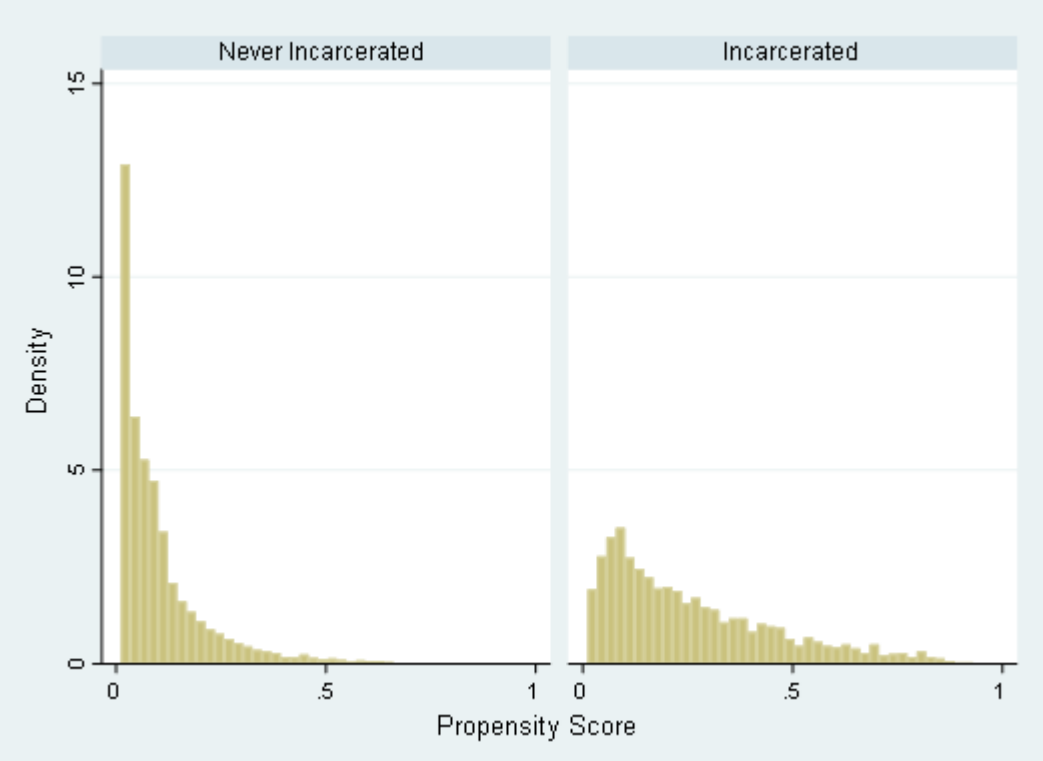
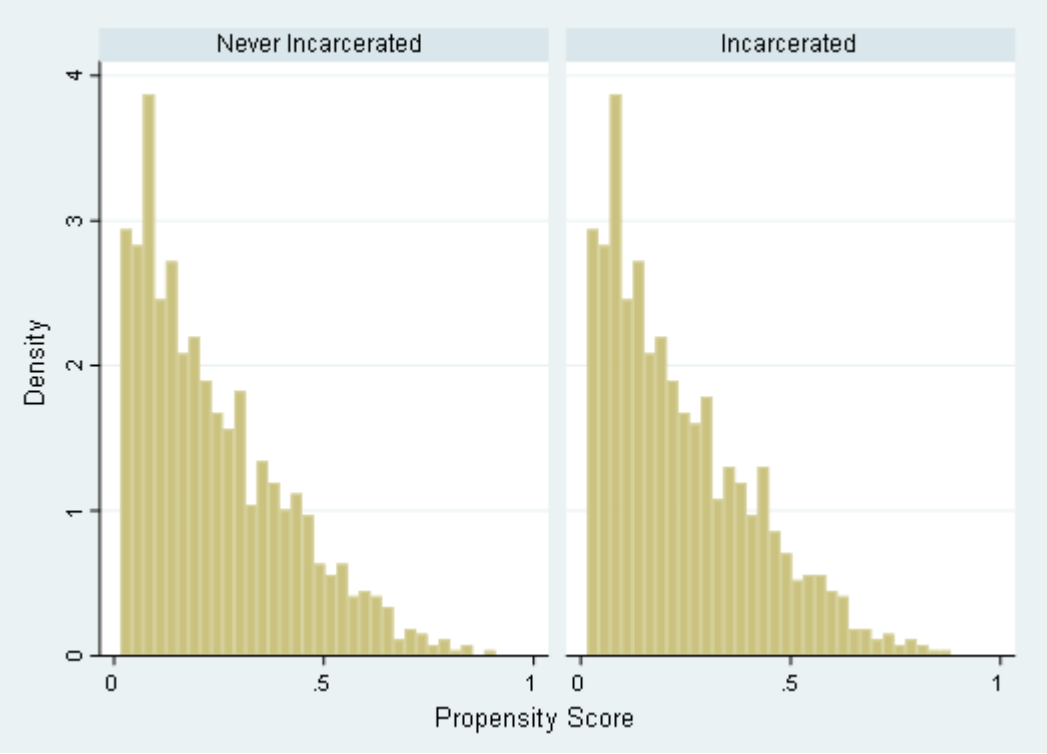


Figure F2: Propensity to be Incarcerated after Matching



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