Chelsea Eats Dietary Data Preanalysis Plan

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1 Introduction

Diet quality is an important driver of cardiometabolic health but remains poor in the United States (US) despite modest improvements over the past two decades.[1–5] Americans continue to score low on aggregate measures of diet quality. In 2018-19 the average adult scored only 58 points out of 100 on the Health Eating Index-2015 (HEI), reflecting poor adherence to the US *Dietary Guidelines for Americans (2015-2020)*; lower HEI scores have been found to be associated with excess weight gain, cardiovascular disease, cancer, type 2 diabetes, and all-cause mortality.[6–8] These trends were driven by low intakes of fruits, vegetables, whole grains, dairy, and unsaturated fatty acids, and higher intakes of refined grains, sodium, added sugars, and saturated fats.[9]

Simultaneously, socioeconomic disparities in diet exist and may serve to explain disparities in health at large with those living with lower incomes and with lower educational attainment scoring lower on measures of diet quality compared to their White (non-Hispanic) and higher-income counterparts.[10,11] In addition, studies on food assimilation and acculturation suggest that individuals who have lived in the US for longer periods of time demonstrate worse diet quality and higher risk of being classified as overweight.[12,13] For example, Batis et al. (2011) report that compared to individuals from Mexico, Mexican Americans born in Mexico and Mexican Americans born in the US experience higher intakes of unhealthy foods such as saturated fat, sugar, and dessert and salty snacks.[14] While Hispanic American immigrants do tend to have healthier diets compared to other Americans,[15] they may also be at increased risk of experiencing food insecurity or a lack of consistent access to adequate food.[16,17] As the onset of the COVID-19 pandemic abruptly disrupted food distribution lines and employment, 31% of Hispanic families in the US reported very low food security.[18] Prior to the pandemic in 2018, the national average rate of very low food insecurity was 4.3%.[19]

While many drivers of diet have been proposed, prior work on disparities has focused on three interrelated domains: the availability of healthy foods in the neighborhood, the food marketing environment, and the financial capacity to purchase adequate food to promote nutrition security.[20–22] First, those living in communities with lower household income are more likely to be exposed to a higher density of retail outlets offering calorie-dense but nutritionally-empty foods. Living in these areas has been shown to be associated with increased risk of obesity and worse diet quality.[23,24] In a large study of adults living in the United Kingdom, those with lowest income and highest fast-food outlet proportion in their neighborhood had higher odds of obesity than expected from either exposure alone.[25] While some have highlighted lack of access to healthy food outlets as a potential source of diet-related disparities, work specific to the greater Boston area, including Chelsea, Somerville, and Cambridge, Massachusetts, suggests that objective access to supermarkets (supermarkets within 1 kilometer of housing) is not predictive of better diet quality for this region.[26]

Second, food and beverage advertising may lead to worse diet quality when the majority of products advertised are not nutritionally ideal, as advertising has been shown to result in higher *ad libitum* intake of these foods in experimental conditions.[27] Advertisements may frame those who

consume certain products as attractive or successful, or shape perceptions about normative eating behaviors and the perceived taste of a product that lead to an increased desire to purchase and consume.[28,29] For adolescents in particular, exposure to food-related advertisements increased by nearly 4% between 2003 to 2007, with the largest gains seen for teen exposure to fast food advertising.[30] In addition, recent studies have documented clear disparities by race/ethnicity and income with non-White, lower-income, and lower-education adolescents aged 12-17 years exposed to 54% more ads for regular soda and 56% more ads for energy drinks compared to their White, higher income, and higher education counterparts.[31]

Last, the capacity of households living with lower incomes to purchase healthy foods is often low, and adults who are food insecure are more likely to score lower on measures of diet quality including the Healthy Eating Index.[32] In a mediation analysis, Pechey and Monsivais (2016) found that higher occupational social class was associated with greater food expenditure and healthier subsequent food purchases.[33] In addition, work by Drewnowski and colleagues suggests that healthier diets higher in dietary fiber, vitamin A, and vitamin C and lower in total and saturated fat intake cost more per calorie compared to others that are energy dense but nutrient poor.[34–36] Federal programs that aim to improve food insecurity by providing a near-cash benefit (e.g., the Supplemental Nutrition Assistance Program, SNAP) or by offsetting food purchases (e.g., the National School Lunch Program or the Special Supplemental Nutrition Program for Women, Infants, and Children) have been found to effective to this end, though impacts on diet quality are mixed.[37–39] While interventions that increase the absolute value of SNAP benefits for fruit and vegetable purchases have resulted in higher intake and improved HEI scores, suggesting that strategies that improve the financial security of individuals with lower incomes may be valuable tools in promoting healthy diet,[40–42] other studies that have tried to assess the causal impact of incremental income or assistance on food have found small impacts.[43] This study, which examines a randomized allocation of cash cards to residents of Chelsea, Massachusetts in the middle of the Covid epidemic offers the opportunity to further clarify the causal relationship between income and diet. While unconditional cash transfers have led to improvements in diet and food security in lower- and middle-income countries,[44] we are not aware of any that have evaluated the dietary consequences of unconditional cash transfer programs in the US.

2 The Intervention

Chelsea, Massachusetts, a city of 40,000 people just north of Boston, is among the places in the country hardest hit by Covid-19, both from a health and an economic perspective. Its heavily Latino population is concentrated in sectors of the economy that were shut down when the pandemic hit, and Chelsea residents are also disproportionately likely to be front-line service workers exposed to infection risk. In April 2020, local community organizations and the City of Chelsea responded to the economic crisis facing jobless Chelsea residents by mounting an unprecedented food distribution effort.

In September 2020, after five months of running its food distribution sites, the City decided to redirect its efforts toward distributing financial support so that residents could purchase their own food through a program called Chelsea Eats. By combining city general revenue funds, state aid, and philanthropic contributions, the City assembled enough resources to distribute Chelsea Eats cash cards to approximately 2,000 households and to replenish the cards on a monthly basis for a total of six months. The card amounts vary with household size. Most households are receiving $400 per month, but one- and two-person households receive $200 and $300, respectively. The

cards can be spent anywhere Visa is accepted. In total, 3,615 households applied for the cards, and 2,074 were chosen to receive the cash assistance cards via a lottery. Gift cards were credited with the first payment on November 18th, 2020, and monthly payments continued through August 2021.

3 Methods

3.1 Study Design

The lottery creates an opportunity to evaluate the impact of the Chelsea Eats program by comparing the outcomes of lottery winners to those of applicants who were unsuccessful in the lottery. 1,936 applicants were enrolled in the study prior to randomization. Of these, 1,122 individuals ultimately won the lottery and form the treatment group, and 814 did not and form the control group. Two baseline surveys were administered, in September 2020 prior to randomization and in November 2020 post-randomization but before the Chelsea Eats Cards were issued, along with a final survey in April-May 2021, and an interviewer-assisted 24-hour dietary recall collected in April and June 2021. In addition, short surveys were administered in December 2020 and February 2021. Surveys were administered through Qualtrics, with 74% of baseline surveys conducted in Spanish. Respondents received a $20 gift card after every completed survey, and response rates for the final survey was 95%. Response rates for the dietary recall component was 83% completing a single recall and a sub-sample of individuals completing an additional 24-hour recall. Additional details about survey design are available in the pre-analysis plan for the main Chelsea Eats Study.[45]

3.2 Hypotheses

We hypothesize *a priori* that beneficiaries of the program will consume more total kilocalories than non-beneficiaries. In addition, we hypothesize that beneficiaries will consume greater quantities of foods that, per calorie, are more expensive,[46] including fruits, vegetables (excluding white potatoes), and total fresh meats. We will examine effects on intake both with and without adjustment for total energy intake (kilocalories). We also hypothesize that treatment effects will be larger in magnitude for those who are food insecure at baseline.

3.3 Outcomes

During study follow-up, participants completed an interviewer-assisted 24-hour dietary recall (specifically, the Automated Self-Administered 24-Hour Dietary Assessment Tool, ASA24). During the interviews, respondents reported the foods they consumed in the previous 24 hour period of time while trained study staff recorded their responses in ASA24 in real time. A multi-pass method built into the ASA24 prompts minimizes underreporting and aims to improve recall. Output generated by ASA24 includes a complete list of foods eaten by each respondent, along with their constituent nutrients such as total kilocalories, total fat, total carbohydrates, and total protein. ASA24 also provides intake values for each of the 37 food groups needed to calculate Healthy Eating Index (HEI-2015) scores, which is a measure of adherence to the US *Dietary Guidelines for Americans, 2015-2020*. **Primary outcomes** for this analysis will include the following variables. Unless otherwise noted, these variables are provided as part of standard ASA24 output.

- Total kilocalories (kcals)
- Total fruit (cup equivalents)

- Total vegetables, excluding white potatoes (cup eq.)
- Total fresh meat, including red meat, poultry, organ meat, and seafood, but not cured meats (oz. eq)

These outcomes were chosen due to their higher per-calorie cost, and therefore their likelihood of being impacted by changes to monthly income. In primary analyses, we will use data from the first day of recall recorded for individuals. In sensitivity analyses, we will average across multiple days of recall where applicable.

Secondary outcomes will also include:

- White potatoes (cup eq.)
- Whole grains (oz. eq.)
- Refined Grains (oz. eq.)
- Red and cured meat, including beef, veal, pork, lamb, game meats, and cured meats (oz. eq)
- Nuts, seeds, and legumes (oz. eq.)
- Total dairy, including milk (dairy or fortified soy), yogurt, and cheeses (cup eq.)
- Added sugars (tsp eq.)
- Sugar-sweetened beverages (g): We will classify each food item using an indicator for whether the item is a sugar-sweetened beverage using a cross-walk to the What We Eat in America (WWEIA) food groups (i.e. WWEIA food codes that begin with the prefix "72"), then calculate the sum amount (in grams) of all SSBs consumed per each individual recall.

3.3.1 Effect heterogeneity

We will explore effect heterogeneity by the following measures:

- Very low food security: Household food insecurity was measured using the USDA six-item short form instrument.[1] Individuals will be classified as experiencing very low food security if they provided five or six affirmative responses to the questionnaire, following USDA guidelines.

3.4 Statistical analysis

To estimate absolute differences in dietary intake by whether an individual was assigned to receive the unconditional cash transfer benefit, we will fit linear regression models of the form:

$$\mathbb{E}(Y|z, \mathbf{x}, \mathbf{v}) = \beta_0 + \beta_1 z + \boldsymbol{\delta}\mathbf{x} + \zeta\mathbf{v} + \boldsymbol{\eta}(\mathbf{x} \times \mathbf{v}) \tag{1}$$

Where Y denotes dietary intake of a specific food group, z is an indicator for receipt of the cash benefit, $\mathbf{x}$ is a vector of covariates, and $\mathbf{v}$ is a subset of $\mathbf{x}$ being evaluated as effect modifiers (if assessing interaction). The parameter β_1 provides evidence of the treatment effect conditional on covariates in a model without interaction. As in the main analysis, models will be weighted by the inverse probability of winning the lottery, obtained via Monte Carlo simulation based on the number of tickets a household received. In sensitivity analyses, we will also assess the robustness of our results to techniques for accounting for survey non-response.

[1] https://www.ers.usda.gov/media/8282/short2012.pdf

3.4.1 Covariates

As indicated above, covariates will be included in the main analysis to improve precision and adjust for any random variation between the treatment and control groups in baseline characteristics. To assess the robustness of the results, we will also present results without covariates.

- Age: indicator variables for five-year age groups
- Sex: indicator variable for female sex
- Race and ethnicity: indicator variables for Latino, Non-Hispanic White, and Non-Hispanic Black
- Number of adults in the household
- Number of children younger than 5 in the household
- Number of children between 5-17 years in the household
- Financial situation compared to last month: indicator variables for better and worse (reference = "the same")
- Expectations of future financial situation: indicator variables for better and worse (reference = "the same")
- Indicator for financial difficulty from respondent having lost job
- Indicator for financial difficulty from spouse having lost a job
- Indicator for financial difficultly from respondent having reduced hours or lower pay
- Indicator for financial difficulty from spouse having reduced hours or lower pay
- Indicator for having expenses in August that household could not pay
- Food insecurity (three indicator representing three of the four responses to the standard one-question food insecurity question)
- Food insecurity index (a count of the number of the five additional household food insecurity questions with affirmative responses)
- Monthly income before COVID (will adjust for household size using the recommended adjustment in the National Academy of Sciences Measuring Poverty book, will include both linearly and squared).
- Current income as percentage of pre-COVID income (will include both linear and squared terms).
- General health (indicator variables for four of the five response categories)
- Mental health (K6 score)
- COVID (an indicator variable for whether the respondent or another member of the respondent's household has had COVID).
- Employment (indicator variables for unemployed looking for work and unemployed not looking for work – omitted category is "working for pay")

- Indicator for disability being the reason for not working
- Indicator for either “family responsibilities” or “taking care of kids” as reason for not working.

4 Table scaffolds

Table 1: Overall Impact of Intervention

Outcome	Treatment	Control	**Without Covariate Adjustment** Difference (95%CI)	**With Adjustment** Difference (95%CI)	**With TEI Adjustment** Difference (95%CI)
Kilocalories					
Total fruit					
Total vegetables (excl. white potatoes)					
Total fresh meat					

Table 2: Overall Impact of Intervention, Other Components of Diet

Outcome	Treatment	Control	**Without Covariate Adjustment** Difference (95%CI)	**With Adjustment** Difference (95%CI)	**With TEI Adjustment** Difference (95%CI)
White potatoes					
Refined grains					
Red and cured meats					
Nuts, seeds, legumes					
Total dairy					
Added sugar					
SSBs					

Table 3: Subgroup Impacts of Intervention (No adjustment for TEI)

Outcome	**Overall** Difference (95%CrI)	**Among Food Insecure** Difference (95%CrI)	**Among Food Secure** Difference (95%CrI)
Kilocalories			
Total fruit			
Total vegetables (excl. white potatoes)			
White potatoes			
Refined grains			
Total fresh meat			
Red and cured meats			
Nuts, seeds, legumes			
Total dairy			
Added sugar			
SSBs			

Table 4: Subgroup Impacts of Intervention (With adjustment for TEI)

Outcome	**Overall** Difference (95%CrI)	**Among Food Insecure** Difference (95%CrI)	**Among Food Secure** Difference (95%CrI)
Kilocalories			
Total fruit			
Total vegetables (excl. white potatoes)			
White potatoes			
Refined grains			
Total fresh meat			
Red and cured meats			
Nuts, seeds, legumes			
Total dairy			
Added sugar			
SSBs			

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