Fast food restaurant availability around home and around work: differential relationships with women's diet

By

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A Thesis

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TABLE OF CONTENTS

List of Tables

List of Figures

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ABSTRACT

Background: To understand the multifaceted causes of obesity, numerous studies have investigated how the neighborhood food environment is associated with diet. This literature has focused almost exclusively on home neighborhood environments in urban settings while the neighborhood food environment around an individual's workplace has received little attention. We tested the hypothesis that fast food restaurant (FFR) availability around the workplace is more strongly related to dietary behaviors than FFR availability around the home for rural women.

Methods: In 2013 we conducted a cross-sectional analysis of Astoria Warrenton Heart Health Initiative (AWWHHI) participants (20-69 years of age, coastal towns in Oregon) who worked outside the home (n=142). Using a Geographic Information System (GIS) we calculated the availability of FFRs by closest distance to a FFR and number of FFRs within 400 and 800 meters of the women's home and workplace. Descriptive analysis and multivariate regression models were used to determine the association between availability of FFRs in home and workplace neighborhoods and women's diet (Fast Food, Fruit & Vegetable, and Sugar Sweetened Beverage (SSB) intake), controlling for household income, age, marital status, and child living at home.

Results: Greater Fast Food consumption was associated with greater FFR availability within 800 of homes [OR (95%CI): 2.35 (1.06, 5.22)] and shorter distance from home to nearest FFR [OR (95%CI): 0.73 (0.55, 0.97)]. SSB intake was positively associated with FFR availability around home but these associations were not statistically significant. Greater FFR availability around work had non-significant negative associations with Fast Food consumption and SSB intake ($p>0.1$). Fruit & Vegetable intake was not associated with FFR availability around home or work. Associations between FFR availability and dietary outcomes were similar when FFR availability around home and work were combined.

Conclusion: FFR availability around the home, but not the workplace, was associated with greater Fast Food consumption. These associations were not observed for Fruit & Vegetable or SSB intake. Investigation of other environmental or social determinants of dietary behaviors in rural women is needed.

BACKGROUND

Obesity has overtaken tobacco use as the leading preventable cause of lost quality-adjusted life years among Americans.[1] Not only has millions of Americans died of obesity-related illness, namely cardiovascular disease (CVD) and diabetes, obesity costs the U.S. billions of dollars every year. In response to this epidemic, a surge of research has investigated modifiable causes of obesity and related disease that can be addressed at the population-level.[2]

Critical to population-level prevention of obesity-related disease is the promotion of healthy diets. Recent public health interventions have focused on specific types of foods associated with obesity and related conditions and the environmental contexts in which diet decisions are made. In particular, fast food is typically low cost, high in fat[3] and, correspondingly, is associated with high caloric intake[4] and elevated risk of obesity, diabetes and CVD.[5] Sugar Sweetened Beverages (SSB) such as soda are high in calories and low in nutrients[6] and a staple for many fast food restaurants (FFR). Drinking one SSB or more per day is associated with two times the risk of diabetes compared to drinking one or fewer SSBs per month.[7,8] Similarly, intake of fruit and vegetables is associated with lower risk of CVD, fruits and vegetables are uncommon in FFRs.[9]

Neighborhood food retail environments

Accordingly, reduction in the availability of fast food within neighborhood environments has received substantial attention at the national, state, and local levels.[10] FFR availability is one aspect of food environment research that considers how availability of specific types of food retailers may influence food purchasing and consumption decisions. Other food retailers studied as potential determinants of diet include supermarkets, grocery stores, and other outlets (e.g., convenience stores, drug stores). The underlying premise of research and policy related to neighborhood food environments is that the availability of different types of foods, at varying prices, at different types of food retailers will influence food purchasing decisions and diet.[11] Initial research focused on proximity to supermarkets, with the idea that they provide fresh fruits and vegetables at lower prices relative to smaller markets.[12] Areas lacking food retailers typically selling affordable healthy foods are often referred to as 'food deserts'.[13]

In contrast, availability of affordable unhealthy foods may also be important component to a poor diet. A 'food swamp' has been described as an area that has an over-abundance of food selling these low cost, energy dense, high-calorie foods.[14] FFRs have received the most attention due to their growing number[15] and the empirical evidence showing that fast food is detrimental to health.[16] Furthermore, access to different types of food retailers varies considerably depending on neighborhood wealth and racial composition. Neighborhoods with lower socio-economic status[17] and higher percentage of minorities have higher FFR availability.[17] [18] Both 'food deserts' and 'food swamps' have been associated with an unhealthy diet.[2]

Fast food restaurant availability in home versus work neighborhoods

The majority of the previous research on FFR availability has focused specifically on home neighborhood locations. Since almost half of adults spend their waking hours at work,[19] examining only home neighborhood FFR availability may seriously limit conclusions about how FFR availability impacts diet. For example, a survey of adult workers reported their typical place for purchasing lunch was at a FFR (43.4%). In addition, FFR around home accounted for only 30% of total exposure to FFR around individuals' home, workplace, and work commute routes.[20] These observational studies have yielded mixed evidence that availability of FFRs is related to poor diet with some studies finding a positive association[16,21,22] and some studies finding no association.[23–25] Better understanding of how FFR may influence diet is needed to guide more effective policies. For example, in 2008 a one-year moratorium on opening and expanding fast food establishments in Los Angeles neighborhood had no significant impact on the residences' diet.[26] These inconsistent associations between FFR availability and diet in prior studies could be attributed to only focusing on the home neighborhood.[27]

That is, fast food availability in workplace neighborhoods may make greater contributions to diet than fast food availability in home neighborhoods. Neighborhoods around the workplace have a higher density of FFRs than home neighborhoods[28] while home neighborhood environments have more access to supermarkets.[29] In addition, foods consumed away from the home are typically less healthy than those consumed at home.[30] Inclusion of FFR availability in the workplace neighborhood could also, potentially, improve estimates of how overall FFR availability impacts diet. However, few studies have estimated effects of food retailers in both home and workplace neighborhoods on diet, and their findings have been mixed. One study found no evidence of an association between the FFR environment within 0.8km or 2km of either work or home for fast food consumption.[31] In contrast, another study found that greater FFR availability around the workplace was associated with greater fast-food consumption, with evidence of a dose response. When exposure of FFR around workplace was combined with exposure around home and commute route, there was a significant association between greater exposure to FFRs and greater fast food consumption, BMI, and odds of obesity.[28] Both of these studies were outside of the U.S. (England and Australia) and neither was in a rural environment.

Understudied populations

The vast majority of neighborhood food environment research focuses on urban areas. However, twenty-nine percent of American's live outside of urban areas.[32] Rural residents are 15% more likely to be obese than urban residents.[33] While the rural obesogenic environment is not well understood, rural residents typically travel further distances by car and often have a different selection of food.[34] For example, a rural Florida community was reported to have convenience stores comprise 72% of their food retail[35] while urban zip codes reported having 14% more supermarkets than rural zip codes.[36] Therefore, findings based on urban study populations may not be translatable to rural populations.

While past studies have not shown gender differences in the association between food environment and diet there does appear to be gender differences in fast food consumption. For example, women reported they would travel further distances to purchase fast food than men,[37] but associations between FFR availability and fast food consumption were generally weaker among women than among men.[13] Thus it is important to consider how FFRs around the home versus work is associated with diet in women.

Objectives

The objectives of this study were to determine the (a) associations of FFR availability around the home neighborhood and workplace neighborhoods on diet (Fast Food, Sugar Sweetened Beverages, and Fruits & Vegetables) and (b) combined and interactive associations of FFR availability around home neighborhood and workplace neighborhood in adult women living in a rural environment. We hypothesized women with more FFR availability around home and workplace would have higher Fast Food consumption and, correspondingly, lower Fruit & Vegetable intake and higher Sugar Sweetened Beverage intake. Specifically, we hypothesized (a) FFR availability around the workplace would be more strongly associated with dietary behaviors than FFR availability around the home, and (b) association between FFR availability around the home and work would be stronger when home and work FFR availability are both included in the model.

METHODS

Sample Population

A cross-sectional analysis was conducted using the Astoria & Warrenton Women's Heart Health Initiative (AWWHHI) dataset. The AWWHHI is a study of CVD risk factors in a population of women residing in Clatsop County, Oregon. Clatsop County is located on the Oregon Coast, approximately 95 miles from Portland, Oregon, the closest metropolitan area. Astoria and Warrenton are the population centers of Clatsop County. Study enrollment and data collection were performed through two data collection events held in January and April of 2013. Eligibility criteria were female gender, residence in Clatsop County, and 20-69 years of age. Participants were recruited through radio and newspaper ads, e-mail list serves, and flyers. A total of 430 women enrolled in AWWHHI. In the current study, women who were currently employed (n=247) were considered for inclusion. Detailed study exclusions are described in the Statistical Analysis.

Data Sources

Behavioral and health data were collected through Let's Get Healthy!, an education and research program in which participants visit interactive research stations to learn about their health through diet questionnaires, anthropologic and body composition measurements, and blood chemistry measures.[38] In addition to Let's Get Healthy! stations, participants completed a computerized survey to collect information on detailed sociodemographic characteristics and potential confounders, such as household income, marital status, and if there was a child in the household. Neighborhood food environment data included the 2012 Oregon Employment Database, which provided data and location on FFRs for the time the data was collected. The Oregon Employment Database consists of all registered business listings, including FFRs, in Oregon and has been used for food environment research[39,40] and government reports.[41]

Study Variables

Primary study exposure and outcome variables are summarized in **Table 2**.

Fast Food Restaurant (FFR) availability in home and workplace neighborhoods (exposures)

Fast food restaurants. FFRs were identified as businesses with North American Industry Classification system (NAICS) code 722513 (Limited-service restaurants) in the Oregon Employment database. While there is no standard definition of FFR availability this nomenclature is widely used in food environment research[42–44] and has been compared to other existing data resources.[45–48] Restaurants found under this code include Dairy Queen, Burger King, and Taco Bell. Appendix A contains the complete list of all FFRs located for this study.

Field validation of the presence, type, and location of FFRs contained in the employment database was not possible because data was collected in early 2013 and data analysis was conducted in late 2014. We could not ensure the recorded restaurants did not move, close, or change type of food retail. However, we conducted an informal quality assessment of the data by web search and found 92% agreement. **Appendix A** describes our quality assessment process and results.

*Home, workplace, and fast food restaurant locations***.** Home addresses were collected through the study enrollment process. Work locations were collected through a computerized survey: employed participants reported the business name and closest intersection (two cross streets) of their primary work location. The survey questions:

- "In order to help us learn more about environmental factors in your area, we'd like to know about your workplace location. If you have more than one employer, please tell us about your primary workplace. What is the name of the business you work for?"
- "Please name the two cross-streets of the intersection of your workplace location."

FFR locations were determined from latitude and longitude coordinates provided in the Oregon Employment Database.

Geographic Information System analysis: geocoding and spatial linkage

Spatial analysis was performed by Sam Hermes using ArcGIS (10.0 North American Geocode Service).

Geocoding. Home address and nearest intersection to workplace were geocoded using a custom address locator created for use with the Census Bureau's 2010 TIGER/line (Topologically Integrated Geographic Encoding and Referencing) road files. Participants who provided PO Boxes as home address (n=32) could not be geocoded and were therefore excluded from analyses. FFR locations were geocoded by the Oregon Employment Department; we used the latitude and longitude coordinates provided in the Oregon Employment Database.

Spatial linkage. Using ArcGIS 10.0, home, workplace, and FFR locations were spatially overlaid with Clatsop County street networks (U.S. Census Bureau's 2010 TIGER/line [Topologically Integrated Geographic Encoding and Referencing] database). We calculated distance to the nearest FFR from home and from work, and count of FFRs within 400m and 800m of home and work (neighborhood buffers). Count and distance measures are common measurements for fast-food availability.[49] Distance to the nearest FFR and neighborhood buffers were calculated using distance through the street network instead of a straight line (Euclidean distance) in order to represent plausible travel routes the participant might take.[31] In sum, we calculated the following FFR availability variables: count within 400m of home, count within 800m of home, and distance from home to nearest FFR; count within 400m of workplace, count within 800m of workplace, and distance from workplace to nearest FFR.

Since there is no standard measure of FFR availability we analyzed the unique layout of Clatsop County and selected 400m and 800m buffers to capture easily walk-able distances to FFRs.[23,31,50] While larger neighborhood buffers may be more relevant for rural populations,[3] the majority of AWWHHI participants live in the towns of Astoria (62%) or Warrenton (19%). Therefore, a large neighborhood buffer may be inappropriate for measuring the resources used by our study population. Furthermore, both towns are relatively small in geographic area (Astoria: 10.11 square miles (26.18 km^2); Warrenton: (12.77 square miles (33.07 km^2), so large buffers would capture a large portion of the town. Counts of FFRs were measured instead of density due to the already small population living predominately in the few towns in a largely rural county.

Fast Food consumption (outcome) Fast food consumption was assessed through the web-based survey using the question, "In the past week, how often did you eat something from a fast-food restaurant (e.g., McDonald's, Burger King, Hardee's)?" This survey question was developed by Project EAT and has been tested and retested for reliability. This question has also been used in numerous of studies measuring fast food consumption.[4,16,27,51]

Fruit & Vegetable & Sugar Sweetened Beverage (SSB) intake (outcomes)

Fast Food consumption was examined to assess a more direct path from FFR availability to diet. SSB and Fruits & Vegetables were examined to assess an unhealthy and healthy diet behavior, respectively, as a potential downstream effect of Fast Food consumption. While SSB and Fruit & Vegetable intake are correlated with Fast Food consumption, these outcomes are not mutually inclusive. For example, one could consume SSB without eating fast food and vice versa.

Fruit & Vegetable and SSBs were collected using the National Cancer Institute's (NCI) Dietary Screener Questionnaire (DSQ) administered via computerized self-administered survey. The NCI DSQ was developed and validated in the National Health and Nutritional Examination Survey (NHANES). The questionnaire was validated by comparing 24-hour dietary recalls to DSQ items.[52]

The DSQ asked participants how often they ate a series of food items within the past month. Participants selected frequencies ranging from ‘never’ to ‘6 or more times per day’ (nine response options). The DSQ scoring algorithm was developed using NHANES 24-hour recall data to estimate predicted daily equivalent food group intake given consumption frequencies of each type of food. We applied these algorithms to our data focusing on intake of Fruit & Vegetable (cups per day) and added sugar from Sugar Sweetened Beverages (SSB; teaspoons per day) given reported consumption frequencies. The algorithm calculated daily intake of Fruit & Vegetable and added sugar from SSB’s by assigning a score for each food type consumption frequency. Age and gender were factored in the algorithm predicting daily intake. A cup is the standard Fruit & Vegetable serving size from the guidelines specified by the US Department of Agriculture and the US Department of Health and Human Services in the dietary guidelines for Americans (2010). SSB is defined in the Dietary Guidelines for Americans (2010) as “Liquids that are sweetened with various forms of sugars that add calories. These beverages include, but are not limited to, soda, fruit drinks, and sports and energy drinks.” We used added sugar from SSB’s to characterize SSB intake. **Table 1** lists the screener questions used to calculate intake of our dietary outcomes of interest.

Table 1. Questionnaire items used to measure intake of Fruits & Vegetables and Added Sugar from Sugar Sweetened Beverages

Fruit & Vegetable intake (excluding french fries)
“During the Past month how often did you…. 1) Drink **100% pure fruit juices** such as orange, mango, apple, grape, and pineapple juices? Do not include fruit-flavored drinks with added sugar or fruit juice you made at home and added sugar to.” 2) Eat **fruit**? Include fresh, frozen, or canned fruit. Do not include juices.” 3) Eat a green leafy or lettuce **salad**, with or without other vegetables?” 4) Eat any **other kind of potatoes**, such as baked, boiled, mashed, sweet potatoes, or potato salad?” 5) Eat refried beans, baked beans, beans in soup, pork and beans or any other type of cooked dried beans? Do **not** include green beans. 6) Eat **other vegetables**, not including what you just told me about (green salads, potatoes, cooked dried beans.)?” 7) Have Mexican-type **salsa** made with tomato?” 8) Eat **pizza**? Include frozen pizza, fast food pizza, and homemade pizza.” 9) Have tomato sauces such as with spaghetti or noodles or mixed into foods such as lasagna? Do not include tomato sauce on pizza.”
Sugar Sweetened Beverage intake
“During the past month how often did you… 1) Drink **regular soda or pop** that contains sugar? Do not include diet soda.” 2) Drink coffee or tea that had **sugar** or **honey** added to it? Include coffee and tea you sweetened yourself and presweetened tea and coffee drinks such as Arizona Iced Tea and Frappuccino. Do not include artificially sweetened coffee of diet tea.”

3) Drink **sweetened** fruit drinks, sports or energy drinks, such as Kool-Aid, lemonade, Hi-C, cranberry, Gatorade, Red Bull, or Vitamin Water? Include fruit juices you made at home and added sugar to. Do not include diet drinks or artificially sweetened drinks."

Table 2. Summary of primary study exposure and outcome variables

Exposure		
FFR count around **home**	Binary	Number of FFR within 400m and 800m network buffers
FFR distance to **home**	Continuous	Distance to closest FFR from home via road network
FFR count around **work**	Ordinal	Number of FFR within 400m and 800m network buffers
FFR distance to **work**	Continuous	Distance to closest FFR from work via road network
Outcome		
Fast Food consumption	Binary	Consumed Fast-food in the past week 0 = None 1 = One or more
Fruit and Vegetable Intake	Continuous	Cups of Fruit & Vegetable (minus french fries) eaten daily
Sugar Sweetened Beverage (SSB) Intake	Continuous	Teaspoons of added sugar in SSB's consumed daily

Potential confounders

The association between fast food availability and diet may be distorted by other factors affecting Fast Food, Fruit & Vegetable, and SSB intake. Household income, age, marital status, and children in the household may impact fast food availability and diet. For example, higher household income and marital status can provide resources to healthier food resulting in higher Fruit & Vegetable intake and lower Fast Food and SSB intake. These sociodemographic factors may also influence home location. Individuals living in higher income neighborhoods may have better access to grocery stores and live further away from high density FFRs. Families with a child at home may prioritize neighborhood safety and home size potentially leading to a decision to move into a more suburban neighborhood, further away from downtown areas and high density FFRs, but may also have little time to cook healthy meals.

In the present study, these variables were self-reported through a web-based survey (**Table 3**). Household income was reported in 8 categories ranging from 'less than $10,000' to 'More than $150,000'. The median of each category was created to form a semi-continuous variable. Participants gave their age at the screening process of the study to include only women 20 to 69 years of age; age ranged from 21 to 66 and was analyzed as a continuous variable. Both marital status and child in home were grouped into binary variables. All these variables have been used as covariates in previous studies.[16,23,37,49,53]

Table 3. Description of potential confounding variables for AWWHHI sample population

Variables	Type	Survey Question	Categories
Household Income	Ordinal[a]	What was the total family income (before taxes) from all sources within your household in the least year?	The median of 8 categories Less than $10,000 ($5,000) $10,000 to $19,999 ($15,000) $20,000 to $34,999 ($27,500) $35,000 to $49,999 ($42,500) $50,000 to $74,999 ($62,500) $75,000 to $99,999 ($87,500) $100,000 to $149,000 ($125,000) $150,000 or more ($150,000)
Age	Continuous	What is your age?	**-NA-**
Marital Status	Categorical	What is your current marital status? [1] Never Married [2] Divorced [3]Separated [4] Widowed [5] Married [6]Living in a marriage-like relationship	**Yes** [5] Married [6] Marriage-like relationship **No** = All other responses
Child under the age of 18 years old	Categorical	Q1:How many people are currently living in your household, including yourself? Q2: What is this person's relationship with you? 1] Spouse 2] romantic partner[3] biological child[4] step child[5] adopted child[6] extended family (grandparent, aunt, etc.)[7] non-relative (friend, room-mate)[9] Other	**Yes** [3] Biological child [4] Step child [5] Adopted child **No** = All other responses

[a] Household income was used as a continuous variable during model building.

Study Population

Among the 430 women enrolled in the AWWHHI, 247 women were employed ('Employed for wages' or 'Self-employed'); of these, 18 women were working from home therefore excluded from the sample, leaving 229 women employed outside of the home and eligible for inclusion in the current study. 197 women were employed and had a valid home address; of these, 44 were excluded due to invalid workplace address, and an additional 11 were excluded due to missing diet or income data. The final analytic sample included 142 women.

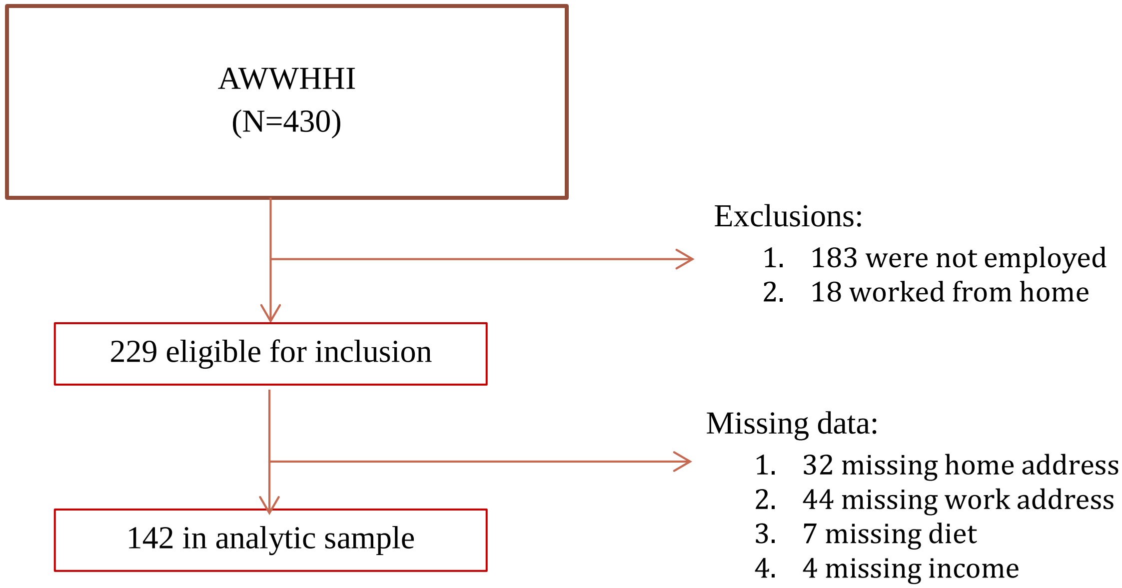


Figure 1: Flow Chart of Analytic Sample

Statistical analysis

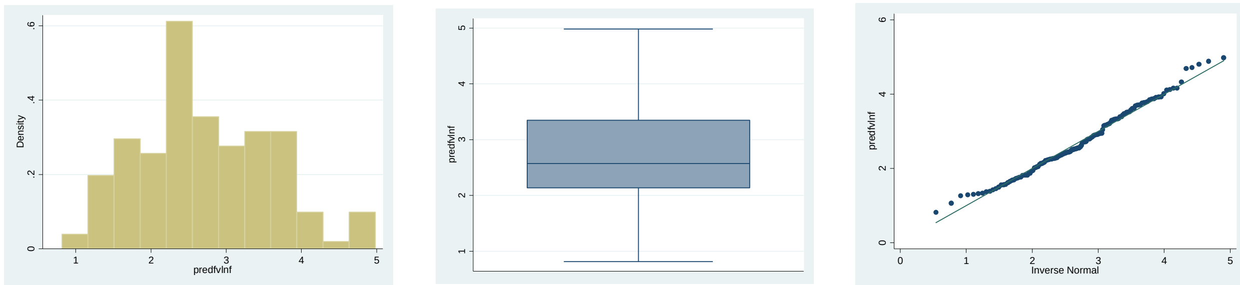
Descriptive analysis

Initial descriptive analysis consisted of comparison of (1) outcome with exposure variables and potential confounders and (2) exposure variables with potential confounders using t-tests, ANOVA and Spearman correlation. Categorical variables were collapsed to ensure adequate cell counts (**Table 4**). However, only 10 (7%) of women had more than one FFR within 400m of their home; this small frequency was considered throughout the analysis and interpretation.

We examined the observed distributions of Fast Food, Fruit & Vegetable, and SSB intake. Fast Food consumption was grouped into a binary variable (0 versus 1+ times per week) due to low consumption levels; 67% of women reported no consumption of Fast Food. Histograms, boxplots, Q-Q plots, and Shapiro Wilk's test for normality indicated Fruit & Vegetable intake was normally distributed. SSB had a highly skewed distribution due to the large proportion of women who consumed less than 0.5 tablespoons of added sugar from SSB (37%). SSB most closely approximated a gamma family distribution under a generalized linear model. Distributions of Fruit & Vegetable and SSB are shown in Figure 2.

Fruit & Vegetable Intake

Histogram	Boxplot	QQ-Plot



Sugar Sweetened Beverage Intake

Histogram	Boxplot	QQ-Plot

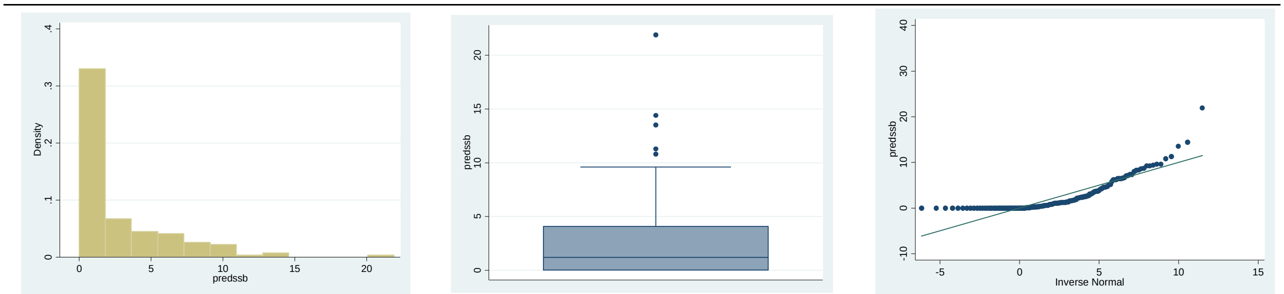


Figure 2: Distribution of Fruit & Vegetable and Sugar Sweetened Beverage outcomes via histograms, boxplots, and qq-plots

Regression Analysis

We conducted regression analysis to model Fast food, Fruit & Vegetable and SSB intake as a function of FFR availability and confounding variables. We used logistic regression for Fast Food consumption, a generalized linear model with a gamma distribution and log link function for SSB intake, and linear regression for Fruit & Vegetable intake. First, we fit 18 crude models (3 outcomes, 3 home FFR availability measures, 3 workplace FFR availability measures): Fast Food, Fruit & Vegetable or SSB intake was modeled as a function of a single FFR availability measure: count of FFR within 400m or 800m buffer around the home, count of FFR within 400m or 800m buffer around the workplace, FFR proximity around the home, or FFR proximity around the workplace. In crude models, continuous variables (home proximity, work proximity, age, and household income) were checked for linearity with respect to Fast Food, Fruit & Vegetable, and SSB outcomes using the Stata function nlcheck, a non-linearity test that categorizes the independent variable into bins, refits the model including dummy variables for the bins, and then performs a joint Wald test for the added parameters. Graphical displays via the Lowess smoother also suggest linear relationships. All continuous independent variable were linearly related to all outcomes, with one exception. For the SSB outcome and predictor variable work distance (log transformation), the test for nonlinearity was significant (p-value = 0.04), although graphic display suggested this was due to one extreme value. The Lowess smoother and nonlinearity tests are reported in **Appendix B**.

Second, for each of the 18 models, we empirically tested for confounding using a forward selection process, a commonly used method employing change-in-estimate to build regression models.[54–56] Starting with the crude model, we added one of four covariates (household income, age, marital status, and child in home) individually. Variables were considered confounders and thus candidates in the full model if their inclusion to the crude model changed the beta estimate for the exposure by more than 10%. We built the full model by adding the strongest confounder (assessed by the magnitude of the percent change in exposure coefficients), then the second strongest, proceeding until the beta coefficient for the exposure changed by less than 10% (compared to the preceding model).[55] We reported our forward selection model building process in Appendix C.

Third, we included FFR availability in both the home and work neighborhoods in the regression models. For each outcome, we created one model containing FFR counts within 800m home and work neighborhood buffers, and a second model containing the nearest distance to FFR from home and from work (9 models total: 3 outcomes, each containing either FFR count or FFR proximity measures). We selected the 800m buffers instead of the 400m buffers due to the small frequency of homes and workplaces with at least one FFR. For each of the four combined models, confounders were included if they were contained in any of the component models to ensure a fully adjusted model. With our sample size of 142, these combined models had 80% power to detect an effect size of 0.1, given five independent variables and a p=0.05 statistical significance level.

Fourth, we added interaction terms between home and work FFR availability to test if the association of the home exposure on diet differs depending on the work exposure and vice versa. For example, greater FFR availability around the workplace might enhance the effects of FFR around home by priming food cravings that can then be fulfilled after the workday.

Fifth, model diagnostics were performed on the final models. Shapiro Wilk's test for normality deemed the residuals normally distributed and visualization of the residual plots showed data points were mostly consistent in variability and few potential outliers. Visualization of Q-Q plots showed most of the residuals was normally distributed for linear model with Fruit & Vegetable outcome. Outlier diagnostics were also performed on all twenty-two models. Influential points were not identified using the DFITS test for the potential influence of single values and DFBETAS. No outlying and influential points were captured using the Cook's distance test. Collinearity was also not detected using Spearman's correlations between exposure and covariates and variance inflation factor (VIF) analysis.

Sixth**,** to address selection bias due to missing observations between home and work locations from our analytic sample (n=142) a sensitivity analysis was performed to determine if the association between our home exposures and outcomes differed when we included all women with a valid home location (n=357). In addition, we assessed if the association between work exposures and outcomes differed from our analytic sample (n=142) when we included all employed women with a valid work address, even if home address was not available (n=191). This sensitivity analysis showed similar results when models were re-estimated in both home and work sample populations. The largest difference between the two samples was for the associations with FFR availability within 800m around work as the exposure and SSB as the outcome with a 0.24 change in the work coefficient. A comparison of each model's coefficient between the two samples is reported in **Appendix C**.

RESULTS

Participants were on average 49.5 years of age with a mean annual income of $68.3 thousand; 25% were married, and 33% had a child living at home (**Table 4**). The nearest distance to a FFR was more than two times longer from home (median 1.8 km) than from work (median 0.8 km). Neighborhoods around work had more FFRs than home neighborhoods; for example, 35% of workplace neighborhoods had at least one FFR within 400m, compared to only 7% of home neighborhoods. 33% of women ate Fast Food at least one time in the prior week. Women consumed an average of 2.7 cups of Fruit & Vegetable and 2.7 tablespoons of added sugar in SSB per day.

Table 4. Characteristics of the Astoria and Warrenton Women's Heart Health Initiative (AWWHHI) study population (n=142)[a]

	Mean ±SD or n (%)
Demographics	
Age (years)	49.5 ± 11.5
Marital Status	
Married	107 (73%)
Not Married	39 (27%)
Household Income	
Less than $20,000	11 (8%)[b]
$20,000 to $34,999	22 (15%)
$35,000 to $49,999	26 (18%)
$50,000 to $74,999	20 (14%)
$75,000 to $99,999	38 (27%)
More than $100,000	25 (17%)[b]
Child <18 years living at home	
0	98 (67%)
1+	48 (33%)
Fast Food Restaurant Availability (FFR; exposures)	
Count within 400m of home)	
0	136 (93%)
1+	10 (7%)
Count within 800m of home	
0	112 (76%)
1+	34 (24%)
Count within 400m of work	
0	95 (65%)
1-2	29 (20%)
3+	22 (15%)
Count within 800m of work	
0	77 (53%)
1-2	28 (19%)
3+	41 (28%)
Distance between home and nearest FFR (kilometers)	1.8 (0.8, 6.1)[b]
Distance between work and nearest FFR (kilometers)	0.8 (0.3, 1.2)[b]
Dietary intake (outcomes)	
Fast Food (consumed 1+ time in the past week)	48 (33%)
Fruit & Vegetable (cups/day)	2.7 ± 0.8
Sugar sweetened beverages (tablespoons of added sugar/day)	2.7 ± 3.6

[a] Employed women among 430 AWWHHI participants, collected in 2013
[b] Distance was reported as median (25[th], 75[th] percentile).

Fast Food consumption was higher in women living within 800 meters of a FFR, and women who ate Fast Food at least once a week lived and worked closer to a FFR (**Table 5**). However, a small proportion of women consumed Fast Food, so we interpret these findings with caution. There were no significant differences in Fruit & Vegetable or SSB intake across any FFR availability buffer measure (p > 0.4). SSB intake was slightly higher in women living within 400 or 800 meters of a FFR and slightly lower in women working within 400 meters of a FFR, but these differences were not significant. Correlations between distance from FFR around home or work and Fruit & Vegetable/SSB were negative, suggesting the greater distance from home or work to a FFR corresponded to less Fruit & Vegetable and SSB intake, but these correlations were also not statistically significant (p > 0.10).

Table 5: Daily intake of Fruit & Vegetable and SSB and weekly intake of Fast Food, by FFR availability around home and work [a]

	Fast Food Consumption within past week		**SSB intake** (Mean (SD)[b] or Correlation)	**Fruit & Vegetable intake** (Mean (SD)[b] or Correlation)
	0 Mean ±SD or n (%)	**1+** Mean ±SD or n (%)		
FFR count within:				
400m of home				
0	92 (68%)	43 (32%)	2.6 (3.6)	2.7 (0.9)
1+	5 (50%)	5 (50%)	3.3 (3.5)	2.6 (0.8)
800m of home				
0	80 (71%)*	32 (29%)*	2.6 (3.6)	2.8 (0.9)
1+	17 (52%)*	16 (48%)*	3.0 (3.6)	2.6 (0.8)
400m of work				
0	60 (63%)	35 (37%)	2.9 (3.9)	2.7 (0.9)
1-2	37 (74%)[d]	13 (26%)[d]	2.4 (3.1)	2.7 (0.8)
3+			2.2 (2.4)	2.8 (0.9)
800m of work				
0	50 (65%)	27 (35%)	2.7 (3.6)	2.7 (0.9)
1-2	47 (68%)[d]	21 (31%)[d]	2.9 (4.3)	2.6 (0.8)
3+			2.5 (3.1)	2.8 (0.9)
Distance to nearest FFR from:				
home	5466 ± 6674	3127* ± 4076	-0.08[c]	-0.01[c]
work	1920 ± 4631	1249 ± 2333	-0.14[c]	-0.04[c]
Covariates				
Household Income	$62.5k ($42.5k, $87.5k)[e]	$62.5k ($42.5k, $87.5k)[e]	-0.22*	-0.08
Age	50 ± 11.3	48 ± 11.9	-0.34*	0.02
Marital Status				

Married	73 (69%)	33 (31%)	2.8 (3.4)	2.8 (0.9)
Not Married	24 (62%)	15 (38%)	2.4 (4.0)	2.6 (0.8)
Child <18 years living at home				
0	64 (66%)	33 (34%)	2.3 (3.1)	2.8 (0.9)
1+	33 (69%)	15 (31%)	3.4 (4.4)	2.6 (0.8)

[a] 142 employed women among 430 AWWHHI participants; data collected in 2013.
[b] Mean Fruit and Vegetable (cups/day) or SSB (tablespoons added sugar/day) intake compared across FFR availability category using t-tests and ANOVA. No differences were significant (p>0.4).
[c] Spearman's correlations between Fruit and Vegetable or SSB intake with FF Distance measures were not significant (p>0.1)
[d] FFR count around work was combined to 0 & 1+ due to low frequency of women consuming Fast Food.
[e] Household income reported as median (25th, 75th percentile)
*Statistically significant (p<0.05) difference in fast food consumption across FFR availability, per Chi-square test or t-test for categorical or continuous FFR availability measures, respectively

Multivariable adjusted associations for fast food restaurant availability with Fast Food consumption

Table 6: Odds Ratios for Fast Food consumption associated with fast food restaurant count within 400m buffer (Odds Ratio (95% confidence interval)

	Model 1 (Home)	**Model 2** (Work)
FFR around within 400m of **home** (1+ vs. 0)	2.60 (0.66, 10.15)	
FFR around within 400m of **work** (1+ vs. 0)		0.60 (0.28, 1.28)
Covariates		
Income (thousands)	0.97 (0.88, 1.07)	

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within a 400m buffer. Due to the small frequency of homes and workplaces with at least one FFR within the 400m buffer a combined Model 3 was not implemented. Covariates were determined using forward selection. No covariates were selected for Model 2.

Table 7: Odds Ratios for Fast Food consumption associated with fast food restaurant count within 800m buffer (Odds Ratio (95% confidence interval)

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
FFR around within 800m of **home** (1+ vs. 0)	2.35 (1.06, 5.22)		2.46 (1.10, 5.52)
FFR around within 800m of **work** (1+ vs. 0)		0.83 (0.41, 1.7)	0.75 (0.36, 1.53)

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within an 800m buffer. No Covariates were selected using forward selection.

We fit a series of models to test the hypothesis that Fast Food consumption is higher with greater numbers of FFR around the home or work neighborhood. This was an *a priori* hypothesis but results should be interpreted with caution due to the low frequency of women who consumed Fast Food and have 1+ FFRs around home and work. In Model 1 (FFR availability in the home neighborhood), consistent with our hypothesis, women with at least one FFR within 400m of home had 2.6 greater odds of eating Fast Food than women with no FFR (**Table 6**); this was not statistically significant. This association was slightly weaker for the 800m buffer, but significant (2.35, p = 0.04) (**Table 7**). In Model 2 (FFR availability in the workplace neighborhood), FFR count in the work neighborhood had an unexpected negative association to Fast Food consumption; Odds Ratios were not statistically significant (**Tables 6 and 7**). In Model 3 (FFR availability in the home and workplace neighborhoods), associations between Fast Food consumption with FFR availability around the home and work were similar in the combined model. Interaction between FFR availability in home and work neighborhoods was not significant (p=0.6) therefore excluded from the model. In summary, FFR availability within the home neighborhood was positively associated with Fast Food consumption while FFR availability in the work neighborhood was not related to Fast Food consumption. At most, 2% of variance in weekly Fast Food consumption was explained by the independent variables in the models.

Table 8: Odds Ratios for Fast Food consumption associated with distance from FFR (Odds Ratios (95% confidence interval) [a,]

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
Nearest distance to FFR from **home**	0.73 (0.55, 0.97)		0.73 (0.55, 0.97)
Nearest distance to FFR from **work**		0.98 (0.76, 1.3)	0.98 (0.76, 1.26)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of nearest distance to Fast Food Restaurant. No covariates were selected using forward selection. All interpretation of distance coefficients were translated via log transformation

In a similar series of models, we tested the hypothesis that Fast Food consumption is lower among women living or working further distance from a FFR. This hypothesis was supported for the home neighborhood (Model 1): For every e-fold (2.72-fold) greater distance, women had 0.73 the odds of eating Fast Food (p=0.03), while FFR distance from work (Model 2) was unrelated to Fast Food consumption (p=0.83). Interaction between FFR distance from home and work was not significant (p=0.28) therefore excluded from Model 3. In summary, distance to FFR from home was negatively associated with Fast Food consumption, while distance from work was not related to Fast Food consumption.

Multivariable adjusted associations for fast food restaurant availability with SSB intake

Table 9: Exponentiated coefficients for SSB intake associated with fast food restaurant count within 400m buffer (exponentiated coefficient (95% confidence interval))[a]

	Model 1 (Home)	**Model 2** (Work)
FFR around within 400m of **home** (1+ vs. 0)	2.08 (0.84, 5.05)	
FFR around within 400m of **work** (1-2 vs. 0)		0.76 (0.45, 1.31)
FFR around within 400m of **work** (3+ vs. 0)		0.75 (0.40, 1.38)
Covariates		
Age	0.96 (0.94, 0.98)	0.96 (0.94, 0.81)
Income	1.07 (1.01, 1.13)	1.07 (1.01, 1.12)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). General Linear Model with log-link gamma distribution regression modeling daily SSB intake as a function of Fast Food Restaurant availability within a 400m buffer. Due to the small frequency of homes and workplaces with at least one FFR within the 400m buffer a combined Model 3 was not implemented Covariates were determined using forward selection; estimates did not change after adjusting for age and income. To facilitate interpretability of the gamma model, values shown are exponentiated coefficients, representing the fold-difference in SSB associated with the exposure.

Table 10: Exponentiated coefficients for SSB intake associated with fast food restaurant count within 800m buffer (exponentiated coefficient (95% confidence interval))[a]

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
FFR around within 800m of **home** (1+ vs. 0)	1.10 (0.66, 1.86)		1.08 (0.65, 1.82)
FFR around within 800m of **work** (1-2 vs. 0)		0.97 (0.53, 1.78)	0.98 (0.51, 1.79)
FFR around within 800m of **work** (3+ vs. 0)		0.78 (0.47, 1.30)	0.78 (0.47, 1.30)
Covariates			
Age	0.96 (0.94, 0.98)	0.96 (0.94, 0.98)	0.96 (0.94, 0.98)
Income	1.06 (1.01, 1.12)	1.07 (1.01, 1.14)	1.07 (1.01, 1.13)
Child	0.97 (0.58, 1.62)	0.97 (0.56, 1.63)	0.98 (0.58, 1.62)
Marital Status		1.06 (0.58, 1.62)	1.05 (0.58, 1.62)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). General Linear Model with log-link gamma distribution modeling daily SSB intake as a function of Fast Food Restaurant availability within an 800m buffer. Covariates were determined using forward selection. To facilitate interpretability of the gamma model, values shown are exponentiated coefficients, representing the fold-difference in SSB associated with the exposure.

Table 11: Exponentiated coefficients for SSB intake associated with distance from fast food restaurant (exponentiated coefficient (95% confidence interval))[a]

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
Nearest distance to FFR from **home**	0.93 (0.77, 1.11)		0.93 (0.77, 1.12)
Nearest distance to FFR from **work**		1.03 (0.85, 1.24)	1.01 (0.83, 1.23)
Covariates			
Age	0.66 (0.96, 0.98)	0.96 (0.94, 0.98)	0.96 (0.94, 0.98)
Income	1.07 (1.01, 1.14)	1.06 (1.01, 1.12)	1.07 (1.01, 1.12)
Child	0.99 (0.59, 1.67)		0.99 (0.59, 1.67)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). General Linear Model with log-link gamma distribution modeling daily SSB intake as a function of distance to nearest FFR. Covariates were determined using forward selection. To facilitate interpretability of the gamma model, values shown are exponentiated coefficients, representing the fold-difference in SSB associated with the exposure.

For SSB intake, we hypothesized that SSB intake was higher with greater numbers of FFRs in the home or work neighborhood. In Model 1 (FFR availability in the home neighborhood), consistent with our hypothesis, women living within 400m of 1+ FFR consumed, on average, 2.1 times more tablespoons of SSB than those with no FFR (**Table 9**), but this was not statistically significant. This association was not observed for the 800m buffer (1.1, p = 0.72) (**Table 10**). FFR count in the work neighborhood was unrelated to SSB intake (Model 2); associations were generally weak, not statistically significant, and in inconsistent directions than the home models (**Tables 9 and 10**). Associations between SSB intake with FFR availability around the home and work were similar in the combined models (Model 3). SSB intake was also unrelated to distance to nearest FFR from home or work (**Table 11**). No interactions between FFR availability in the home and work models were significant and therefore omitted from the combined models. In summary, FFR availability was not related to SSB intake. At most, 3% of variance in daily SSB intake was explained by the independent variables in the models.

Multivariable adjusted associations for fast food restaurant availability with Fruit & Vegetable intake

Table 12: Regression coefficients for Fruit & Vegetable intake associated with fast food restaurant count within 400m buffer (coefficient (95% confidence interval) [a]

	Model 1 (Home)	**Model 2** (Work)
FFR around within 400m of **home** (1+ vs. 0)	0.05 (-0.56, 0.67)	
FFR around within 400m of **work** (1-2 vs. 0)		-0.03 (-0.41, 0.35)
FFR around within 400m of **work** (3+ vs. 0)		0.10 (-0.32, 0.52)
Covariates		
Income	0.02 (-0.02, 0.06)	
Marital Status	-0.08 (-0.44, 0.29)	-0.16 (-0.50, 0.17)
Child	-0.14 (-0.48, 0.20)	-0.14 (-0.45, 0.17)
Age	-0.01 (-0.02, 0.01)	-0.01 (-0.02, 0.02)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modelling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 400m buffer. Covariates were determined using forward selection.

Table 13: Regression coefficients for Fruit & Vegetable intake associated with fast food restaurant count within 800m buffer (coefficient (95% confidence interval)[a]

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
FFR around within 800m of **home** (1+ vs. 0)	-0.08 (-0.43, 0.28)		-0.07 (-0.43, 0.29)
FFR around within 800m of **work** (1-2 vs. 0)		-0.13 (-0.53, 0.27)	-0.12 (-0.52. 0.29)
FFR around within 800m of **work** (3+ vs. 0)		0.08 (-0.27, 0.43)	0.09 (-0.26, 0.44)
Covariates [b]			
Income	0.02 (-0.02, 0.06)	0.02 (-0.02, 0.06)	0.02 (-0.02, 0.06)
Marital Status	-0.06 (-0.42, 0.30)	-0.06 (-0.43, 0.31)	-0.05 (-0.42, 0.32)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 800m buffer. Covariates were determined using forward selection.
[b] Age was not included in any of the 3 models using forward selection.

Table 14: Regression coefficients for Fruit & Vegetable associated with distance from Fast Food Restaurant (coefficient (95% confidence interval) [a]

	Model 1 (Home)	**Model 2** (Work)	**Model 3** (Home and Work)
Nearest distance to FFR from **home**	-0.02(-0.14 0.10)		-0.02 (-0.14, 0.10)
Nearest distance to FFR from **work**		-0.02 (-0.14, 0.08)	-0.03 (-0.14, 0.09)
Covariates			
Age	-0.01 (-0.02, 0.01)	-0.01 (-0.02, 0.01)	-0.01 (-0.17, 0.01)
Income	0.03 (-0.19, 0.66)	0.03 (-0.14, 0.64)	0.02 (-0.16, 0.63)
Marital Status	-0.08 (-0.44, 0.28)		-0.09 (-0.45, 0.27)
Child	-0.14 (-0.48, 0.21)		-0.11 (-0.43, 0.20)

[a] Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of nearest distance to Fast Food Restaurant. Covariates were determined using forward selection. All interpretation of distance coefficients were translated via log transformation

With regard to Fruit and Vegetable intake, we hypothesized that Fruit & Vegetable intake would be lower among women with greater numbers of FFR in the home or work neighborhood. Associations between FFR availability and Fruit & Vegetable intake were weak, not statistically significant, and in inconsistent directions (**Tables 12-14**); this held true for home and work neighborhoods within 400 and 800m buffers. At most we observed 0.13 fewer servings (p=0.5) of Fruits and Vegetables among women with 1-2 FFRs within 800m of their workplace location (**Table 13**, Model 2). No interactions between FFR availability in the home and work models were significant and therefore omitted from the model. In summary, no independent variables were related to Fruit & Vegetable intake. At most, 2% of variance in daily Fruit & Vegetable intake was explained by the independent variables in the models.

DISCUSSION

In this study, we examined associations between diet and FFR availability in both the home and work neighborhood environments among women living in a rural coastal county. We tested the hypothesis that FFR availability in the work neighborhood would be more strongly related to Fast Food, Fruit & Vegetable and SSB Intake than FFR availability in the home neighborhood. We found greater numbers of FFRs in work neighborhoods than in home neighborhoods. Fast Food consumption was positively associated with FFR availability within an 800 meter buffer around the home and negatively associated with distance to the nearest FFR from home, but unrelated to FFR availability in work neighborhoods. Fruit & Vegetable or SSB intake was not associated with FFR availability in work or home neighborhoods.

Associations between fast food availability and fast food consumption

The positive association between FFR availability around home and Fast Food consumption has also been reported in past studies.[16,27,56] Burgoine et al's (2014) study addressing both and home and work neighborhood FFR availability had a significant positive association with Fast Food consumption around the home neighborhood. However, while we found little change in associations when FFR in home and work neighborhoods were included in the same model, Burgoine et al. found strong positive associations between density of FFR for Fast Food consumption and BMI when home and work were both exposures in the same model.[56] These differences may be explained by the additional FFR availability around commuting route of employed participants in his combined models and his use of density measures instead of count. Unlike the more urban environment that Burgoine studied, the present study was located in a rural environment with much fewer FFRs and lacked information on participants' commuting routes.

We found discordant associations with FFR availability in work neighborhoods for Fast Food consumption, which were negative and not statistically significant. Greater FFRs around workplace may represent greater availability of other food retail offering alternatives to FFRs. In addition, women may lack sufficient time to eat lunch at nearby FFRs. These results emphasize the differences between home and work neighborhood food environments. While we found workplace neighborhoods had more counts of FFRs and an overall closer distance to FFRs than home neighborhoods we did not investigate the environments *within* homes and workplaces. Offices and worksites are different from homes in that they are more likely to have SSBs (but not Fruits and Vegetables) available via vending machines and onsite cafes. For example, 14% of the participants worked at Columbia Memorial Hospital, which offers extensive onsite food outlets. Acknowledging that home and workplace are different entities with different neighborhood environments and investigating the relative importance of these differences in diet decisions should be an important feature for future research.

Associations between fast food availability and SSB and Fruit & Vegetable intake

While no statistically significant associations were observed, findings for SSB intake were more consistent with Fast Food consumption than findings for Fruit & Vegetable intake. These differences may reflect the hypothesized pathways through which Fruit & Vegetables versus SSB are purchased. SSB can be purchased in FFRs and in the majority of food stores, while Fruit & Vegetables are predominantly found in grocery stores. Indeed, higher Fast Food consumption is associated with higher SSB intake in a study focusing on the diet of rural adults. Prior studies of home and work neighborhood food environments did not examine SSB intake.[31,56]

In contrast, eating at a FFR does not preclude purchase and consumption of Fruit & Vegetables from other retail outlets. For example, Thornton (2013) found Fast Food consumption was not associated with Fruit & Vegetable intake. Our studies were comparable as both used similar FFR availability measures (counts), Fast Food and Fruit & Vegetable intake measurements, and studied an adult female population.[31] Our studies were different by location. While we studied a more rural environment Thornton's study was based in urban, Melbourne, Australia. Further exploration of these patterns with more complete measurement of food purchases would improve understanding of the pathways from the food environment to food intake.

Measurement of fast food consumption and availability

Fast food consumption was assessed by one question, "In the past week, how often did you eat something from a fast-food restaurant (e.g., McDonald's, Burger King, Hardee's)?". While this question is commonly used in nutrition research[4,16,27] and has test-retest reliability of 0.79[51] there may be systematic error in the accuracy of responses. For example, participants may not have remembered eating at a fast food restaurant (recall error) or may have answered the question differently because they were at a health fair (social desirability error). It is unlikely that these inaccuracies in Fast Food consumption vary systematically by FFR availability, so there is less concern of bias. The high test-retest reliability mitigates the concern that the question focused on a single week, and suggests that it may reasonably reflect the study participant's habitual fast food consumption behavior. This question also does not address the exact food that was consumed. The ambiguity on the definition of fast food is a challenge research in this field is trying to address.

There are no standard measures for assessing the food environment,[49] therefore, many different measurements of fast food availability have been applied in prior research. We used NAICS codes to define FFRs, which categorizes types of stores, rather than categorizing stores on the basis of types of food available for purchase.[49] Fast food and other types of calorie dense food are also available in grocery delis and other types of outlets;[37] by only using FFRs to measure fast food availability we likely underestimated the true exposure to fast food. This restriction may have distorted the representation of the food environment. However, by focusing on only FFRs we give a clear component of the food environment that could be more easily adapted to policy.

In this study, we examined two dimensions of FFR availability by assessing both number of and distance to FFRs. The count and nearest distance measures provided similar results. For example, greater distance between participant's homes and the nearest FFR was associated with lower SSB intake, and greater number of FFRs around the home was associated with in higher SSB intake, as hypothesized. While we chose 400 meter and 800 meter buffers based on previous research[23,50] and rationale, there is still no validated measure on what size is most effective for assessing accessibility of FFR. Our varied results throughout all models, especially around the work neighborhood, could be explained by the lack of standardized measures for assessing the food environment,[49] specifically in rural areas.

Limitations

This study had several limitations in its ability to estimate how the availability of FFRs affects the diets of rural women. First, we cannot determine temporality or causality based on our cross-sectional study design. Second, our diet data was self-reported and therefore subject to recall bias. Third, the women who attended the health fair were volunteers therefore consisted of a non-random convenience sample. This may make results of the study less generalizable to the county. Fourth, we had a small sample size giving this study lower statistical power. Fifth, we did not examine other neighborhood environmental factors, such as neighborhood income; this could have biased our associations because neighborhood income is associated with both diet and FFR availability.[42] Sixth, we did not have data on individual-level education, a prominent characteristic in determining risk of obesity; however, we controlled for income, which is highly associated with education. Seventh, we did not measure the amount of hours employed women worked, so we were unable to estimate temporal exposure to FFRs around work.

Finally, like many prior studies, we did not have data on whether participants actually ate at the FFRs, nor did we have information on individual food purchasing habits. This is a key area for future research. By not having information about where participants actually eat, we can only speculate on outcomes such as diet. In recent research, social media was used to track where individuals actually ate. For example, local food environments were analyzed in Ohio through Twitter 'check-ins'.[57] This has great potential in our ability to observe individual diets as well as food purchasing habits. More studies like this could be cross referenced by different spatial access measurements, such as GPS tracking, to test the accuracy of FFR attendance used by geospatial measurements.

Conclusion

Our hypothesis that FFR availability around the workplace had a stronger association to dietary behaviors than FFR availability around home was not supported. This study found evidence that FFR availability around home is related to Fast Food intake, but neither home nor work neighborhood environments were related to Fruit & Vegetable and SSB intake in our study population of women living in a coastal town. Our results highlight the complexity of studying how the fast food environment is associated with diet. Understanding a person's whole exposure to the fast food environment remains a concern for health researchers and policymakers and it is important to create an entire picture of this exposure. Including the work environment in addition to the more traditionally studied home environment should be an important contribution to this research.

REFERENCES

1. Jia, H. & Lubetkin, E. I. Trends in quality-adjusted life-years lost contributed by smoking and obesity. *Am. J. Prev. Med.* **38,** 138–144 (2010).
2. Walker, R. E., Keane, C. R. & Burke, J. G. Disparities and access to healthy food in the United States: A review of food deserts literature. *Health Place* **16,** 876–884 (2010).
3. Sharkey, J. R., Johnson, C. M., Dean, W. R. & Horel, S. A. Association between proximity to and coverage of traditional fast-food restaurants and non-traditional fast-food outlets and fast-food consumption among rural adults. *Int. J. Health Geogr.* **10,** 37 (2011).
4. Wilcox, S., Sharpe, P. A., Turner-McGrievy, G., Granner, M. & Baruth, M. Frequency of consumption at fast-food restaurants is associated with dietary intake in overweight and obese women recruited from financially disadvantaged neighborhoods. *Nutr. Res. N. Y. N* **33,** 636–646 (2013).
5. Rosenheck, R. Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obes. Rev. Off. J. Int. Assoc. Study Obes.* **9,** 535–547 (2008).
6. Hebden, L., Hector, D., Hardy, L. L. & King, L. A fizzy environment: Availability and consumption of sugar-sweetened beverages among school students. *Prev. Med.* **56,** 416–418 (2013).
7. Wang, Y. C., Coxson, P., Shen, Y.-M., Goldman, L. & Bibbins-Domingo, K. A penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burdens of diabetes. *Health Aff. Proj. Hope* **31,** 199–207 (2012).
8. Schulze, M. B. *et al.* Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA* **292,** 927–934 (2004).
9. Wang, X. *et al.* Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ* **349,** g4490 (2014).
10. Zenk, S. N., Schulz, A. J. & Odoms-Young, A. M. How neighborhood environments contribute to obesity. *Am. J. Nurs.* **109,** 61–64 (2009).

11. Kamphuis, C. B. M. *et al.* Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *Br. J. Nutr.* **96,** 620–635 (2006).

12. Larson, N. I., Story, M. T. & Nelson, M. C. Neighborhood environments: disparities in access to healthy foods in the U.S. *Am. J. Prev. Med.* **36,** 74–81 (2009).

13. Boone-Heinonen, J. *et al.* Fast food restaurants and food stores: longitudinal associations with diet in young to middle-aged adults: the CARDIA study. *Arch. Intern. Med.* **171,** 1162–1170 (2011).

14. Fielding, J. E. & Simon, P. A. Food deserts or food swamps?: comment on 'Fast food restaurants and food stores'. *Arch. Intern. Med.* **171,** 1171–1172 (2011).

15. Fraser, L. K., Edwards, K. L., Cade, J. & Clarke, G. P. The geography of Fast Food outlets: a review. *Int. J. Environ. Res. Public. Health* **7,** 2290–2308 (2010).

16. Moore, L. V., Diez Roux, A. V., Nettleton, J. A., Jacobs, D. R. & Franco, M. Fast-food consumption, diet quality, and neighborhood exposure to fast food: the multi-ethnic study of atherosclerosis. *Am. J. Epidemiol.* **170,** 29–36 (2009).

17. Laxy, M., Malecki, K. C., Givens, M. L., Walsh, M. C. & Nieto, F. J. The association between neighborhood economic hardship, the retail food environment, fast food intake, and obesity: findings from the Survey of the Health of Wisconsin. *BMC Public Health* **15,** 237 (2015).

18. James, P., Arcaya, M. C., Parker, D. M., Tucker-Seeley, R. D. & Subramanian, S. V. Do minority and poor neighborhoods have higher access to fast-food restaurants in the United States? *Health Place* **29,** 10–17 (2014).

19. Bureau of Labor Statistics, U. S. D. of L. American Time Use Survey. (2013).

20. Blanck, H. M. *et al.* Factors influencing lunchtime food choices among working Americans. *Health Educ. Behav. Off. Publ. Soc. Public Health Educ.* **36,** 289–301 (2009).

21. Gustafson, A. A. *et al.* Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. *Public Health Nutr.* **14,** 1032–1038 (2011).

22. Sharkey, J. R., Johnson, C. M. & Dean, W. R. Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. *BMC Geriatr.* **10,** 32 (2010).

23. Paquet, C. *et al.* Interactive effects of reward sensitivity and residential fast-food restaurant exposure on fast-food consumption. *Am. J. Clin. Nutr.* **91,** 771–776 (2010).

24. Hermstad, A. K., Swan, D. W., Kegler, M. C., Barnette, J. K. & Glanz, K. Individual and environmental correlates of dietary fat intake in rural communities: a structural equation model analysis. *Soc. Sci. Med. 1982* **71,** 93–101 (2010).

25. Ding, D. *et al.* Community food environment, home food environment, and fruit and vegetable intake of children and adolescents. *J. Nutr. Educ. Behav.* **44,** 634–638 (2012).

26. Sturm, R. & Cohen, D. A. Zoning for health? The year-old ban on new fast-food restaurants in South LA. *Health Aff. Proj. Hope* **28,** w1088–1097 (2009).

27. Richardson, A. S., Boone-Heinonen, J., Popkin, B. M. & Gordon-Larsen, P. Neighborhood fast food restaurants and fast food consumption: a national study. *BMC Public Health* **11,** 543 (2011).

28. Burgoine, T. & Monsivais, P. Characterising food environment exposure at home, at work, and along commuting journeys using data on adults in the UK. *Int. J. Behav. Nutr. Phys. Act.* **10,** 85 (2013).

29. Hurvitz, P. M. & Moudon, A. V. Home versus nonhome neighborhood: quantifying differences in exposure to the built environment. *Am. J. Prev. Med.* **42,** 411–417 (2012).

30. Lachat, C. *et al.* Eating out of home and its association with dietary intake: a systematic review of the evidence. *Obes. Rev. Off. J. Int. Assoc. Study Obes.* **13,** 329–346 (2012).

31. Thornton, L. E., Lamb, K. E. & Ball, K. Employment status, residential and workplace food environments: Associations with women's eating behaviours. *Health Place* **24,** 80–89 (2013).

32. Iceland, J. *A Portrait of America: The Demographic Perspective*. (Univ of California Press, 2014).

33. Patterson, P. D., Moore, C. G., Probst, J. C. & Shinogle, J. A. Obesity and physical inactivity in rural America. *J. Rural Health Off. J. Am. Rural Health Assoc. Natl. Rural Health Care Assoc.* **20,** 151–159 (2004).

34. Boehmer, T. K., Lovegreen, S. L., Haire-Joshu, D. & Brownson, R. C. What constitutes an obesogenic environment in rural communities? *Am. J. Health Promot. AJHP* **20,** 411–421 (2006).

35. Vilaro, M. & Tracey, B. The Rural Food Environment: A Survey of Food Price, Availability, and Quality in a Rural Florida Community. *Food Public Health* **3,** 111–118 (2013).

36. Powell, L. M., Slater, S., Mirtcheva, D., Bao, Y. & Chaloupka, F. J. Food store availability and neighborhood characteristics in the United States. *Prev. Med.* **44,** 189–195 (2007).
37. Sharkey, J. R., Johnson, C. M. & Dean, W. R. Less-healthy eating behaviors have a greater association with a high level of sugar-sweetened beverage consumption among rural adults than among urban adults. *Food Nutr. Res.* **55,** (2011).
38. Marriott, L. K. *et al.* Let's Get Healthy! Health awareness through public participation in an education and research exhibit. *Prog. Community Health Partnersh. Res. Educ. Action* **6,** 331–337 (2012).
39. Breyer, B. & Voss-Andreae, A. Food mirages: geographic and economic barriers to healthful food access in Portland, Oregon. *Health Place* **24,** 131–139 (2013).
40. Moreno-Black, G. Bethel School District Report: Food Environment Mapping. at <https://cast.ori.org/files/Bethel_Food_Environment_Mapping_Report_200809.pdf>
41. City of Portland Bureau of Planning and Sustainability. Food Systems: Portland Plan Background Report. (2009).
42. Dubowitz, T. *et al.* The Women's Health Initiative: The Food Environment, Neighborhood Socioeconomic Status, BMI, and Blood Pressure. *Obesity* **20,** 862–871 (2012).
43. Lopez, R. P. Neighborhood risk factors for obesity. *Obes. Silver Spring Md* **15,** 2111–2119 (2007).
44. Mehta, N. K. & Chang, V. W. Weight status and restaurant availability a multilevel analysis. *Am. J. Prev. Med.* **34,** 127–133 (2008).
45. Liese, A. D. *et al.* Validation of 3 food outlet databases: completeness and geospatial accuracy in rural and urban food environments. *Am. J. Epidemiol.* **172,** 1324–1333 (2010).
46. Bader, M. D. M., Ailshire, J. A., Morenoff, J. D. & House, J. S. Measurement of the local food environment: a comparison of existing data sources. *Am. J. Epidemiol.* **171,** 609–617 (2010).
47. Powell, L. M. *et al.* Field validation of secondary commercial data sources on the retail food outlet environment in the U.S. *Health Place* **17,** 1122–1131 (2011).
48. Fleischhacker, S. E., Evenson, K. R., Sharkey, J., Pitts, S. B. J. & Rodriguez, D. A. Validity of Secondary Retail Food Outlet Data. *Am. J. Prev. Med.* **45,** 462–473 (2013).

49. Caspi, C. E., Sorensen, G., Subramanian, S. V. & Kawachi, I. The local food environment and diet: A systematic review. *Health Place* **18,** 1172–1187 (2012).

50. Reitzel, L. R. *et al.* Density and proximity of fast food restaurants and body mass index among African Americans. *Am. J. Public Health* **104,** 110–116 (2014).

51. Kirkpatrick, S. I. *et al.* Dietary assessment in food environment research: a systematic review. *Am. J. Prev. Med.* **46,** 94–102 (2014).

52. Thompson, F. E. *et al.* Performance of a short tool to assess dietary intakes of fruits and vegetables, percentage energy from fat and fibre. *Public Health Nutr.* **7,** 1097–1105 (2004).

53. Hoehner, C. M. *et al.* Understanding the independent and joint associations of the home and workplace built environments on cardiorespiratory fitness and body mass index. *Am. J. Epidemiol.* **178,** 1094–1105 (2013).

54. Harrell, F. E. *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis*. (Springer Science & Business Media, 2013).

55. Rothman, K. J., Greenland, S. & Lash, T. L. *Modern Epidemiology*. (Lippincott Williams & Wilkins, 2008).

56. McNamee, R. Regression modelling and other methods to control confounding. *Occup. Environ. Med.* **62,** 500–506 (2005).

57. Burgoine, T., Forouhi, N. G., Griffin, S. J., Wareham, N. J. & Monsivais, P. Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study. *BMJ* **348,** (2014).

APPENDIX

Appendix A: Fast food restaurant informal quality assessment

Two steps were taken to verify the address and FFR name was accurate. First we searched each of the FFR address in Google maps to see if these addresses led us to the FFR in question. Second, we put the name of the FFR and address in a web search engine to see if there was webpage available. All FFRs were confirmed using this approach except for two addresses. One FFR address for Kentucky Fried Chicken (KFC) showed a Subway on Google maps, but there was a KFC .4 miles away. Another FFR address was found on Google maps, but the website said they were CLOSED. The names and counts of the 25 FFRs are below.

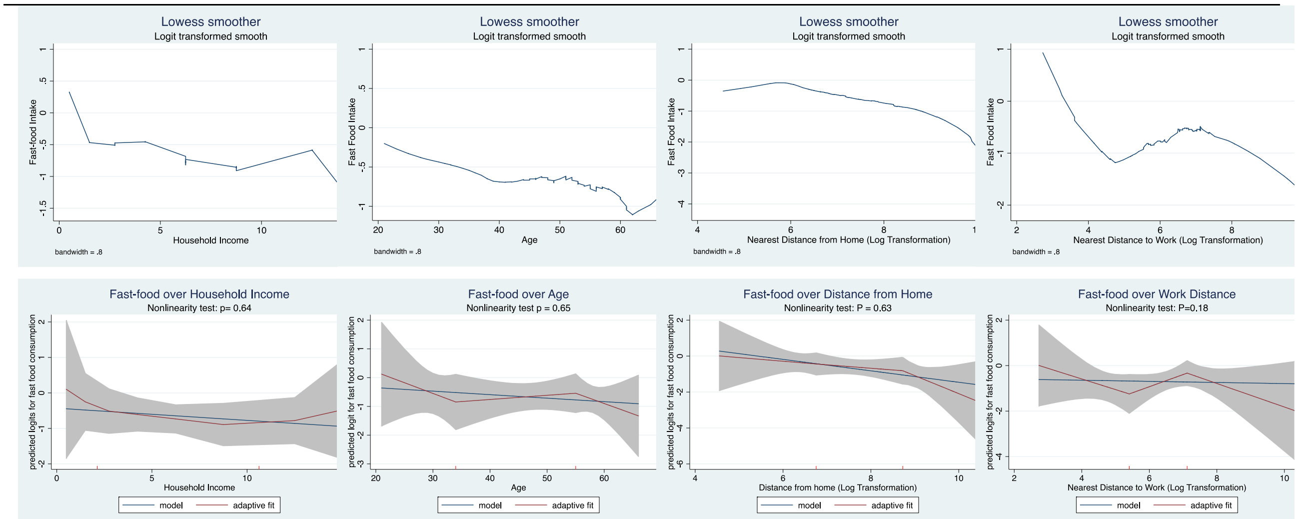
Table A1: Fast Food Restaurant business names located in Clatsop County, Oregon

Fast Food Restaurant	Frequency
Bee Bop Burgers	1
Burger King	1
Dairy Maid	1
Dairy Queen	4
El Rinconcito	1 (CLOSED)
Fultano's Pizza	3
Geno's Pizza and Burgers	1
Kentucky Fried Chicken	2 (One is a Subway)
McDonald's	2
Pizza a'Fetta	1
Pizza Express	1
Pizza Harbor	1
Sahara Pizza	1
Serendipity	1
Subway	1 (Not the same one that is a KFC)
Taco Bell	1
Taco Time	1
Tsunami Sandwich Company	1

Appendix B: Check for linearity between continuous variables via locally weighted scatter plot smoothing (LOWESS) and nonlinearity test (NLCHECK)

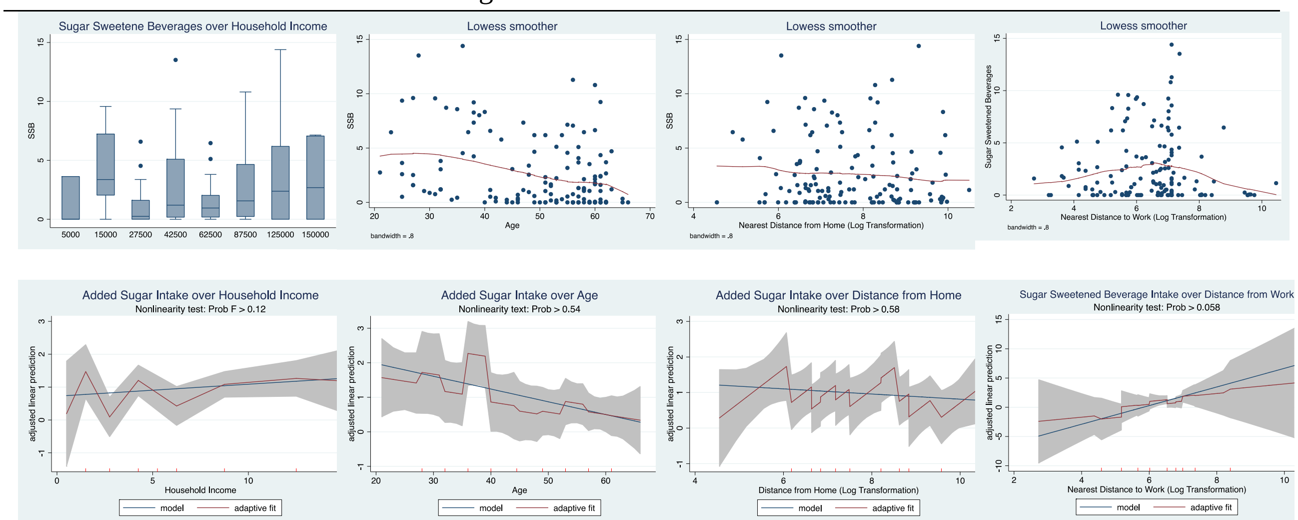
Fast-food Intake

Household Income	Age	Home Distance	Work Distance



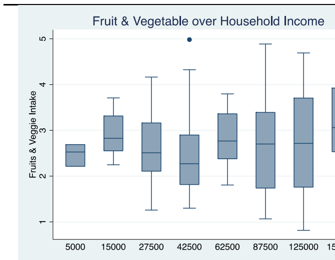
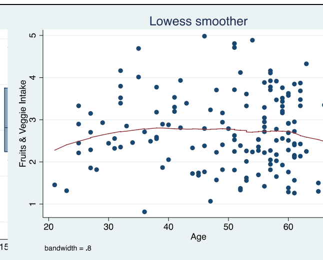
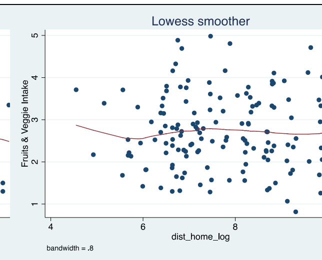
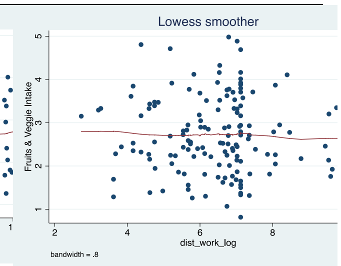
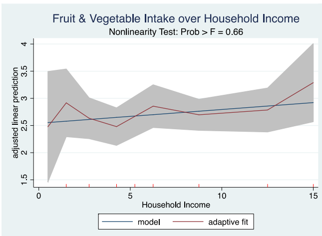
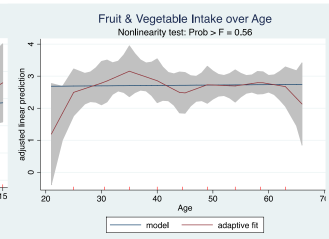
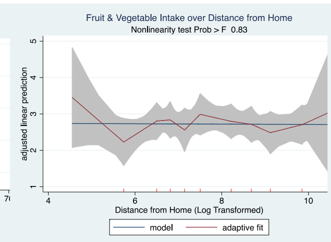
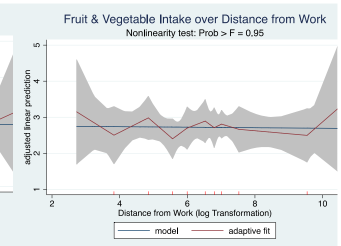
Sugar Sweetened Beverage Intake [a]

Household Income [b]	Age	Home Distance	Work Distance



[a] LOWESS is based in linear regression and is presented to provide a visual illustration of the observed data. NLCHECK properly models a gamma family distribution.
[b] Household income is a semi-continuous variable. A series of box plots is a better visual measure to determine linearity.

Fruit & Vegetable Intake

Household Income [a]	Age	Home Distance	Work Distance
			
			

[a] Household income is a semi-continuous variable. A series of box plots is a better visual measure to determine linearity.

Appendix C: Forward Selection Model Building

C1: Outcome: Fast Food consumption **Exposure:** FFR availability around home

Model Building: Fast Food Consumption Intake & FFR within 400m buffer around home

Crude Model + Individual Covariates	400m buffer Odds Ratio	% Change in Odds Ratio	p-value of FFR coefficient	p-value covariate coefficient
Crude	2.14	NA	0.25	NA
Crude + Income	2.59	20.9%	0.17	0.47
Crude + Marital Status	2.01	-6.2%	0.30	0.50
Crude + Age	2.26	5.8%	0.22	0.36
Crude + Child	2.11	-1.3%	0.26	0.81
Model Development				
Crude	2.14	NA	0.25	NA
Crude + Income	**2.59**	**20.9%**	**0.17**	**0.47**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within a 400m buffer. Covariates were determined using forward selection. Final model is in bold.

Model Building: Fast Food consumption & FFR within 800m buffers around home.

Crude Model + Individual Covariates	800m buffer Odds Ratio	% Change in Odds Ratio	p-value of FFR coefficient	p-value covariate coefficient
Crude	2.35	NA	0.04	NA
Crude + Income	2.36	0.3%	0.04	0.59
Crude + Marital Status	2.27	-3.4%	0.05	0.66
Crude + Age	2.30	-2.2%	0.04	0.54
Crude + Child	2.36	0.1%	0.04	0.41
Model Development				
Crude	**2.35**	NA	**0.04**	N/A
Crude + Income	2.27	-3.4%	0.04	0.59

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within an 800m buffer. Covariates were determined using forward selection. Final model is in bold.

Model Building: Fast Food consumption & Distance to Nearest FFR from home

Crude Model + Individual Covariates	Distance Odds Ratio	% Change in Odds Ratio	p-value of FFR coefficient	p-value covariate coefficient
Crude	0.73	NA	0.03	NA
Crude + Income	0.73	0.3%	0.03	0.53
Crude + Marital Status	0.74	1.1%	0.04	0.66
Crude + Age	0.73	0.6%	0.03	0.51
Crude + Child	0.73	0.1%	0.03	0.83
Cumulative Model				
Crude	**0.73**	NA	**0.03**	NA
Crude + Income	0.74	1.1%	0.03	0.53

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant of nearest distance to FFR. Covariates were determined using forward selection. Final model is in bold.

C2: Outcome: Fast Food consumption **Exposure:** FFR availability around work

Model Building: Fast Food Consumption Intake & FFR within 400m buffer around Work

Crude Model + Individual Covariates	400m buffer Odds Ratio	% Change in Odds Ratio	p-value of FFR coefficient	p-value covariate coefficient
Crude	0.60	NA	0.19	NA
Crude + Income	0.59	-2.1%	0.48	0.48
Crude + Marital Status	0.56	-6.2%	0.15	0.29
Crude + Age	0.61	1.1%	0.20	0.45
Crude + Child	0.60	0.4%	0.28	0.78
Model Development				
Crude*	**0.60**	NA	**0.19**	NA
Crude + Marital	0.56	-6.2%	0.15	0.29

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within a 400m buffer. Covariates were determined using forward selection. Final model is in bold.

Model Building: Fast Food consumption & FFR within 800m buffers around Work.

Crude Model + Individual Covariates	800m buffer Odds Ratio	% Change in Odds Ratio	p-value of FFR coefficient	p-value covariate coefficient
Crude	0.83	NA	0.59	NA
Crude + Income	0.80	-3.0%	0.54	0.48
Crude + Marital Status	0.77	-7.3%	0.47	0.33
Crude + Age	0.83	0.0%	0.59	0.42
Crude + Child	0.83	0.8%	0.61	0.77
Model Development				
Crude	**0.83**	NA	0.59	NA
Crude + Income	0.77	-7.3%	0.54	0.48

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability within an 800m buffer. Covariates were determined using forward selection. Final model is in bold.

Model Building: Fast Food consumption & Distance to Nearest FFR from Work

Crude Model + Individual Covariates	Distance Odds Ratio	% Change in Odds Ratio	p-value FFR coefficient	p-value covariate coefficient
Crude	0.976	NA	0.76	NA
Crude + Income	1.018	4.4%	0.89	0.46
Crude + Marital Status	0.984	0.9%	0.90	0.41
Crude + Age	0.980	0.4%	0.87	0.43
Crude + Child	0.972	-0.4%	0.82	0.73
Model Development				
Crude	**0.976**	NA	**0.76**	NA
Crude + Income	1.018	4.4%	0.89	0.46

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Logistic regression modeling daily Fast-food intake as a function of Fast Food Restaurant availability of nearest distance to FFR. Covariates were determined using forward selection. Final model is in bold and included all potential confounders.

C3: Outcome: Sugar Sweetened Beverage **Exposure:** FFR availability around home

Model Building: SSB Intake & FFR within 400m buffer around Home.

Crude Model + Individual Covariates	400m buffer Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	0.229	NA	0.61	NA
Crude + Income	0.332	45.1%	0.48	0.29
Crude + Marital Status	0.294	28.3%	0.53	0.48
Crude + Age	0.510	123.0%	0.25	0.01
Crude + Child	0.273	19.2%	0.53	0.10
Cumulative Model				
Crude	0.229	NA	0.61	NA
Crude + Age	0.332	45.1%	0.25	0.01
Crude + Age + Income	**0.723**	**117.8%**	**0.12**	**0.02**
Crude + Age + Income + Marital	0.744	2.8%	0.11	0.79
Crude + Age + Income + Child	0.746	0.3%	0.11	0.78

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Fast Food Restaurant availability within a 400m buffer around Work. Covariates were determined using forward selection. Final model is in bold. Marital and Child were not chosen because the primary coefficient did not change more than 10% when added to the model.

Model Building: SSB Intake & FFR within 800m buffer around Home.

Crude Model + Individual Covariates	800m buffer Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	0.167	NA	0.53	NA
Crude + Income	0.196	17.2%	0.47	0.29
Crude + Marital Status	0.177	5.9%	0.52	0.53
Crude + Age	0.083	-50.5%	0.75	0.01
Crude + Child	0.231	38.1%	0.38	0.09
Cumulative Model				
Crude	0.167	NA	0.53	NA
Crude + Age	0.083	-50.5%	0.75	0.01
Crude + Age + Child	0.092	10.8%	0.73	0.83
Crude + Age + Child + Income	**0.102**	**10.7%**	**0.70**	**0.04**
Crude + Age + Child + Income + Marital	0.099	-2.8%	0.71	0.94

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Fast Food Restaurant availability within an 800m buffer around Work. Covariates were determined using forward selection. Final model is in bold. Marital was not chosen because the primary coefficient did not change more than 10% when added to the model.

Model Building: SSB Intake & Distance to Nearest FFR from Home

Crude Model + Individual Covariates	Distance Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.072	NA	0.44	NA
Crude + Income	-0.093	27.9%	0.35	0.24
Crude + Marital Status	-0.084	16.5%	0.39	0.47
Crude + Age	-0.057	-21.1%	0.53	0.01
Crude + Child	-0.115	59.4%	0.22	0.07
Cumulative Model				
Crude	-0.072	NA	0.44	NA
Crude + Child	-0.115	59.4%	0.22	0.07
Crude + Child + Income	-0.130	12.7%	0.19	0.23
Crude + Child + Income + Age	**-0.074**	**-43.0%**	**0.43**	**0.01**
Crude + Child + Income + Age + Marital	-0.075	0.9%	0.44	0.97

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Distance to nearest Fast Food Restaurant from Home. Covariates were determined using forward selection. Final model is in bold. Marital was not chosen because the primary coefficient did not change more than 10% when added to the model.

C4: Outcome: Sugar Sweetened Beverage **Exposure:** FFR availability around work

Model Building: SSB Intake & FFR within 400m buffer around Work.

Crude Model + Individual Covariates	400m buffer Coefficient		% Change in Coefficient (p-value)		p-value of added covariate coefficient
	0 / 1-2 FFR	0 / 3+ FFR	0 / 1-2 FFR	0 / 3+ FFR	
Crude	-0.189	-0.275	NA (0.5)	NA (0.4)	NA
Crude + Income	-0.203	-0.420	7.8 (0.5)	52.5 (0.2)	0.20
Crude + Marital Status	-0.170	-0.267	-9.9 (0.5)	-3.1 (0.4)	0.62
Crude + Age	-0.321	-0.123	69.9 (0.3)	-55.3 (0.7)	0.01
Crude + Child	-0.131	-0.369	-30.5 (0.6)	34.1 (0.2)	0.08
Cumulative Model					
Crude	-0.189	-0.275	NA		NA
Crude + Age	-0.321	-0.123	69.9 (0.3)	-55.3 (0.7)	0.01
Crude + Age + Income	**-0.279**	**-0.294**	**-13.1 (0.3)**	**139.2 (0.3)**	**0.03**
Crude + Age + Income + Child	-0.284	-0.285	2.0 (0.3)	-3.2 (0.4)	0.89
Crude + Age + Income + Marital	-0.298	-0.295	4.9 (0.3)	3.6 (0.4)	0.74

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Fast Food Restaurant availability within a 400m buffer around Work. Covariates were determined using forward selection. Final model is in bold. Child and Marital were not chosen because the primary coefficient did not change more than 10% when added to the model.

Model Building: SSB Intake & FFR within 800m buffer around Work.

Crude Model + Individual Covariates	800m buffer Coefficient		% Change in Coefficient (p-value)		p-value of added covariate coefficient
	0 / 1-2 FFR	0 / 3+ FFR	0 / 1-2 FFR	0 / 3+ FFR	
Crude	0.061	-0.068	NA		NA
Crude + Income	0.051	-0.128	-17.0 (0.8)	88.2 (0.6)	0.28
Crude + Marital Status	0.171	-0.028	181.1 (0.9)	-58.0 (0.6)	0.25
Crude + Age	-0.012	-0.147	-120.2 (0.9)	116.7 (0.6)	0.01
Crude + Child	0.029	-0.117	-52.4 (0.9)	72.0 (0.7)	0.10
Cumulative Model					
Crude	0.061	-0.068	NA		NA
Crude + Age	-0.012	-0.147	-120.2 (0.9)	116.7 (0.6)	0.01
Crude + Age + Marital	0.061	-0.112	-591.0 (0.8)	-23.7 (0.7)	0.51
Crude + Age + Marital + Child	0.06	-0.13	2.2 (0.8)	11.9 (0.6)	0.73
Crude + Age + Marital + Child + Income	**-0.03**	**-0.25**	**-144.1 (0.9)**	**98.4 (0.3)**	**0.03**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Fast Food Restaurant availability within an 800m buffer around Work. Covariates were determined using forward selection. Final model is in bold consisting of all potential confounders.

Model Building: SSB Intake & Distance to Nearest FFR from Work

Crude Model + Individual Covariates	Distance Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.031	NA	0.93	NA
Crude + Income	0.020	-166.3%	0.76	0.28
Crude + Marital Status	-0.038	23.9%	0.83	0.52
Crude + Age	-0.012	-62.0%	0.91	0.01
Crude + Child	-0.017	-44.8%	0.97	0.12
Cumulative Model				
Crude	-0.031	NA	0.93	NA
Crude + Income	0.020	-166.3%	0.76	0.28
Crude + Income + Age	**0.035**	**70.5%**	**0.67**	**0.01**
Crude + Income + Child	0.034	-2.0%	0.67	0.17
Crude + Income + Marital	0.036	3.4%	0.66	0.81

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Generalized Linear Model with a Gamma distribution modeling daily SSB intake as a function of Nearest distance to a Fast Food Restaurant from Work. Covariates were determined using forward selection. Final model is in bold. Child and Marital were not chosen because the primary coefficient did not change more than 10% when added to the model.

C5: Outcome: Fruit & Vegetable **Exposure:** FFR availability around home

Model Building: Fruit & Vegetable Intake & FFR within 400m buffer around Home.

Crude Model + Individual Covariates	400m buffer Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.023	NA	0.94	NA
Crude + Income	0.045	-291.6%	0.88	0.20
Crude + Marital Status	0.019	-180.1%	0.95	0.32
Crude + Age	-0.028	19.6%	0.92	0.84
Crude + Child	-0.042	77.3%	0.89	0.40
Cumulative Model				
Crude	-0.023	NA	0.94	NA
Crude + Income	0.045	-291.6%	0.88	0.20
Crude + Income + Marital	0.060	32.7%	0.85	0.65
Crude + Income + Marital + Child	0.045	-24.0%	0.89	0.47
Crude + Income + Marital + Child + Age	**0.052**	**14.2%**	**0.86**	**0.66**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 400m buffer. Covariates were determined using forward selection. Final model is in bold and included all potential confounders.

Model Building: Fruit & Vegetable Intake & FFR within 800m buffer around Home.

Crude Model + Individual Covariates	800m buffer Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.129	NA	0.50	NA
Crude + Income	-0.086	-33.6%	0.63	0.22
Crude + Marital Status	-0.101	-21.9%	0.57	0.37
Crude + Age	-0.128	-1.4%	0.47	0.89
Crude + Child	-0.130	0.7%	0.45	0.41
Cumulative Model				
Crude	-0.129	NA	0.50	NA
Crude + Income	-0.086	-33.6%	0.63	0.22
Crude + Income + Marital	**-0.077**	**-10.3%**	**0.67**	**0.72**
Crude + Income + Marital + Age	-0.080	3.3%	0.66	0.87

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 800m buffer. Covariates were determined using forward selection. Final model in bold. Age and Child were not chosen because the primary coefficient did not change more than 10% when added to the model.

Model Building: Fruit & Vegetable Intake & Distance to Nearest FFR from Home

Crude Model + Individual Covariates	Distance Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.005	NA	0.94	NA
Crude + Income	-0.020	330.5%	0.73	0.19
Crude + Marital Status	-0.015	222.5%	0.79	0.30
Crude + Age	-0.005	13.4%	0.93	0.84
Crude + Child	-0.002	-61.7%	0.98	0.41
Cumulative Model				
Crude	-0.005	NA	0.94	NA
Crude + Income	-0.020	330.5%	0.73	0.19
Crude + Income + Marital	-0.024	19.2%	0.68	0.64
Crude + Income + Marital + Child	-0.021	-11.8%	0.72	0.48
Crude + Income + Marital + Child +Age	**-0.019**	**-10.6%**	**0.75**	**0.69**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of nearest Fast Food Restaurant from Home. Covariates were determined using forward selection. Final model is in bold and included all potential confounders.

C6: Outcome: Fruit & Vegetable **Exposure:** FFR availability around work

Model Building: Fruit & Vegetable Intake & FFR within 400m buffer around Work.

Crude Model + Individual Covariates	400m buffer Coefficient		% Change in Coefficient (p-value)		p-value of added covariate covariate
	0 / 1-2 FFR	0 / 3+ FFR	0 / 1-2 FFR	0 / 3+ FFR	
Crude	-0.057	0.071	NA (0.7)	NA (0.7)	NA
Crude + Income	-0.016	0.065	-72.7 (0.9)	-9.3 (0.8)	0.22
Crude + Marital Status	-0.026	0.080	-55.0 (0.9)	11.9 (0.7)	0.33
Crude + Age	-0.058	0.069	1.3 (0.8)	-3.5 (0.7)	0.86
Crude + Child	-0.063	0.091	9.8 (0.7)	27.3 (0.7)	0.38
Cumulative Model					
Crude	-0.057	0.071	NA (0.7)	NA (0.7)	NA
Crude + Income	-0.016	0.065	-72.7 (0.9)	-9.3 (0.8)	0.22
Crude + Income + Marital	-0.004	0.071	-74.9 (0.9)	10.1 (0.7)	0.67
Crude + Income + Marital + Child	-0.091	0.088	131.0 (0.9)	23.1 (0.7)	0.44
Crude + Income + Marital + Child+ Age	**-0.028**	**0.099**	**-15.0 (0.9)**	**13.0 (0.6)**	**0.63**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 400m buffer around Work. Covariates were determined using forward selection. Final model is in bold and included all potential confounders.

Model Building: Fruit & Vegetable Intake & FFR within 800m buffer around Work.

Crude Model + Individual Covariates	800m buffer Coefficient		% Change in Coefficient (p-value)		p-value of added covariate
	0 / 1-2 FFR	0 / 3+ FFR	0 / 1-2 FFR	0 / 3+ FFR	covariate
Crude	-0.157	0.054	NA (0.4)	NA (0.8)	NA
Crude + Income	-0.142	0.077	-9.3 (0.5)	41.4 (0.7)	0.21
Crude + Marital Status	-0.119	0.075	-24.2 (0.6)	38.2 (0.7)	0.37
Crude + Age	-0.156	0.053	-0.7 (0.4)	-1.9 (0.8)	0.92
Crude + Child	-0.142	0.060	-7.3 (0.5)	9.6 (0.7)	0.44
Cumulative Model					
Crude	-0.157	0.054	NA (0.4)	NA (0.8)	NA
Crude + Marital	-0.119	0.075	-24.2 (0.6)	38.2 (0.7)	0.37
Crude + Marital + Income	**-0.128**	**0.084**	**7.4 (0.5)**	**12.5 (0.6)**	**0.29**
Crude + Marital + Income + Child	-0.118	0.090	-7.7 (0.6)	5.8 (0.6)	0.48

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of Fast Food Restaurant availability within a 800m buffer around Work. Covariates were determined using forward selection. Final model is in bold. Age and Child were not chosen because the primary coefficient did not change more than 10% when added to the model.

Model Building: Fruit & Vegetable Intake & Distance to Nearest FFR from Work

Crude Model + Individual Covariates	Distance Coefficient	% Change in Coefficient	p-value of FFR coefficient	p-value of added covariate coefficient
Crude	-0.007	NA	0.89	NA
Crude + Income	-0.022	192.2%	0.70	0.20
Crude + Marital Status	-0.012	59.6%	0.82	0.31
Crude + Age	-0.008	5.8%	0.88	0.84
Crude + Child	-0.011	53.3%	0.83	0.40
Cumulative Model				
Crude	-0.007	NA	0.89	NA
Crude + Income	-0.022	192.2%	0.70	0.20
Crude + Income + Marital	-0.023	7.0%	0.68	0.65
Crude + Income + Child	-0.024	5.3%	0.64	0.45
Crude + Income + Age	**-0.021**	**-12.2%**	**0.68**	**0.69**

Astoria Warrenton Women's Heart Health Initiative (AWWHHI) employed population (n =142). Linear regression modeling daily Fruit & Vegetable intake as a function of the nearest Fast Food Restaurant from Work. Covariates were determined using forward selection. Final model is in bold. Marital and Child were not chosen because the primary coefficient did not change more than 10% when added to the model.

Appendix D: Sensitivity analysis between study sample (n=142) and full sample with valid home address (n=357) and valid work address (n=191)

Table D1: Regression coefficients from the study sample (n=142) and full sample with valid home address (n = 357) for Fast-food, Fruit & Vegetable and Sugar Sweetened Beverage intake associated with fast food restaurant availability around the Home using count of FFR within a 400m and 800m buffer and distance to nearest FFR (coefficient (95% confidence interval)

	Model 1 (400m buffer)		**Model 2** (800m buffer)		**Model 3** (Distance)	
	Study Sample (n=142)	Full Sample (n=357)	Study Sample (n=142)	Full Sample (n=357)	Study Sample (n=142)	Full Sample (n=357)
Fast-Food						
Home (0/1+)	2.60 (0.66, 10.15)	2.25 (0.72, 7.19)	2.35 (1.06, 5.22)	1.95 (1.10, 4.01)	0.73 (0.55, 0.97)	0.89 (0.79, 1.01)
Fruit & Vegetable						
Home (0/1+)	0.67 (-0.20, 1.54)	0.42 (-0.95, 0.95)	0.10 (-0.42, 0.63)	0.04 (-0.30, 0.38)	-0.07 (-0.3, 0.1)	-0.04 (-0.25, 0.18)
Sugar Sweetened Beverage						
Home (0/1+)	0.05 (-0.56, 0.67)	-0.03 (-0.4, 0.4)	-0.08 (-0.43, 0.28)	0.06 (-0.2, 0.3)	-0.02(-0.14 0.10)	-0.01 (-0.2, 0.1)

Table D2: Regression coefficients from the study sample (n=142) and full sample with valid work address (n = 191) for Fast-food, Fruit & Vegetable and Sugar Sweetened Beverage intake associated with fast food restaurant availability around Work using count of FFR within a 400m and 800m buffer and distance to nearest FFR (coefficient (95% confidence interval)

	Model 1 (400m buffer)		**Model 2** (800m buffer)		**Model 3** (Distance)	
	Study Sample (n=142)	Work Sample (n=191)	Study Sample (n=142)	Work Sample (n=191)	Study Sample (n=142)	Work Sample (n=191)
Fast-Food						
Work (0/1+)	0.60 (0.28, 1.28)	0.80 (0.58, 1.09)	0.83 (0.41, 1.7)	0.87 (0.71, 1.08)	0.98 (0.76, 1.3)	0.99 (0.90, 1.1)
Fruit & Vegetable						
Work (0/1-2)	-0.28 (-0.85, 0.29)	0.01 (-0.48, 0.51)	-0.02 (-0.64, 0.60)	0.10 (-0.39, 0.59)	.030 (-.16, .22)	-0.07 (-0.17, 0.01)
Work (0/3+)	-0.28 (-0.91, 0.36)	-0.22 (-0.82, 0.38)	-0.20 (-0.73, 0.32)	-0.11 (-0.60, 0.38)		
Sugar Sweetened Beverage						
Work (0/1-2)	-0.03 (-0.41, 0.35)	-0.16 (-0.5, 0.2)	-0.13 (-0.53, 0.27)	-0.37 (-0.7, -0.1)	-0.03 (-0.14, 0.08)	-0.09 (-0.4, 0.2)
Work (0/3+)	0.10 (-0.32, 0.52)	-0.07 (-0.5, 0.4)	0.08 (-0.27, 0.43)	-0.17 (-0.5, 0.2)		