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Examining Obesogenic Behavior Through the Lens of the Food Environment

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Examining Obesogenic Behavior Through the Lens of the Food Environment

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Health Services

by

Joelle Wolstein

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ABSTRACT OF THE DISSERTATION

Examining Obesogenic Behavior

Through the Lens of the Food Environment

by

Joelle Wolstein

Doctor of Philosophy in Health Services

University of California, Los Angeles, 2015

Professor Frederick J. Zimmerman, Chair

A growing literature in public health has suggested that the local food environment influences food choice and obesity outcomes. This dissertation recognizes the importance of the food environment as a potential determinant of health behaviors and health outcomes. These studies examine how the farmers' markets and the workplace food environment impact dietary behaviors and obesity.

Chapter 2 examines the associations between the presence of a farmers' market near home and dietary behaviors among adults in California. It also aims to address whether the selection effect is influencing the relationship between farmers' markets and dietary behaviors. Using data from the 2005, 2007, and 2009 California Health Interview Survey and the locations of Certified

Farmers' Markets, this study tested the association of farmers' markets near home with obesity and dietary behaviors, using (1) a directed acyclic graphical causal approach, and (2) a cross-year variation in farmers' markets to control for selection. Results suggest that, adjusting for demographic characteristics, survey year, and the presence of farmers' market during both the current survey year and other survey years, adults living near a farmers' market are less likely to be obese and more likely to eat three or more servings of fruits and vegetables per day. Living near a farmers' market was not significantly associated with soda consumption. This study suggests that locating new farmers' markets in areas with low demand for fruits and vegetables would increase healthy dietary habits.

Chapter 3 tests the associations between farmers' markets near home and fruit and vegetable consumption among adults in California. It also aims to address whether farmers' markets influence fruit and vegetable consumption through the mechanism of increasing perceptions of availability of fresh produce. Using data from the 2011-2012 California Health Interview Survey and the locations of Certified Farmers' Markets, this study examines the impact of farmers' markets on a population level by testing the relationship between farmers' markets upon fruit and vegetable consumption, via perceived availability of fruits and vegetables. Four sets of logistic regressions were conducted to examine this relationship. Farmers' markets were positively associated with perceived availability of fresh produce. Both perceived availability of fresh produce and presence of a farmers' market were independently associated with increased fruit and vegetable consumption. However, when both variables were included in the model, the magnitudes of the associations were very similar. This similarity reflects the weak association between farmers' markets and perceived availability in the sample. The weak

association between farmers' markets and perceived availability suggests that the principal pathway for the impact of farmers' markets on consumption is not through increasing perceptions of availability but something else. Regardless, farmers' markets are a useful strategy in promoting consumption of fruits and vegetables.

Chapter 4 studies an area of the food environment relatively unexplored by researchers—the workplace food environment. Using data from Wave 2 of the Los Angeles Family and Neighborhood Survey (LAFANS), a longitudinal, population-based survey of individuals living in Los Angeles County and 2007 Los Angeles County Department of Public Health food outlet data, this study examines the association of the food environment around the workplace with obesity and dietary behaviors among adults. Results suggest that, adjusting for demographic characteristics, the workplace food environment is associated with obesity. There were no significant associations between the workplace food environment and dietary behaviors. The relationship between the workplace food environment and obesity appears to taper off as the food environment becomes saturated with unhealthy food outlets. Further research is needed to understand the relationship between the workplace food environment and obesity and dietary behaviors.

The dissertation of Joelle Wolstein is approved.

Arturo Vargas Bustamante

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2015

This dissertation is dedicated to my parents,

Jacob and Flora,

who inspired me to seek to improve the lives of others

and taught me the importance of healthy eating from my first bite.

Words cannot express my gratitude for your love and support.

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CHAPTER 1

INTRODUCTION TO THE DISSERTATION

A growing literature in public health has suggested that the local food environment influences food choice and obesity outcomes. The three papers presented here recognize the importance of the food environment as a potential determinant of health behaviors and health outcomes. The first examines the impact of farmers' markets on obesity and dietary behaviors at the population level, something lacking in the existing literature. It is also the first study to my knowledge to attempt to control for the effect of neighborhood selection in the location of farmers' markets. The results of this paper, which suggest that farmers' markets are negatively associated with obesity and positively associated with fruit and vegetable consumption, raise the question of how farmers' markets positively influence consumption of produce. The second paper aims to address this question by looking into perceived availability of fruits and vegetables as a mechanism by which farmers' markets increase fruit and vegetable consumption. These two papers contribute to existing literature on the home food environment.

The third paper delves into an area of the food environment relatively unexplored by researchers – the workplace food environment. This paper examines the associations between the workplace food environment and obesity.

CHAPTER 2

ASSOCIATION OF THE PRESENCE OF FARMERS' MARKETS WITH ADULT DIETARY BEHAVIORS AND OBESITY: USING DIRECTED ACYCLIC GRAPHS TO EXPLORE NEIGHBORHOOD SELECTION EFFECTS

INTRODUCTION

Disparities in access to healthy food outlets have been associated with disparities in obesity and dietary behaviors, and lower-income neighborhoods have less access to healthy foods than do higher income neighborhoods.[1-5] There is an emerging literature suggesting that individuals living in areas with greater access to supermarkets, produce stores, or farmers' markets have better dietary behaviors and lower risk for obesity than individuals with less access to such food outlets.[6-10]

While the Centers for Disease Control and Prevention recommended increasing the availability of farmers' markets as a way of making fruits and vegetables more accessible, few studies have examined the associations between farmers' markets, dietary behaviors, and weight status at a population level.[11-14]

Existing research primarily focuses on traditionally underserved groups, such as participants of the WIC program. Small-scale studies of providing incentives to low-income individuals to shop at farmers' markets have shown large behavioral effects on fruit and vegetable consumption, but

these studies do not test whether the mere presence of a farmers' market would have similar effects.[15-18]

One study examined the impact of introducing farm stands in low-income, racially-diverse neighborhoods in East Austin and found that fruit and vegetable consumption increased with the introduction of these farm stands.[19] Because this study used a pre/post design, it is possible to draw causal inferences, assuming that there were no significant secular trends at the same time as the introduction of fruit and vegetable stands and over the 12 week intervention period. The authors emphasize that the findings of this study underscore the potential for farmers' markets to increase fruit and vegetable consumption in low-income communities. Yet it remains unclear whether similar effects would be obtained in other geographical areas or with other socioeconomic groups.

Moreover, causal interpretation of these results is complex. In particular, it could be that farmers' markets increase the availability of fruits and vegetables, and so have a causal influence on consumption. However, it could also be that farmers' markets locate in areas in which consumers are more likely than elsewhere to consume fruits and vegetables (the selection effect). The Evans study partially controls for the selection effect because farm stands were introduced in low-income communities with limited access to fruits and vegetables.[19]

Although the causal questions loom large in this literature, large-scale randomized trials of the introduction of farmers' markets are unlikely. Because of the difficulty in randomly placing farmers' markets in a large-scale community trial, carefully examining the effects of natural

experiments will be the best way to infer likely causality. Such research will have to employ before-and-after designs with suitable controls and will have to articulate a plausible causal pathway, with variables clearly specified.

The major threat to internal validity in this research is that there may be unobserved variables, such as a taste for fresh fruits and vegetables, that drive the location of farmers' markets. If so, an observed association between a farmers' market and higher consumption of fruits and vegetables could be the result not of the farmers' market itself but the unobserved preferences for fruits and vegetables. Following the literature, the effects of these unobserved variables will be referred to as the selection effect – the tendency of farmers' markets to select to locate in neighborhoods that have a high proportion of consumers who value fresh produce.

The nearly five-fold increase in farmers' markets during the past 20 years presents an important opportunity to understand how the presence of farmers' markets influences dietary behaviors and weight status among the general population.[20] This study examines the associations between the presence of a farmers' market near home and dietary behaviors and obesity among adults in California. It also aims to address whether the selection effect is influencing the relationship between farmers' markets, dietary behaviors, and obesity.

Conceptual Framework

It is unclear why farmers' markets locate in certain neighborhoods and not others. Although selection, as discussed above, is one possibility, there is little evidence testing the hypothesis that farmers' markets locate where demand is likely to be highest. The key conceptual question is

how strong is the link between the presence of a farmers' market near an individual's residence with that individual's unobserved pre-existing preferences for healthy eating? This research uses observed evidence of this relationship to gauge the importance of the selection effect. Following recent advances in causality research, this study uses Directed Acyclic Graphs (DAGs) to do so.[21,22]

Figure 1 shows two DAGs illustrating the hypothesized relationship between healthy preferences, farmers' markets, and consumption of soda and fruits and vegetables. The solid lines represent true causal effects, and the dashed line represents association only, with no direct causality. Because healthy preferences are unobserved, it is necessary to use measured variables as proxies. In this study soda and fruit and vegetable consumption were used to gauge whether individuals had a general preference for healthy dietary behaviors. This strategy assumes there is a common element among healthy preferences—that all food preferences are related. As represented by the solid lines in DAG A of Figure 1, one would expect that individuals with healthy preferences would consume both less soda (b) and more fruits and vegetables (a). As such, one would also expect to see a negative correlation between soda consumption and fruit and vegetable consumption. In support of this contention note that the correlation between soda and fruit and vegetable consumption was highly significant -0.12 ($p<0.001$), indicating these indicators of healthy preferences are inversely related. Correlations of similar magnitudes between health behaviors have been reported in the literature. Correlations between consumption of healthier beverages (milk, 100% fruit juice) and unhealthy beverages (sugar-sweetened beverages) range from -0.08 to -0.37.[23] A correlation of -0.12 was found between TV viewing and physical activity.[24] The correlations for other health behaviors and outcomes that have been

widely accepted and are, arguably, obvious are similar in magnitude. The correlation between condom use and sexually transmitted HIV is approximately 0.2 and that of calcium intake and bone mass is approximately 0.1.[25] DAG A (like DAG B) assumes that there is no direct causal relationship between presence of a farmers' market and soda consumption.

DAG A represents the theory that farmers' markets locate for reasons unrelated to healthy preferences or the demand of individuals in the neighborhood. Farmers' markets may locate in certain areas because of zoning requirements or for philanthropic reasons, such as increasing the supply of fresh produce where it would otherwise be lacking.

As represented by the solid line from healthy preferences to farmers' markets (d), DAG B represents the theory that farmers' markets locate where there is a market whose demand it may meet. According to this theory, if we observe a farmers' market in a neighborhood we can assume that neighborhood has healthy preferences. If individuals in the neighborhood have healthy preferences, one would expect to see decreased consumption of soda (b). DAG B implies that a statistically significant negative association exists between the presence of a farmers' market and soda consumption, indicated by the curved dashed line in DAG B (e), caused by the indirect casual pathway d,b.

If the causal theory of DAG A is true, one would expect to find no association between the presence of farmers' markets and soda consumption, since there is no causal arrow from healthy preferences to both soda consumption and farmers' markets that would result in an association of farmers' markets and soda consumption.

In a multivariate analysis, one would like to statistically control for the preferences of the individuals. Doing so cuts the indirect causal pathway (d,a) and so allows for consistent (unbiased) estimation of the causal pathway from farmers' markets to fruit and vegetable consumption (c). When these preferences are entirely or partially unobserved, as they almost always are, statistical control is not possible. However, the DAG analysis provides an alternative way of building confidence in the unbiasedness of the estimation of (c), namely by providing evidence that the link from preferences to the location of farmers' markets (d) is weak or non-existent.

The relationship between farmers' markets and soda consumption (e) provides an indirect measure of whether there are selection effects in neighborhoods with individual healthy preferences. In this analysis, the association between farmers' markets and soda consumption is tested, so as to rule out either DAG A or DAG B. If the results suggest that DAG B can be ruled out and DAG A is preferred, then the association of farmers' markets with fruit and vegetable consumption (c) is plausibly unbiased by local preferences.

METHODS

Data Source and Population

Data for this study were from the 2005, 2007, and 2009 California Health Interview Survey (CHIS). CHIS is a random-digit-dial telephone survey of households and is designed to be representative of California's non-institutionalized population. A 2-stage, geographically

stratified design was used to produce a representative sample of the state. Residential telephone numbers were selected from within predefined geographic areas, and respondents were then randomly selected from within sampled households. CHIS 2007 and 2009 also included a sample of cell phones. One randomly selected adult (18 years or older) was interviewed in each household.

CHIS interviews were conducted in English, Spanish, Chinese, Vietnamese, and Korean. Detailed information about the CHIS methodology is available elsewhere.[26] The interview completion rate for adults in the 2005, 2007, and 2009 landline sample was 54.0%, 52.8%, and 49.0%, respectively. Response rates for the 2007 and 2009 cell phone only samples were 52.0% and 56.2%, respectively.[27,28]

Data for farmers' markets are from the California Federation of Certified Farmers' Markets. They include the market name, location (street address, latitude, and longitude), and days of operation. Farmers' markets held in the same location more than one time per week were accounted for only once. At Certified Farmers' Markets producers can sell fresh fruits, nuts, vegetables, shell eggs, honey, flowers and nursery stock. Information regarding regulations for other products sold at farmers' markets can be found elsewhere.[29] Data on non-certified farmers' markets were not available. Farmers' market data were linked to CHIS data by using ArcGIS software for the 2007 data sample. Farmers' market data for analyses using three years of CHIS were linked by respondent zip code.

Measures

The outcomes of interest were obesity status, soda consumption, and fruit and vegetable consumption. Body Mass Index (kg/m^2) was based on self-reported height and weight measures; respondents with a BMI greater than or equal to 30 were categorized as obese. Soda consumption was assessed based on responses to the following question: "During the last month, how many times per day, week, or month did you drink soda such as coke or 7-up?" Responses were standardized to number of times per day and categorized as consuming less than one or one or more sodas per day. Fruit and vegetable consumption was based on responses to the following questions: "During the past month, how many times per day, week or month did you eat fruit? Do not count juice" and "During the past month, how many times did you eat vegetables, like green salad, green beans, or potatoes? Do not include fried potatoes." Responses to each question were standardized to number of times per day, summed, and categorized as consuming fruits and vegetables less than three versus three or more times per day.

The primary predictor of interest was the presence of farmers' markets near the respondent's home. For primary analyses the presence of farmers' markets near the respondent's home was calculated using Geographic Information Systems (GIS) software. Data from CHIS 2007 were linked with the locations of Certified Farmers' Markets. Following the literature, for each adult CHIS respondent, the number of farmers' markets within a given radius, or buffer, around their home (one mile in urban areas, two miles in smaller cities and suburban areas, and five miles in rural areas) was determined.[9,30] Using data obtained from Claritas, households were assigned to urbanicity levels (urban, suburban, second city, rural) based on population density of the

household's zip code and surrounding areas. Results were categorized as zero or one or more farmers' markets. See Table 1 for category breakdowns.

For secondary analyses zip code was used as a proxy for neighborhood. The presence of at least one farmers' market within each zip code was determined for CHIS 2005, 2007, and 2009. This information was used to establish whether a farmers' market was present in the neighborhood during each of the three survey years. For each CHIS respondent, the number of farmers' markets in his/her zip code was determined. Results were categorized as zero or one or more farmers' markets. The zip code-based measure of presence of a farmers' market is not as accurate as the buffer-based measure; however, it allowed for measurement across different survey years.

Dummy variables for survey year were created to indicate the CHIS survey year in which respondents participated. Additionally, the number of farmers' markets in each respondent's zip code was used to create a variable representing the presence of farmers' markets in the respondent's zip code during any of the three survey years. See Table 1 for category breakdowns of presence of a famers' market in the survey year and presence of a farmers' market any year.

The following demographic characteristics were included as controls: age, gender, household income, and race/ethnicity (White, Latino, Asian, African-American, American Indian, Pacific Islander, and two or more races). Household income was reported by the respondent and examined as percent of the Federal Poverty Level (99% and below, 100-199%, 200-299%, 300% and above). Data from the 2000 Census were linked by census tract to examine neighborhood

income. Census tracts in which 30% or more of the households were below 200% of the Federal Poverty Level were considered lower-income.

Analyses

A test of correlation between soda and fruit and vegetable consumption was conducted to examine the relationship between these indicators of healthy preferences.

Logistic regression analyses were conducted to examine the association of the availability of farmers' markets with obesity and dietary behaviors. In primary analyses the main outcome variables were regressed on the presence of farmers' markets in 2007 using the buffer-based variable for presence of a farmers' market, controlling for age, gender, race, and household income. Models were also stratified by neighborhood income to examine differences between neighborhoods. The identification of a potential selection effect in the primary analysis is through the DAG approach discussed above.

In additional analyses, a secondary identification of possible selection was tested as follows. The presence of a farmers' market in 2005, 2007, and 2009 was assessed using zip code as a proxy for neighborhood. Two models were examined in this analysis. In both models, the main predictor was presence of a farmers' market in the survey year (farmers' market this year). In the second model, presence of a famers' market in any year, a proxy for healthy preferences, was included. Models controlled for age, gender, race, and household income.

The inferential logic of these models is as follows. If one assumes farmers' markets will locate in areas where there is high demand for fruits and vegetables, and if one further assumes that these unobserved preferences change very slowly over time, then the presence of a farmers' market during *any* of the three survey years is an indicator of healthy preferences of that neighborhood. On the other hand, neighborhoods that never have a farmers' market are those where unobserved demand for fruits and vegetables is weak. Neighborhoods without a farmers' market in a given year (say 2007) but which do have a farmers' market in some other year (say, 2009), are neighborhoods that do in fact have healthy preferences in the given year (2007), but this demand is unmet, representing a pent-up demand for fresh produce. Controlling for the presence of a farmers' market during any of the survey years allows the analysis to control to some extent for the relative strength of healthy preference across different neighborhoods, and therefore somewhat mitigates concern over selection bias.

Figure 2 makes this logic concrete with the aid of specific examples. Figure 2 displays three neighborhood scenarios with respect to farmers' markets across survey years. When comparing neighborhoods A and B in 2007, any observed differences in fruit and vegetable consumption could come either from unobserved healthy preferences *or* from the causal effect of farmers' markets. Conversely, consumption differences in 2007 between B and C are more likely to arise because of the effect of farmers' markets, rather than the effects of unobserved preferences.

Underweight individuals (BMI <18.5) were dropped from all analyses (N=981 in 2005, 1,082 in 2007, and 1,068 in 2009) because underweight individuals may be atypical eaters. Regression analyses using only CHIS 2007 data included 49,966 adults. Analyses using three years of CHIS

data included 138,552 adults. Data were analyzed with SAS (version 9.3; SAS Institute, Inc, Cary, North Carolina) and SUDAAN (version 11.0.0; Research Triangle Institute, Research Triangle Park, North Carolina). Analyses were weighted to be representative of the California population and adjusted for the complex survey design of CHIS. The University of California, Los Angeles (UCLA) Office for the Protection of Research Subjects certified this research exempt from IRB review.

RESULTS

Population Characteristics

Using the buffer-based farmers' market variable only 35% of adults had at least one farmers' market near home. Table 1 displays additional characteristics of California adults ages 18 and above for all analyses. In 2007 the average age of respondents was 45 years, and 50% were female. The racial/ethnic distribution of adults was 48% white, 32% Latino, 12% Asian, 6% African American, and 2% mixed race.

Using zip code as a proxy for neighborhood, 34% of adults had a farmers' market in 2005, 37% in 2007, and 44% in 2009. Table 1 displays additional characteristics of California adults ages 18 and above for analyses using CHIS 2005, 2007, and 2009 data. Across the 3-year pooled sample, the average age of respondents was 45 years, and 50% were female. The racial/ethnic distribution of adults was 48% white, 32% Latino, 13% Asian, 6% African American, and 1% mixed race.

Multivariate Results

Table 2 displays the results of the unstratified logistic regression models, and those stratified by neighborhood income, using the buffer-based variable. The results indicate that individuals living near at least one farmers' market were less likely to be obese [OR = 0.86; 95% CI: (0.81, 0.93)] and more likely to consume fruits and vegetables three or more times per day [OR=1.15; 95% CI: (1.07, 1.23)] than individuals not living near a farmers' market. The results for soda consumption were not statistically significant. These results hold to a similar extent for those living in poor and non-poor neighborhoods, with the effects slightly larger in the poor sample and slightly lower in the non-poor sample. Results for soda consumption were not statistically significant in poor or non-poor neighborhoods.

Table 3 displays results of the logistic regression models accounting for presence of farmers' markets in any of the 3 years. The results indicate that individuals with a farmers' market in the neighborhood during the index year were more likely to consume fruits and vegetables three or more times per day compared to individuals in neighborhoods without access to a farmers' market in the index year (1a). These results hold to the same extent when presence of a farmers' market in any of the survey years is added to the model (1b). In the model for soda consumption that only includes the variable for presence of a farmers' market in the index year (2a), presence of a farmers' market has a significant negative association with soda consumption. However, when controlling for neighborhood selection by including the variable for presence of a farmers' market any year, soda consumption loses statistical significance (2b). In the model for obesity that only includes the variable for presence of a farmers' market in the index year (3a), presence

of a farmers' market has a significant negative association with obesity. However, when controlling for neighborhood selection by including the variable for presence of a farmers' market any year, obesity loses statistical significance (3b).

Findings were similar in models limited to respondents with a farmers' market in any of the three survey years. Results are available in Appendix 1.

DISCUSSION

The results of this study show that among adults, living near at least one farmers' market is associated with decreased likelihood of being obese, and an increased likelihood of consuming fruits and vegetables three or more times per day. In addition, the two analyses reported build confidence in a causal interpretation of these results.

Using different inferential approaches, results of both models suggested that selection is not driving associations of farmers' markets with dietary behaviors. In the DAG approach, farmers' markets are not associated with soda consumption, suggesting that they are not associated with neighborhood preferences for healthy eating in general. This result builds confidence that the association of farmers' markets with fruit and vegetable consumption is an unbiased estimate of the causal effect.

The model that includes both zip code-based variables for presence of a farmers' market in the index year and in any of the survey years also controls for neighborhood selection. When presence of a farmers' market any year is added to the model to control for selection, results do not change meaningfully. Fruit and vegetable consumption maintain statistical significance and the odds ratio does not change meaningfully in magnitude. There was a statistically significant negative relationship between presence of a farmers' market and soda consumption when only presence of a farmers' market in the index year was in the model. This relationship could be due to an unmeasured factor associated with both farmers' markets and soda consumption. One possibility is that farmers' markets locate in areas where soda is less likely to be available, such as church or school parking lots. However, when controlling for selection by including presence of a farmers' market any year, soda consumption loses statistical significance.

Obesity was significant when only presence of a farmers' market in the index year was in the model. When controlling for selection by including presence of a farmers' market any year, obesity loses statistical significance. This result is not surprising, since the effect of farmers' markets on obesity is indirect. All the same, it is noteworthy that the observed effect of farmers' market on obesity status is different in the two analyses.

The magnitude of the effects identified in these analyses are not huge, but they are in line with other public-health attempts to improve fruit and vegetable consumption. The Evans study assessed fruit and vegetable intake before and after introducing farm stands in neighborhoods.[19] Although not significantly different, the mean difference in overall intake post-intervention was

0.42 servings. The mean difference in consumption of whole fruit (not including juice) was 0.46 servings and statistically significantly. Mean intake of green salad, tomatoes or salsa, and other vegetables significantly increased by 0.14, 0.20, and 0.23 servings, respectively. As with the results of the present study, these differences may be small but they are improvements nonetheless.

There are several possible reasons why the presence of farmers' markets may be associated with increased consumption of fruits and vegetables. Farmers' markets likely increase the supply of fresh produce in neighborhoods, leading to increased demand for and consumption of fruits and vegetables. Farmers' markets may also increase the cognitive salience of fruits and vegetables, in effect serving as advertising for fresh produce. Farmers' markets are a weekly reminder for individuals to purchase fruits and vegetables, whether from the farmers' market itself or other suppliers.

To our knowledge this is the first study to examine the association of the presence of farmers' markets with weight status and dietary behaviors using population-based data. Additionally this is the first study to our knowledge to attempt to control for the effect of neighborhood selection in the location of farmers' markets. Existing research related to farmers' markets focuses primarily on the low-income and elderly population. Studies have found that introducing farmers' markets or farm stands in low-income, racially diverse neighborhoods is associated with increased fruit and vegetable consumption. Our findings support these conclusions.

One major strength of this study is its ability to examine the effects of natural experiments in order to draw causal inferences, since large-scale randomized trials of the introduction of farmers' markets were not possible. Using individual-level data from CHIS and neighborhood-level farmers' market data, this study was able to employ a before-and-after design to assess variables along the proposed causal pathways.

The study results must also be interpreted in light of clear limitations to the data. The research approach here is motivated by a concern for omitted variables bias. While the methods used represent an important and useful approach to dealing with omitted variables bias, they cannot rule it out definitively. In particular, it could be that there are separate preferences for consumption of fresh produce and for soda. If these preferences are uncorrelated with each other, it would undermine the DAG analysis presented here. There is a limit to what can be known from observational data.

There are both strengths and limitations to using CHIS data. One of the strengths of using a large dataset designed to be representative of the diverse state of California, is that the results are at least generalizable to the state level. California is the most populous state in the U.S., with residents living in urban, suburban, exurban, and rural areas. It is also a racially diverse state. Thus, CHIS likely captures respondents living in a wide range of food environments that are generalizable to food environments throughout the state and possibly elsewhere. However, the response rate of CHIS may lead to questions about potential non-response bias. Nevertheless, CHIS respondents provide a representative sample of the state of California and studies have

found no evidence of non-response bias.[31] Additionally, height and weight, as well as dietary behaviors are based on self-reported data.

Conclusions

Would proactively locating new farmers' markets in areas with low demand for fruits and vegetables increase healthy dietary habits? This analysis suggests that it would. This study makes advances in understanding if neighborhood selection biases the relationship between farmers' markets and fruit and vegetable consumption. More research is needed to definitively rule out selection.

Table 2.1: Characteristics of California Adults, CHIS 2005, 2007, and 2009[a]

	2005		2007						2009	
	all neighborhoods		all neighborhoods		not poor neighborhoods		poor neighborhoods		all neighborhoods	
Characteristic	N	%	N	%	N	%	N	%	N	%
Age										
18-39	11,721	43.4	11,061	41.7	5,278	36.9	5,776	47.7	8,822	41.1
40-64	20,757	42.0	24,630	43.8	14,757	46.7	9,867	40.3	22,547	44.2
65+	9,561	14.6	14,275	14.5	8,792	16.5	5,482	12.0	15,177	14.8
Gender										
Male	17,314	49.7	20,326	49.6	11,832	49.9	8,487	49.2	19,234	49.7
Female	24,725	50.3	29,640	50.4	16,995	50.1	12,638	50.9	27,312	50.3
Race/Ethnicity										
White	27,022	48.8	32,746	47.8	21,414	60.4	11,326	32.0	30,525	46.6
Hispanic	7,918	31.2	8,955	31.8	2,966	18.7	5,984	48.2	8,173	32.7
African American	1,795	5.6	2,375	5.7	878	4.1	1,497	7.8	1,837	5.7
American Indian/Alaskan Native	330	0.6	415	0.6	180	0.6	235	0.8	350	0.7
Asian	3,670	12.1	4,130	12.3	2,720	14.4	1,407	9.6	4,607	12.4
Native Hawaiian/Pacific Islander	93	0.4	93	0.4	53	0.4	40	0.3	65	0.4
Two or more races	1,211	1.4	1,252	1.5	616	1.5	636	1.4	989	1.6
Income										
0-99% FPL	4,172	12.8	4,944	13.8	1,431	6.9	3,510	22.5	5,587	15.8
100-199% FPL	6,747	18.5	7,829	16.9	2,909	10.2	4,916	25.3	7,767	18.0
200-299% FPL	5,427	12.9	6,768	13.8	3,358	12.0	3,410	16.2	6,408	13.9
300% FPL and above	25,693	55.7	30,425	55.5	21,129	71.0	9,289	36.1	26,784	52.4
BMI										
Normal (18.5-24.99)	18,653	43.3	21,138	42.3	13,214	46.5	7,916	36.9	19,831	42.4
Overweight (25.0-29.99)	14,438	35.1	17,560	34.6	10,061	34.0	7,494	35.4	16,152	34.4
Obese (30.0+)	8,948	21.7	11,268	23.1	5,552	19.5	5,715	27.7	10,563	23.2

Daily Soda Consumption										
<1 soda	36,842	83.7	44,817	86.4	26,651	90.4	18,156	81.5	42,913	88.0
1+ sodas	5,197	16.3	5,149	13.6	2,176	9.6	2,969	18.5	3,633	12.0
Daily Fruit & Vegetable Consumption										
<3	31,836	79.0	34,169	73.1	19,041	70.9	15,117	75.9	32,611	74.7
3+	10,203	21.0	15,797	26.9	9,786	29.1	6,008	24.1	13,935	25.3
Number of Farmers' Markets Near Home--Buffer-based										
0	—	—	30,515	64.6	17,412	63.3	13,091	66.2	—	—
1+	—	—	19,451	35.4	11,415	36.7	8,034	33.8	—	—
Farmers' Markets in Neighborhood This Year--Zip code-based										
No	25,341	65.7	29,415	62.7	—	—	—	—	24,102	56.1
Yes	16,698	34.3	20,551	37.3	—	—	—	—	22,444	43.9
Farmer's Market in Neighborhood Any Year--Zip code-based										
No	18,512	47.4	21,907	47.7	—	—	—	—	20,247	47.7
Yes	23,527	52.6	28,059	52.4	—	—	—	—	26,299	52.3

[a]Sample size is 42,039 for CHIS 2005, 49,966 for CHIS 2007, and 46,546 for CHIS 2009. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
FPL, federal poverty level

Table 2.2: Results of Logistic Regression Models Examining Presence of a Farmers' Market Using Buffer-based Farmers' Market Variable, Obesity & Dietary Behaviors Among Adults: California Health Interview Survey, 2007

Presence of A Farmers' Market		Obesity (BMI ≥30 kg/m^2)[b]		Fruit & Vegetable Consumption (3+ times per day)[b]		Soda Consumption (1+ per day)[b]	
Neighborhoods	N	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value
All	49,952	0.86 (0.81, 0.93)	<.01	1.15 (1.07, 1.23)	<.01	0.97 (0.87, 1.08)	0.62
Not Poor	13,214	0.89 (0.80, 0.98)	0.02	1.11 (1.02, 1.22)	0.02	1.09 (0.95, 1.25)	0.25
Poor	21,125	0.84 (0.76, 0.94)	<.01	1.19 (1.07, 1.33)	<.01	0.89 (0.76, 1.05)	0.16

[a]Sample size is 49,966 for adults age 18 and over in CHIS 2007. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
[b]Models control for age, gender, race/ethnicity, and household income.
OR, odds ratio; CI, confidence interval

Table 2.3: Results of Logistic Regression Models Examining Presence of a Farmers' Market Using Zip Code-based Farmers' Market Variable, Dietary Behaviors, and Obesity Controlling for Neighborhood Selection Among Adults: California Health Interview Survey, 2005, 2007, and 2009[a]

	Fruit & Vegetable Consumption (3+ times/day)[b]				Soda Consumption (1+ time/day)[b]				Obesity (BMI ≥30 kg/m^2)[b]			
model	1a		1b		2a		2b		3a		3b	
	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value
FM in Index Year	1.08 (1.03, 1.14)	<.01	1.12 (1.04, 1.20)	<.01	0.92 (0.86, 0.98)	<.01	0.99 (0.89, 1.10)	0.80	0.91 (0.87, 0.96)	<.01	0.94 (0.88, 1.01)	0.10
FM Any Year	—	—	0.96 (0.89, 1.03)	0.29	—	—	0.91 (0.82, 1.01)	0.07	—	—	0.96 (0.89, 1.04)	0.34

[a]Sample size is 138,552 for adults age 18 and over in CHIS 2005, 2007, and 2009. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
[b]Models control for age, gender, race/ethnicity, household income, and survey year.
FM, farmers' market; OR, odds ratio; CI, confidence interval

Figure 2.1: Directed Acyclic Graphs

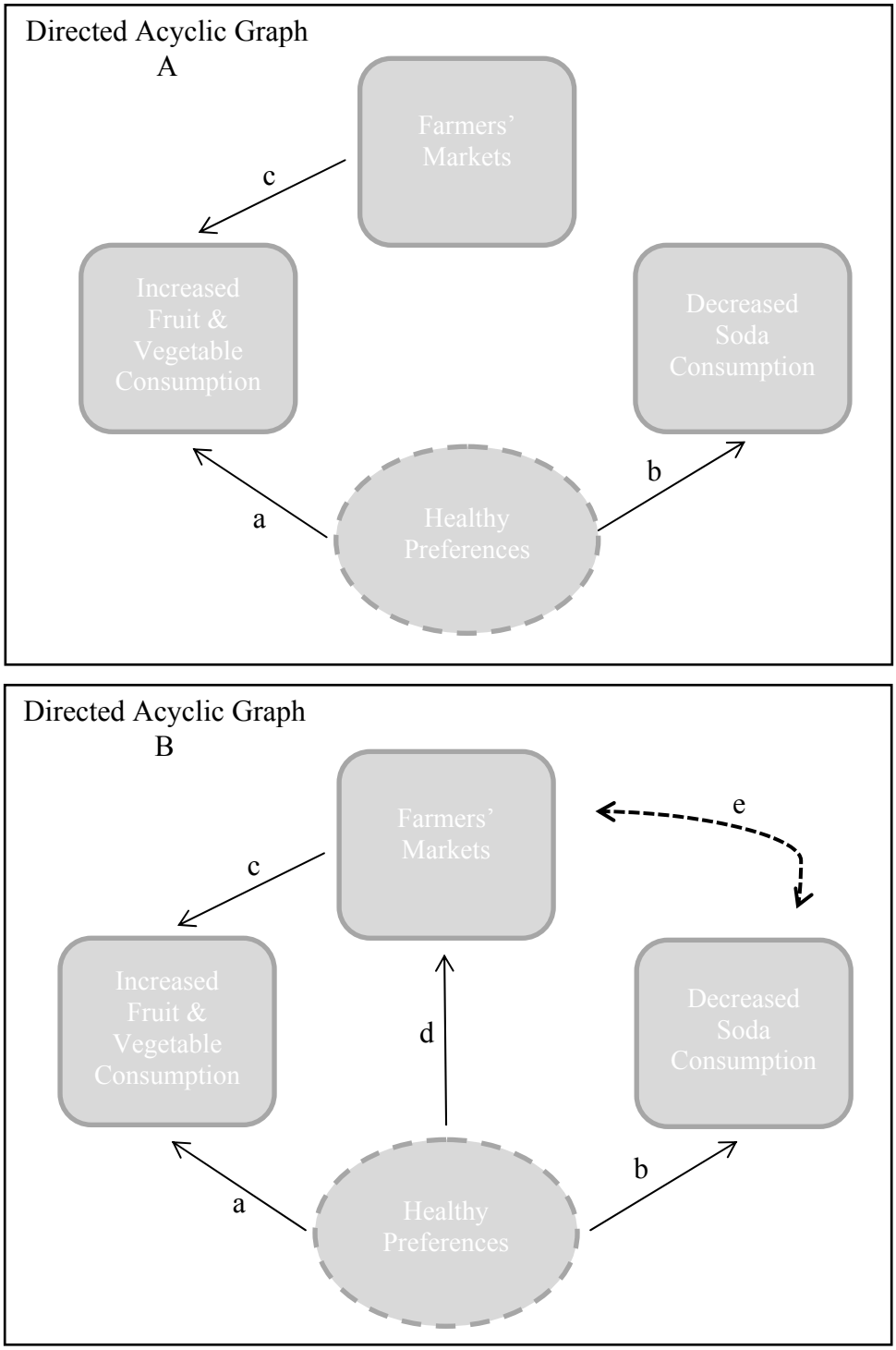

Figure 2.2: Neighborhood scenarios of farmers' markets across survey years

Neighborhood	2005	2007	2009
A	0	0	0
B	0	1+	1+
C	0	0	1+

Appendix 2.1: Results of Logistic Regression Models Examining Presence of a Farmers' Market Using Zip Code-based Farmers' Market Variable, Dietary Behaviors, and Obesity Controlling for Neighborhood Selection Among Adults with a Farmers' Market in Any of the Survey Years: California Health Interview Survey, 2005, 2007, and 2009[a]

	Fruit & Vegetable Consumption (3+ times/day)[b]		Soda Consumption (1+ time/day)[b]		Obesity (BMI ≥30 kg/m^2)[b]	
model	1a		2a		3a	
	OR (CI)	p-value	OR (CI)	p-value	OR (CI)	p-value
FM in Index Year	1.12 (1.04, 1.20)	<.01	0.99 (0.89, 1.10)	0.81	0.94 (0.88, 1.01)	0.11

[a]Sample size is 77,885 for adults age 18 and over in CHIS 2005, 2007, and 2009. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
[b]Models control for age, gender, race/ethnicity, household income, and survey year.
FM, farmers' market; OR, odds ratio; CI, confidence interval

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CHAPTER 3

ASSOCIATION OF FARMERS' MARKETS WITH PERCEIVED AVAILABILITY OF FRUITS AND VEGETABLES AND ADULT DIETARY BEHAVIORS

INTRODUCTION

There is limited literature examining how farmers' markets influence dietary behaviors at a population level.[1,2] Existing research suggests that farmers' markets are associated with increased fruit and vegetable consumption, however, to our knowledge no studies have examined the pathway by which farmers' market are positively influencing fruit and vegetable consumption. Given national-level recommendations to increase the number of farmers' markets as a means of increasing access to fruits and vegetables, it is important to understand how farmers' markets improve dietary behaviors.[3] This study examines the impact of farmers' markets on a population level by testing the relationship between farmers' markets upon fruit and vegetable consumption, via perceived availability of fruits and vegetables.

Existing research on farmers' markets and fruit and vegetable consumption primarily focuses on traditionally underserved groups, such as participants of the WIC program.[1] Most studies that provided incentives for study participants to shop at farmers' markets found that recipients of incentives had higher fruit and/or vegetable intake than those who did not receive incentives.[4-7] Herman et al. found that WIC recipients who received a subsidy to purchase fruits and vegetables at a local farmers' market increased their fruit and vegetable

consumption by 1.4 servings per 1000 calories of consumed food.[4] While these studies suggest that people respond to incentives in choosing fruits and vegetables, they do not provide direct evidence of the effectiveness of farmers' markets in increasing fruit and vegetable consumption among the general population, or how farmers' markets impact consumption when incentives are not available.

Another study examined the impact of introducing farm stands in low-income, racially-diverse neighborhoods in East Austin and found that fruit and vegetable consumption increased with the introduction of these farm stands.[8] The authors emphasize that the findings of this study underscore the potential for farmers' markets to increase fruit and vegetable consumption in low-income communities. Yet it remains unclear whether similar effects would be obtained in other geographical areas or socioeconomic groups.

One study examining farmers' markets at the population level found that the presence of a farmers' market near home was associated with decreased prevalence of obesity and increased fruit and vegetable consumption (JW, UCLA, unpublished observations, 2014). This study also found the same associations in poor and non-poor neighborhoods, suggesting that the beneficial effect of farmers' markets is not limited to individuals living in low-income neighborhoods.

To our knowledge no studies have examined the impact of farmers' markets on perceived availability of fruits and vegetables in the neighborhood. There is a small literature examining associations between perceived availability of fruits and vegetables and consumption of fruits and vegetables. However, the majority of these studies do not take into account direct

perceptions of availability of produce. Rather, they construct a variable for perceived availability based on other measures, such as quality of local produce, convenience of the place respondents shop for fruits and vegetables, and selection or variety of fruits and vegetables.[9,10] The only study found that directly asked respondents about their perceptions of produce availability found no significant association between perceived availability and fruit and vegetable consumption.[11] However, this study was limited to residents in Philadelphia and had a sample of 4,399 adults.

The existing research raises the question of how the effect of farmers' markets operates. Two mechanisms are possible. First, it could be that farmers' markets increase the availability of fruits and vegetables in neighborhoods, and so have a direct causal influence on consumption. Second, it could be that that the presence of farmers' markets in a neighborhood raises the cognitive salience of fruits and vegetables, in effect serving as advertising for healthy eating—an indirect causal effect on consumption.[12] Of course, these causal mechanisms are not mutually exclusive.

The nearly five-fold increase in farmers' markets during the past 20 years presents an important opportunity to understand how the presence of farmers' markets influences consumption and availability of fruits and vegetables among the general population.[13] Furthermore, it is important to understand the mechanisms by which farmers' markets influence dietary behaviors in order to better inform policy efforts to increase access to fresh produce via farmers' markets. It is valuable to know if the relationship between farmers' markets and fruit and vegetable consumption is mediated by another factor. This study examines the associations between the presence of a farmers' market near home and fruit and vegetable consumption among adults in California. It also examines whether the relationship between

farmers' markets and fruit and vegetable consumption is mediated by perceptions of availability of fresh produce.

Conceptual Framework

It is unclear if farmers' markets increase fruit and vegetable consumption directly or if they operate through other mechanisms. Farmers' markets may attract clientele because of non-comestible goods or child-friendly activities offered. Some farmers' market operators allow clothing stands, petting zoos, pony rides, or bounce houses to locate in areas adjacent to the Certified Farmers' Market, which may be the primary reason individuals attend; fruit and vegetable purchase and consumption may be an afterthought but leads to fruit and vegetable consumption nonetheless. Additionally, the scheduled nature of farmers' markets may serve as weekly reminders for individuals to shop for fresh produce, whether at the farmers' market itself or other food outlets, resulting in consumption of fruits and vegetables. As discussed earlier, it is possible that farmers' markets may indirectly influence consumption by raising awareness of the presence of fruits and vegetables in neighborhoods—through increasing the availability of and/or cognitive salience of fruits and vegetables. The mere presence of a farmers' market may increase perceptions of availability of fresh produce in the neighborhood among residents, which may lead to increased consumption of fruits and vegetables. The data do not permit measurement of all these pathways, but they do measure perceived availability.This research uses a mediation model to test the theory that farmers' markets increase fruit and vegetable consumption by increasing perceptions of available of fresh produce.

Figure 1 illustrates the hypothesized relationship between farmers' markets, fruit and vegetable consumption, and perceived availability of fresh produce in the neighborhood. The solid lines represent the hypothesized causal relationship between the variables. The top panel represents a direct relationship between farmers' markets and fruit and vegetable consumption. The lower panel represents the relationship if it is mediated by perceived availability of fresh produce in the neighborhood.

In order to test whether the relationship between farmers' markets and fruit and vegetable consumption is mediated by perceived availability of fresh produce, one must examine each of the pathways between the variables (a, b, c, d). The total effect pathway pathway between farmers' markets and fruit and vegetable consumption (a) must be statistically significant and of real-world importance in order to begin the mediation analysis. If this pathway is not statistically significant, there is no relationship to mediate.

If perceived availability is a mediator, there must be a statistically significant path from farmers' markets to perceived availability of fruits and vegetables (b), and one from perceived availability to fruit and vegetable consumption (c). If the individual pathways from farmers' markets to fruit and vegetable consumption via perceived availability are statistically significant and of real-world importance, there must also be a statistically significant path from presence of a farmers' market to fruit and vegetable consumption, accounting for the mediator variable (a).

The analysis testing this relationship would include both farmers' markets and perceived availability as predictors. If perceived availability fully mediates the relationship between

farmers' markets and fruit and vegetable consumption, the magnitude of the effect of farmers' markets should be zero. As a full mediator, perceived availability would completely absorb the effect of farmers' markets on fruit and vegetable consumption. If perceived availability only partially mediates the relationship between farmers' markets and fruit and vegetable consumption, the magnitude of the effect of farmers' markets on fruit and vegetable consumption should decrease substantially when both predictors are included in the model. As a partial mediator, perceived availability would absorb part of the effect of farmers' markets on fruit and vegetable consumption. If there is not a statistically significant relationship between perceived availability and consumption, or the magnitude of the effect is not altered when both predictors are included in the model, then perceived availability is not a mediator and one of the other proposed pathways may be influencing fruit and vegetable consumption.

METHODS

Data Source and Population

Data for this study were from the 2011-2012 California Health Interview Survey (CHIS), a random-digit-dial telephone survey of households designed to be representative of California's non-institutionalized population. A 2-stage, geographically stratified design was used to produce a representative sample of the state. Residential telephone numbers were selected from within predefined geographic areas, and respondents were then randomly selected from within sampled households. CHIS 2011-2012 also included a cell phone-only sample. One randomly selected adult (18 years or older) was interviewed in each household.

CHIS interviews were conducted in English, Spanish, Chinese, Vietnamese, and Korean. Detailed information about the CHIS methodology is available elsewhere.[14] The interview completion rate among adults in 2011-2012 was 47.4% in the landline sample and 53.8% in the cell phone-only sample.[15] The University of California, Los Angeles (UCLA) Office for the Protection of Research Subjects certified this research exempt from IRB review.

Because data for farmers' markets were not available in 2011 or 2012, instead data from 2009 were used. Data for farmers' markets are from the California Federation of Certified Farmers' Markets. They include the market name, location (street address, latitude and longitude), and days of operation for farmers' markets in 2009. At Certified Farmers' Markets producers can sell fresh fruits, nuts, vegetables, shell eggs, honey, flowers and nursery stock. Information regarding regulations for other products sold at farmes' markets can be found elsewhere.[16] Farmers' markets erected in the same location more than one time per week were accounted for only once. Farmers' market data were linked to CHIS data using ArcGIS software.

Measures

The primary outcomes of interest were perceived availability of fresh fruits and vegetables near home and fruit and vegetable consumption. Perceived availability of fresh fruits and vegetables near home was based on responses to the question "How often can you find fresh fruits and vegetables in your neighborhood?" Responses were categorized as always available versus not always available (never, sometimes, usually, and doesn't eat fruits or vegetables. Fruit and vegetable consumption was calculated from responses to the following two questions: "During

the past month, how many times per day, week or month did you eat fruit? Do not count juice" and "During the past month, how many times did you eat vegetables, like green salad, green beans, or potatoes? Do not include fried potatoes." Responses to each question were standardized to number of times per day, summed, and categorized as consuming fruits and vegetables less than three versus three or more times per day.

The primary predictors of interest were the presence of a farmers' markets near the respondent's home and perceived availability of fresh fruits and vegetables near home. The presence of farmers' markets near the respondent's home was calculated using ArcGIS (Geographic Information Systems) software. Data from CHIS 2011-2012 were linked with the locations of Certified Farmers' Markets. For each adult CHIS respondent, the number of farmers' markets within a given radius around his/her home (one-mile in urban areas, two miles in smaller cities and suburban areas, and five miles in rural areas) was determined. Using data obtained from Claritas, a marketing information resources company, households were assigned to urbanicity levels (urban, suburban, rural) based on population density of the household's zip code and surrounding areas. Results were categorized dichotomously as zero versus one or more farmers' markets.

The following demographic characteristics were included as controls: age, gender, and race/ethnicity (White, Latino, Asian, African-American, American Indian, mixed race). Household income, also included as a control variable, was reported by the respondent and coded in categories by percent of the Federal Poverty Level (99% and below, 100-199%, 200-299%, 300% and above).

Analyses

Bivariate analyses were used to preliminarily test how perceived availability of fresh produce and consumption of fresh fruits and vegetables varied when farmers' markets were present in the respondents' neighborhoods.

Four logistic models corresponding to the conceptual framework were used to further examine any associations of perceived availability of fresh fruits and vegetables near the home, farmers' market presence, and fruit and vegetable consumption. The first model tested the relationship between the presence of a farmers' market and fruit and vegetable consumption [Figure 1 (a)]. The second examined the relationship between the presence of a farmers' market and perceived availability of fresh fruits and vegetables, the potential mediator (b). The third model tested the relationship between perceived availability of fresh produce and fruit and vegetable consumption (c). The final model examined the relationship between fruit and vegetable consumption and both presence of farmers' markets and availability of fresh fruits and vegetables near home (d). All models controlled for age, gender, race, and household poverty level.

Underweight individuals (BMI <18.5) were dropped from all analyses (N=747) because they may be atypical eaters. Models included a sample of 42,188 adults. Data were analyzed using SAS (version 9.4; SAS Institute, Inc, Cary, North Carolina). Analyses were weighted to be representative of the California population and adjusted for the complex survey design of CHIS.

RESULTS

Population Characteristics

Table 1 displays characteristics of California adults age 18 and above included in the sample, adjusting for sample weights. The average age of respondents was 45 years, and 51% were female. The racial/ethnic distribution of adults was 44% white, 34% Latino, 14% Asian, 6% African American, and 2% mixed race. Among respondents only 27% reported eating fruits and vegetables at least three times per day. Yet 78% reported always having access to fresh produce in their neighborhood. Forty-three percent of respondents had one or more farmers' markets near his/her home, accounting for level of urbanicity (one-mile in urban areas, two miles in smaller cities and suburban areas, and five miles in rural areas).

Bivariate Results

Table 2 displays bivariate results of the variation in perceived availability and fruit and vegetable consumption among individuals with and without a farmers' market near home. Over three-quarters of respondents (78%) reported that fruits and vegetables were always available near home, regardless of whether a farmers' market was present. There were minor differences in perceived availability when taking into account the presence of a farmers' market. Eighty percent of individuals living in neighborhoods with a farmers' market reported always having fresh produce available, compared to 77 percent of individuals without a farmers' market. These differences were statistically significant.

Fruit and vegetable consumption also varied by perceived availability of fresh produce in the neighborhood. Among respondents reporting always having fresh produce available, 29 percent consumed fruits and vegetables three or more times per day. Among those reporting not always having fresh produce available, only 20 percent reported consuming fruits and vegetables at least three times per day. This difference was statistically significant. These figures varied slightly when taking into consideration the presence of a farmers' market.

Multivariate Results

Table 3 presents the logistic models. The results from the first model indicate that there is also a statistically significant but small relationship between the presence of a farmers' market and fruit and vegetable consumption. Consuming fruits and vegetables three or more times per day was more likely among individuals with a farmers' market near home than among those without [OR = 1.10; 95% CI: (1.03, 1.18)].

Results from the second model indicate that there is a statistically significant but small relationship between the presence of a farmers' market and perceived availability of fresh produce near home. The odds of reporting always having fresh produce available in the neighborhood were 1.13 times as high among individuals who had a farmers' market near home as among those without [OR = 1.13; 95% CI: (1.04, 1.23)].

Results from the third model indicate that there is a statistically significant relationship between perceived availability of fresh fruits and vegetables and fruit and vegetable consumption. The odds of consuming fruits and vegetables were 1.42 times as high among individuals who

reported always having fresh fruits and vegetables available in their neighborhood as among those without such perceived availability [OR = 1.42; 95% CI: (1.28, 1.56)].

The results of the fourth model indicate that both the presence of farmers' markets and perceived availability of fresh produce near home have an independent and statistically significant but small relationship with fruit and vegetable consumption. Controlling for demographic factors and simultaneously including the farmers'-market and perceived-availability variables, consuming fruits and vegetables three or more times per day was more likely among individuals who reported always having fresh produce available [OR = 1.41; 95% CI: (1.28, 1.56)], and also more likely among those with a farmers' market near home [OR = 1.09; 95% CI: (1.02, 1.17)].

DISCUSSION

This study tested whether there is a significant association between the presence of a farmers' market and increased consumption of fruits and vegetables, and if so, whether this association is mediated by an increased perception of the availability of fruits and vegetables.

The results suggest that that farmers' markets have a small but significant impact on fruit and vegetable consumption (conceptual model, pathway a); that the presence of a farmers' market has a statistically significant, albeit very small, effect on perceived availability of fresh fruits and vegetables in the neighborhood (pathway b); perceived availability has a small but significant impact on fruit and vegetable consumption (pathway c); and that when

both primary predictors are included in the model, the relationships remain the same (pathway d); the magnitudes of the effects of farmers' markets and perceived availability on fruit and vegetable consumption change only very little.

It is noteworthy that the magnitudes of the association between consumption and farmers' markets in model 3 (pathway c), which does not include a direct measure of perceived food availability, and model 4 (pathway d), which includes the perceived availability measure, are very similar. This similarity reflects the weak association between farmers' markets and perceived availability in the sample and reinforces the conclusion that the principal pathway for the impact of farmers' markets on consumption is not through increasing perceptions of availability but something else.

The most direct explanation for the relationship between perceived availability and fruit and vegetable consumption is that individuals eat what is available to them. If fruits and vegetables are always available in the neighborhood, individuals are more likely to consume them. Low reported availability may be associated with higher travel and time costs to obtain fruits and vegetables, with the higher costs lowering demand for fresh produce.

The presence of farmers' markets is associated with increased fruit and vegetable consumption but not only or primarily because of increased perceptions of availability of fresh produce. There are a number of ways farmers' markets may increase consumption of fresh produce besides through increased perceptions of availability. One avenue is through increasing the cognitive salience of fruits and vegetables, in effect serving as advertising for

healthy eating. Farmers' markets create a weekly focal point for display of fruits and vegetables and, subsequently, a reminder to individuals to purchase and consume fresh produce, whether from the farmers' market itself or other suppliers. Farmers' markets may also remind individuals to purchase fresh produce because of their scheduled nature. Individuals may plan their shopping days on farmers' market days, thus increasing the likelihood of produce being purchased and consumed routinely. Similarly, because farmers' markets are not held daily in the same neighborhoods, visiting a farmers' market may seem like a recreational or leisure activity.[17] As such, individual may plan an activity around visiting the farmers' market. Attending a farmers' market has the potential to be a social event, more so than going to the grocery store, and thus may increase the likelihood that individuals attend and subsequently purchase fresh produce.

There are both limitations and strengths to the data used in this study. The response rate of CHIS may lead to questions about potential non-response bias. Nevertheless, CHIS respondents provide a representative sample of the state of California and studies have found no evidence of non-response bias.[18] Additionally, consumption of fruits and vegetables is based on self-reported data, which is subject to self-report bias. Likewise, self-reported perceived availability of fresh fruits and vegetables in the neighborhood may not coincide with objective measures of availability, since individuals may interpret the meaning of availability or the span of one's neighborhood differently. Regardless, perceived availability is a distinct and important measure; unobserved and psychological barriers to accessing fresh produce may be better captured in a subjective variable. One weakness of the California Certified Farmers' Markets is that farmers' market data for 2011-12 were not available, so 2009 data were linked with CHIS 2011-12. Albeit

unlikely, there is a possibility that farmers' markets in 2009 were not representative of farmers' markets in 2011-12. Another weakness of these data is the possibility that a farmers' market may have closed between 2009 and 2011-12 or that the locations of farmers' markets are misclassified. However, this dataset provides the ability to use objective criteria for defining farmers' markets. One of the strengths of using a large dataset designed to be representative of the diverse state of California, such as CHIS, is that the results are at least generalizable to the state level. California is the most populous state in the U.S., with residents living in urban, suburban, exurban, and rural areas. It is also a racially diverse state. Thus, CHIS likely captures respondents living in a wide range of food environments that are generalizable to food environments in other parts of the state and possibly elsewhere.

To the authors' knowledge this is the first study to examine the relationship between presence of farmers' markets, perceived availability of fresh produce, and consumption of fruits and vegetables. Additionally this is the first study to examine whether perceived availability mediates the relationship between presence of a farmers' market and consumption of fruits and vegetables.

Conclusions

The findings of this study suggest that farmers' markets are not increasing fruit and vegetable consumption exclusively or primarily by increasing perceptions of fruit and vegetable availability. There are other mechanisms by which farmers' markets improve dietary behavior; further research is needed to identify these mechanisms. Regardless of whether the influence is due to a cognitive salience or other unmeasured effect, farmers' markets are a useful strategy in promoting consumption of fruits and vegetables.

Table 3.1: Descriptive statistics of sample population, California Health Interview Survey, 2011-12[a]

Characteristic	Sample size	% (SE)
Age		
18-39	8,850	41.4 (0.4)
40-64	19,515	42.8 (0.4)
65+	13,823	15.8 (0.2)
Gender		
Male	17,688	49.0 (0.4)
Female	24,500	51.0 (0.4)
Race/Ethnicity		
White	25,376	43.6 (0.4)
Hispanic	9,397	34.4 (0.4)
African American	1,985	5.7 (0.2)
American Indian/Alaskan Native	461	0.4 (0.0)
Asian	4,079	13.6 (0.3)
Native Hawaiian/Pacific Islander	62	0.4 (0.1)
Two or more races	828	1.9 (0.1)
Income		
0-99% FPL	6,104	16.5 (0.3)
100-199% FPL	7,751	19.4 (0.3)
200-299% FPL	5,994	14.3 (0.3)
300% FPL and above	22,339	49.9 (0.4)
Number of FMs in Neighborhood[b]		
0	22,442	57.0 (0.4)
1	12,057	26.9 (0.4)
2	4,547	9.8 (0.2)
3+	3,142	6.3 (0.2)
Perceived Availability of Fruits & Vegetables[c]		
Always	34,172	77.9 (0.4)
Usually	3,575	9.8 (0.3)
Sometimes	2,695	7.6 (0.2)
Never	1,754	3.5 (0.2)
Doesn't Eat/Shop for F&V	739	1.1 (0.1)
Daily Fruit & Vegetable Consumption[d]		
0	6,825	20.3 (0.4)
1	13,408	32.3 (0.4)
2	9,372	20.2 (0.3)
3	5,824	12.0 (0.3)
4	3,888	8.0 (0.2)
5+	3,618	7.2 (0.2)
Body Mass Index		
Normal (18.5-24.99)	16,310	39.2 (0.4)

Overweight (25.0-29.99)	15,008	35.6 (0.4)
Obese (30.0+)	10,870	25.2 (0.4)

[a]Sample size is 42,188 adults age 18 and over. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
[b]Responses were dichotomized as 0 vs. 1+ for analyses
[c]Responses were dichotomized as Always available vs. Not always available for analyses
[d]Responses were dichotomized as consuming fruits and vegetables <3 vs. 3+ times per day for analyses
SE, standard error; FPL, federal poverty level

Table 3.2: Bivariate analyses of perceived availability of fruits and vegetables, fruit and vegetable consumption, and presence of a farmers' market, California Health Interview Survey, 2011-2012[a]

	Proportion Reporting Fruit & Vegetables Always Available			
Farmers' Market	N	F&V Always Available	N	F&V Not Always Available
Yes	16,075	79.9	3,671	20.1
No	17,530	76.6***	4,912	23.4***
Total	33,605	78.0+++	8,583	22.0+++
	Fruit & Vegetable Consumption 3+ times/day			
Farmers' Market	N	F&V Always Available	N	F&V Not Always Available
Yes	5,577	30.8	873	20.8
No	5,555	28.0***	1,083	19.5***
Total	11,132	29.2+++	1,956	20.0

[a]Sample size is 42,188 adults age 18 and over. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
*p<0.10; **p<0.05; ***p<0.01 in testing for significant differences between "Yes" and corresponding "No" category
+p<0.10; ++p<0.05; +++p<0.01 in testing for significant differences between "F&V Always Available" and "F&V Not Always Available"
F&V, fruits and vegetables

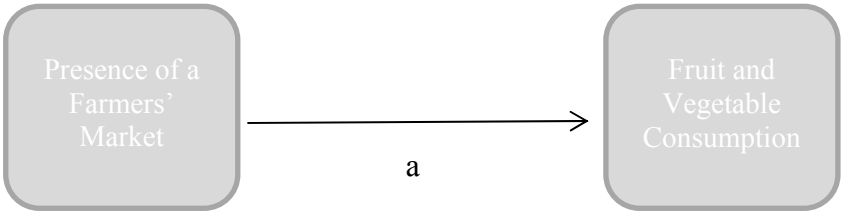
Table 3.3: Results of multivariate logistic analyses, California Health Interview Survey, 2011-2012[a]

Outcome	Model 1 F&V Consumption (3+ times/day)	Model 2 Perceived Availability of F&V (always available)	Model 3 F&V Consumption (3+ times/day)	Model 4 F&V Consumption (3+ times/day)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Farmers' market near home				
0 (ref)	—	—	—	—
1+	**1.10 (1.03 - 1.18)*** **	**1.13 (1.04 -1.23)*** **	—	**1.09 (1.02 - 1.17)*** **
Perceived Availability of F&V				
Always	—		**1.42 (1.28 - 1.56)*** **	**1.41 (1.28 - 1.56)*** **
Other (ref)				
Age	**1.01 (1.00 - 1.01)*** **	**1.01 (1.01 - 1.01)*** **	**1.01 (1.00 - 1.01)*** **	**1.01 (1.00 - 1.01)*** **
Gender				
Male (ref)	—	—	—	—
Female	**1.96 (1.83 - 2.11)*** **	**1.31 (1.19 - 1.44)*** **	**1.94 (1.81 - 2.08)*** **	**1.94 (1.81 - 2.08)*** **
Race/ethnicity				
African American	**0.62 (0.52 - 0.73)*** **	**0.56 (0.47 - 0.67)*** **	**0.63 (0.53 - 0.74)*** **	**0.63 (0.53 - 0.75)*** **
American Indian/Alaskan Native	0.85 (0.55 - 1.30)	1.09 (0.79 - 1.51)	0.84 (0.54 - 1.29)	0.84 (0.55 - 1.29)
Asian	0.87 (0.77 - 0.97)	**0.48 (0.43 - 0.54)*** **	0.90 (0.8 - 1.00)*	**0.90 (0.80 - 1.01)***
Latino	**0.69 (0.62 - 0.77)*** **	**0.60 (0.55 - 0.66)*** **	**0.70 (0.63 - 0.78)*** **	**0.71 (0.64 - 0.79)*** **
Native Hawaiian/Pacific Islander	0.48 (0.20 - 1.18)	1.01 (0.38 - 2.73)	0.47 (0.19 - 1.18)	0.48 (0.19 - 1.19)
Two or more races	1.11 (0.87 - 1.42)	**0.68 (0.51 - 0.92)*** **	1.13 (0.88 - 1.45)	1.13 (0.88 - 1.45)
White (ref)	—	—	—	—
Household Income (FPL)				
0-99% FPL	**0.74 (0.65 - 0.83)*** **	**0.45 (0.40 - 0.50)*** **	**0.77 (0.68 - 0.87)*** **	**0.77 (0.68 - 0.87)*** **
100-199% FPL	**0.72 (0.64 - 0.80)*** **	**0.50 (0.45 - 0.56)*** **	**0.74 (0.66 - 0.83)*** **	**0.74 (0.66 - 0.83)*** **
200-299% FPL	**0.79 (0.71 - 0.89)*** **	**0.63 (0.55 - 0.71)*** **	**0.81 (0.72 - 0.91)*** **	**0.81 (0.72 - 0.91)*** **
300%+ FPL (ref)	—	—	—	—

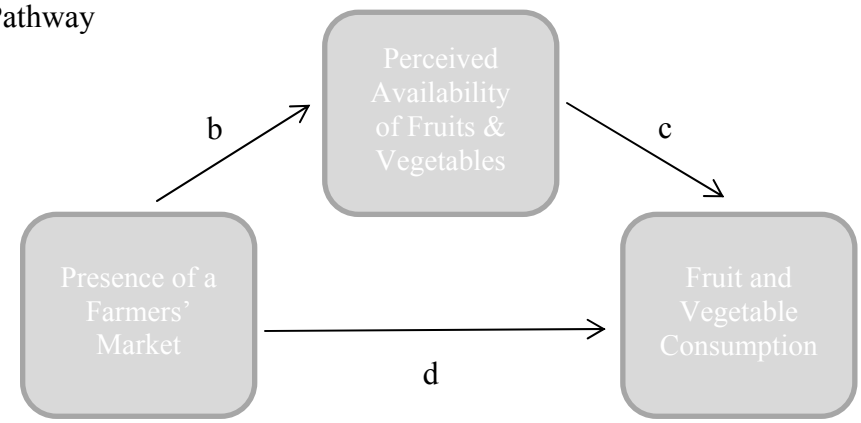
[a]Sample size is 42,188 adults age 18 and over. Results are weighted to be representative of the California population and are adjusted for complex survey design effects.
*p<0.10; **p<0.05; ***p<0.01
F&V, fruits and vegetables; OR, odds ratio; CI, confidence interval; FPL, federal poverty level

Figure 3.1: Mediation Model

Total Effect



Mediated Pathway



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CHAPTER 4

FOOD ENVIRONMENT NEAR THE WORKPLACE AND ASSOCIATIONS WITH OBESITY AND DIETARY BEHAVIORS

INTRODUCTION

During the last three decades, the prevalence of obesity has increased dramatically in both adults and children.[1] In the 1970s, approximately 15% of adults were obese and by 2004 the prevalence rose to 32%. Likewise, childhood obesity increased from 6% to 17% among those aged 12 to 19 years, and from 4% to 19% among those aged 6 to 11 years between the early 1970s and 2003-2004.[2-4] Obesity is a major public health concern because of its association with increased mortality and debilitating health conditions, such as cardiovascular disease, Type II diabetes, and certain cancers.[2,5,6]

Increasingly, research suggests that the retail food environment is associated with dietary behaviors and health outcomes.[7-13] Previous research has examined the association of the food environment near home or school. The purpose of doing so is to understand what types of foods individuals are exposed to through their local establishments. Researchers focus on the school food environment to understand the types of foods that school age children encounter while at or en route to and from school. The school environment is of great importance because children spend at least one-third of their weekday hours in this environment and consume up to two meals and snacks at school.[13] Although one can argue that children typically stay on campus during

school hours, they are exposed to retail food outlets on their way to and from school and potentially during lunchtime depending on school off-campus lunch policies. One study found that students at schools with open-campus lunch policies were more likely to eat lunch purchased at a fast food outlet or convenience stores than students with closed- campus lunch policies.[14] Another study found that students with fast food outlets within a half-mile of their schools were more likely to be obese, and to consume more soda and fewer fruits and vegetables than students at schools not near fast food restaurants.[15] Additionally, a recent study examined the combined effects of the home and school food environments and found that students who live and go to school in less healthy food environments were more likely to consume fast food and soda than those in healthier food environments.[16]

Despite extensive research to understand the environments where children spend a large portion of their time, minimal attention has been paid to understand the environments where most adults spend a large portion of their weekdays—the workplace. Understanding the workplace food environment is of particular importance because the majority of the U.S. adult population is employed.[17,18] Thus, most adults likely interact with the food environment around the workplace during mealtimes and may purchase between one and three meals and snacks from food retailers surrounding their place of work.

While there have been some studies to evaluate the foods offered in the workplace, such as foods accessible through vending machines, on-site snack shops, and cafeterias, only one looked at the neighborhood surrounding the worksite. Oldenburg and colleagues published findings from a study implementing the Checklist of Health Promotion Environments at Worksites (CHEW), an

instrument created for the purposes of assessing worksite characteristics known to influence health-related behaviors.[19] One component of the CHEW is a "measurement of the neighborhood and surroundings of the worksite", through which the workplace property and the areas visible from the edge of the property can be characterized.[19] Although the food environment was assessed, limited information was presented about the types of food outlets. Additionally, this measure was not used to make associations between the food environment around work and obesity or dietary behaviors.

The second study, by Jeffrey and colleagues, looked at the association between the workplace food environment and BMI, as well as the frequency of eating at fast food restaurants, among adults in Minnesota.[20] The authors found no association between the proximity of fast food restaurants to the workplace and BMI or eating at fast food restaurants. However, race/ethnicity of the sample population was not discussed and was likely not representative of a diverse population. Additionally, this study only considered the impact of fast food restaurants, which do not represent all sources of unhealthy foods.

Given the amount of time adults spend at their place of work, an important shortcoming of the existing literature on the food environment is the failure to examine the impact of the workplace food environment on health-related behaviors and outcomes in a more diverse sample and with a more comprehensive definition of what constitutes the food environment. An additional shortcoming is the failure to examine the association between the workplace food environment and a range of dietary behaviors, as these are important health-related behaviors to consider. The

purpose of this study is to understand how the food environment around an individual's workplace is associated with obesity and dietary behaviors.

METHODS

Data Source and Population

Data for this study were from the Los Angeles Family and Neighborhood Survey (LAFANS), Wave 2. LAFANS is a longitudinal, population-based survey that collects information about the social environment and physical condition of neighborhoods in Los Angeles, as well as extensive data on demographic and social factors. It also includes a diverse range of health outcomes, including dietary behaviors and anthropometry collected in Wave 2.

LAFANS is based on a probability sample of all neighborhoods throughout Los Angeles County, with an oversample of low-income neighborhoods. The survey sampled census tracts, then census blocks within them, and households within the sampled census blocks. Stratified sampling was used to select the census blocks, with an oversample of poor and very poor census tracts. Survey weights were applied based on the known sampling probability results in an analytic sample that is representative of the population of Los Angeles County. In each household, one adult respondent was selected at random and designated the Randomly Sampled Adult (RSA). In households with children, LAFANS also surveyed one child, the primary care giver (PCG), and one sibling, if applicable. Interviews were

conducted in-person in the sampled households. The survey design and sampling technique are further described elsewhere.[21]

Data for Wave 2 were collected between 2006 and 2008. Wave 2 data includes interviews for adults and children sampled at Wave 1 regardless of whether they moved or continue to live together. Respondents who remained in Los Angeles County were interviewed in person in Wave 2 even if they moved to a new neighborhood. Those who relocated outside of Los Angeles County were interviewed by telephone. In Wave 2 data also includes a sample of "new entrants" – people who moved into the neighborhood between baseline and Wave 2. LAFANS included the geocoded locations of sampled households, as well as workplace locations for working adults.

The secondary source of data is the 2007 Los Angeles County Department of Public Health (LAC DPH) food outlet data, which contains information on all retailers selling food products in Los Angeles County. LAC DPH obtained this data through permits submitted by retailers. The dataset contains information on the type and location of food retailers, and LAC DPH categorizes outlets as restaurants, food stores, and farmer's markets. Food outlets were further categorized as the following types of outlets for the purposes of this study: fast food restaurants, pharmacies, liquor stores, convenience stores (including those in gas stations), dollar stores, grocery stores, warehouse stores, and produce vendors. ArcGIS (Geographic Information Systems) software was used to geocode LAC DPH food outlet data and link it to LAFANS based on the geocoded locations of the respondents' workplace and home locations.

Measures

The outcome measures of interest were obesity status and consumption of fast food, sugar-sweetened beverages, and fruits and vegetables. Body Mass Index (kg/m^2) was based on measured height and weight; respondents with a BMI greater than or equal to 30 were categorized as obese. Fast food consumption was assessed based on responses to the question, "Yesterday, how many times did you eat fast food, such as McDonald's, Burger King, Taco Bell, or Jack in the Box? Make sure you include fast food meals you ate at fast-food restaurants, take out, drive thru, at home or at school or work." Responses were categorized as consuming no fast food or consuming fast food one or more times in the previous day. Soda consumption is based on responses to the question, "Yesterday, how many cans or glasses of soda (such as Coke or Sprite), sports drinks like Gatorade, or other sweetened drinks (Sunny Delight or fruit punch) did you drink? Do not include diet or sugar-free drinks." Responses were categorized as no soda consumption or any soda consumption in the previous day. Fruit and vegetable consumption is based on responses to the following two questions: "Yesterday, how many servings of fruit did you eat? A serving is a small cup of fruit, a handful of grapes, or one piece of fruit, like and apple, orange, or banana" and "Yesterday, how many servings of vegetables, like corn, green beans, green salad, or other vegetables did you have?" Responses to each question were summed and categorized as consuming fruit and vegetables less than three versus three or more servings in the previous day.

The primary predictor of interest is workplace retail food environment, captured by the workplace Retail Food Environment Index (RFEI). The workplace RFEI is a measure of the availability of food outlets near the respondent's workplace that are less likely to carry healthy

foods, such as fresh produce, relative to those that are more likely to have such healthy options available (Figure 1). For each LAFANS respondent the number of fast food restaurants, convenience stores (including those in gas stations), liquor stores, dollar stores, pharmacies, grocery stores, warehouse stores, produce vendors, and farmers' markets within a given radius around the workplace (one-mile in urban areas, two miles in smaller cities and suburban areas, and five miles in rural areas) was determined. Workplaces were assigned to urbanicity levels (urban, suburban, second city, rural) based on population density of the workplace zip. The workplace RFEI was categorized as <6, 6-11, 12-18, 19+, with higher RFEI indicating increasingly more unhealthy food environments. For those individuals who worked in areas that did not contain a grocery or warehouse store, produce vendor, or farmers' market, a zero was placed in the denominator of the equation, resulting in an undefined value for the RFEI. Individuals with an undefined RFEI were categorized separately. The workplace RFEI was not calculated for LAFANS respondents working outside of Los Angeles County since food outlet data was limited to Los Angeles County.

Primary workplace is established through a series of questions in the LAFANS adult survey. Each adult respondent is asked, "Are you currently working?", "How many jobs do you have?", "What is/was the address of your employer, the company you work/worked for, or this business?" If the respondent reports having two or more jobs, he/she is asked to specify which is the main job ("Which one would you say is your main job?"). The respondent is also asked, "For this job, do you usually work at one location, two different locations, or three or more different locations?" The respondent is then asked to verify that the address given is the place where he/she works most of the time. This address was considered the respondent's primary workplace.

The food environment near home, also captured using the RFEI measure, was calculated for each respondent to control for the food environment near home. For each LAFANS respondent the number of fast food restaurants, convenience stores (including those in gas stations), liquor stores, dollar stores, pharmacies, grocery stores, warehouse stores, produce vendors, and farmers' markets within a given radius around home (one-mile in urban areas, two miles in smaller cities and suburban areas, and five miles in rural areas) was determined. Households were assigned to urbanicity levels (urban, suburban, second city, rural) based on population density of the home zip code. Results were categorized as <6, 6-11, 12+. For those individuals who lived in areas that did not contain a grocery or warehouse store, produce vendor, or farmers' market, a zero was placed in the denominator of the equation, resulting in an undefined value for the RFEI.

Other control variables included age, gender, race, and family wealth. Age was measured as a continuous variable. Race included categories for Latino, non-Hispanic white, African American, Asian, and two or more or other races. Family level socioeconomic status was captured using a measure for family wealth, which was constructed by summing self-reports of wages, assets, and transfers. Transfers include disbursements like SSI, pensions, and public assistance. Family wealth was adjusted for family size and transformed to reflect changes in thousand dollars rather than single dollar increments. Due to the skewness, this variable was log-transformed for inclusion in the analyses.

Analyses

Multilevel logistic regression analyses were conducted to examine the association of the workplace food environment with obesity and dietary behaviors. The first model tested the relationship between the workplace food environment and obesity. The second model examined the relationship between the workplace food environment and soda consumption. The third tested the relationship between the workplace food environment and fast food consumption. The fourth model examined the relationship between the workplace food environment and fruit and vegetable consumption. All models controlled for age, gender, race/ethnicity, family wealth, and the home food environment.

The sample included Randomly Sampled Adults (RSA) and Primary Care Givers (PCG) ages 18 and over (N=1884). Individuals who reported they were not currently working were excluded from all analyses (N=663). Additionally, adults who worked outside of Los Angeles County were excluded because food outlet data was limited to Los Angeles County (N=97). Adults who worked from home were also excluded as their work and home food environments overlapped entirely (N=43). Individuals whose workplace or home food environments were undefined were excluded (N=61) because of the inability to calculate a RFEI for them. Individuals who had no food outlets of any kind (N=20), resulting in a zero in the numerator and denominator, were also excluded from the analyses to prevent confusion between a true RFEI of zero (the most healthy food environment) and one with no outlets near the workplace or home. Underweight individuals (BMI <18.5) were also excluded from all analyses (N= 15) because they may be atypical eaters. Final analyses included 782 adults. Data were analyzed with SAS (version 9.3; SAS Institute, Inc, Cary, North Carolina). Analyses were weighted to be representative of the Los Angeles

County population and adjusted for the complex survey design of LAFANS. The University of California Los Angeles (UCLA) Office for Protection of Research Subjects approved this research.

RESULTS

Population Characteristics

Table 1 displays the characteristics of adults included in the sample. The average adult respondent in the sample was 44 years old. The racial/ethnic distribution was 47% Latino, 7% white, 13% Asian, 9% African American, and 30% multiple or other races. The average household income was $42,000. Among respondents included in the sample, approximately 36% were obese, 36% were overweight, and 28% were normal weight. On average, 30% of adults consumed fast food one or more times in the previous day, and 45% consumed soda at least once in the previous day. On the other hand, 45% of respondents consumed three or more servings of fruits and vegetables in the previous day. The average workplace RFEI was 12.7.

Multivariate Results

Table 2 presents the logistic models. The results from the first model indicate that there is a significant relationship between some, but not all, of the workplace RFEI categories and obesity. Relative to individuals with a workplace RFEI below 6, those with a RFEI between 6 and 11 were more likely to be obese [OR = 3.93; 95% CI: (1.76, 8.78)]. Individuals with a workplace RFEI between 12 and 18 were more likely to be obese than individuals with a workplace RFEI

below 6 [OR = 2.31; 95% CI (0.96, 5.55)]; however these results were only marginally significant with a p-value of 0.06. The highest category of the workplace RFEI, indicating the least healthy food environment, was not significantly associated with obesity.

There were no significant associations between the workplace food environment and dietary behaviors.

DISCUSSION

This study examined whether the food environment near the workplace was related to obesity and dietary behaviors. The results suggest that there is no relationship between the workplace food environment and dietary behaviors but there is a positive association with obesity.

The magnitude of the odds ratios for the association between workplace RFEI and obesity decrease as the workplace RFEI increases (that is, as the food environment becomes more unhealthy). This suggests that the effect of the work food environment on obesity may taper off as the food environment becomes saturated with unhealthy food outlets. One explanation is that there is a point at which adding more unhealthy food outlets to a food environment stops having an impact on obesity. In a workplace food environment with 11 fast food outlets and one supermarket, for example, increasing the number of fast food outlets has diminishing effects. This effect diminishes more so in food environments with an even higher ratio of unhealthy to healthier food outlets.

There are both limitations and strengths to this study. A strength of using the LAFANS dataset is that it collects measured height and weight. Although studies have found high correlation between self-reported and measured height and weight, self-reports of these measures tend to underestimate BMI.[22,23] Another strength of this dataset is that it was designed to be representative of the diverse county of Los Angeles, thus results are at least generalizable to Los Angeles County. Los Angeles County is the most populous county in the U.S., with residents living in urban, suburban, exurban, and rural areas. It is also a racially diverse area; in 2000 the population of Los Angeles County was 45% Latino, 31% white, 13% Asian, and 10% African American. In addition, Los Angeles is a major destination for immigrants to the U.S. According to the 2000 Census, 36 percent of adults in Los Angeles County were foreign born. Therefore, results may be generalizable to other parts of California and the U.S.

The cross-sectional nature of the data is a limitation in that there is no way to make causal inferences. The data allow for establishment of associations between predictor and outcome variables, which is nonetheless beneficial in gaining an understanding of how the workplace food environment is related to obesity and dietary behaviors. Another limitation of using LAFANS data is its reliance on self-reported dietary behaviors, which are subject to bias. Food recalls, such as fast food or soda consumptions, are prone to underreporting.[24] Additionally, asking for dietary recalls from the previous day may not be as representative of reality as asking for typical or average weekly behaviors. Some surveys ask respondents, “In a typical day, how many cans/glasses of soda do you drink”. Asking questions in this manner may generate more accurate responses than asking only about the previous day’s behaviors, as they may have been atypical.

The exclusion criteria for this study generated a small sample, creating a weakness. A large portion of the original sample was excluded based on employment status, working outside of Los Angeles County, and working from home. One explanation for the large number of respondents excluded due to employment status is the time frame for LAFANS Wave 2. Wave 2 data were collected between 2006 and 2008, a time of economic distress and high unemployment rates. It is possible that data collected during a different time frame would have allowed for a larger final sample. Wave 1 data, collected from 2000 to 2002, could not be used for this study, as dietary behaviors were not available.

There are also strengths and limitations to using the LAC DPH food outlet data. One of the strengths is the ability to use objective criteria for defining the food environment. However, a weakness is the possibility that food stores are misclassified despite precautions to appropriately categorize the data.

Another limitation of this research is the inability to fully capture the behaviors of individuals using the available data. While LAC DPH food outlet data presents an objective picture of the food environment around the workplace, the data do not allow us to understand how, or even if, individuals interact with their workplace food environment. In the case of meals consumed during work hours, it is unclear if individuals purchase meals from the food environment around work or on their way to work, or if individuals go home for meals or bring food to work from home. Until data on specific food purchasing and consumption behaviors are collected, studies

such as the current one must rely on the assumption that individuals purchase food from the workplace food environment during work hours.

Conclusions

This study begins to fill a major gap in the food environment literature by examining associations between the workplace food environment and obesity and dietary behaviors. Further research is needed to better understand these relationships, and should be done using a larger and more representative dataset.

Future Work

The small final sample, resulting from exclusion criteria applied to an original sample that was not especially large, weakens the confidence of the conclusions of this study. The pattern of the relationships between workplace food environment and obesity and dietary behaviors does not follow the same pattern as results of studies examining the home food environment, calling into question the results of the current study.

In order to understand whether the results of this study may be comparable to those of a study using a larger dataset, logistic regression analyses were conducted to examine the association of the home food environment with obesity and dietary behaviors using both LAFANS Wave 2 data and 2007 California Health Interview Survey (CHIS) data, limited to respondents living in Los Angeles County.

CHIS is a random-digit-dial telephone survey of households and is designed to be representative of California's non-institutionalized population. A 2-stage, geographically stratified design was used to produce a representative sample of the state. Residential telephone numbers were selected from within predefined geographic areas, and respondents were then randomly selected from within sampled households. In recent years CHIS also included a sample of cell phones. The final sample for analyses using CHIS 2007 limited to respondents in Los Angeles County was 11,984 adults. Analyses using LAFANS had a sample between 1,497 and 1,723 adults; differences in sample size across models was due to missing data for measured BMI.

There were minor differences across datasets resulting from inconsistencies in variable construction. Body Mass Index constructed from measured height and weight was available in LAFANS Wave 2 while only self-reported height and weight were available in CHIS. Dietary behavior variables in LAFANS were created from self-reports of the previous day's behaviors, whereas in CHIS they were based on average dietary behaviors from the previous week or month. Thus, fast food consumption in LAFANS was categorized as having eaten fast food one or more times in the previous day, whereas in CHIS it was categorized as having consumed fast food two or more times in an average week. Additionally, LAFANS asked about consumption of sugar-sweetened beverages while CHIS asked only about soda consumption. Finally, CHIS data were linked with food outlet data from InfoUSA and LAFANS data were linked with food outlet data from Los County Department of Public Health. Food outlets in both datasets were categorized using the same criteria.

The food environment near home, captured using the RFEI measure, was calculated for each respondent. Individuals living in areas with no food outlets, as well as those with an undefined home RFEI, were excluded from the analyses. Results were categorized based on univariates, with cut points at 25% and 75%. For LAFANS, home RFEI categories were <7, 7-13.99, and 14+. For CHIS, home RFEI categories were <6.75, 6.75-11.99, and 12+.

The first model tested the relationship between the home food environment and obesity. The second model examined the relationship between the home food environment and sugar-sweetened beverage or soda consumption. The third tested the relationship between the home food environment and fast food consumption. The fourth model examined the relationship between the home food environment and fruit and vegetable consumption. All models controlled for age, gender, race/ethnicity, and family income or wealth.

Results of these analyses reveal inconsistencies across datasets (Appendix 1). In the models examining the relationship between the home food environment and obesity, both datasets found a positive relationship. However, in CHIS the highest RFEI category was statistically significant and had the largest magnitude, whereas in LAFANS the middle RFEI category was statistically significant and had the largest magnitude. In the models examining the relationship between home food environment and fast food consumption, patterns were similar to those of the obesity model. In CHIS the highest RFEI category was statistically significant and had the largest magnitude, while in LAFANS the middle RFEI category was marginally significant and had the largest magnitude. In the models examining the relationship between home food environment and soda or sugar-sweetened beverage consumption, there were no significant associations in

either dataset. The models examining the relationship between home food environment and fruit and vegetable consumption were negatively associated in CHIS and positively associated in LAFANS, with the highest RFEI category being statistically significant in CHIS and the middle RFEI category being statistically significant in LAFANS.

The differing patterns of the results across datasets suggest there may be two issues with the data used. First, LAFANS may not be an appropriate dataset for these analyses, given its small sample size. Second, there may be discrepancies between the two sources of food outlet data used in these analyses. Regardless of what may be causing the problem, the results suggest that further research is needed to draw more confident conclusions about the workplace food environment.

Table 4.1: Descriptive Statistics for Sample Population, LAFANS Wave 2 (2006-2008)

Characteristic	Sample Size	% (SE)
Age		
18-39	353	40.3 (3.1)
40-64	491	55.1 (3.1)
65+	16	4.6 (1.3)
Gender		
Male	555	47.8 (3.1)
Female	305	52.2 (3.1)
Race/Ethnicity		
White	7	0.8 (0.4)
Latino	530	47.7 (3.1)
African American	68	9.0 (2.0)
Asian	49	13.0 (2.5)
Two or more races	192	29.6 (2.9)
Workplace RFEI		
<6	83	13.3 (2.4)
6-11	503	57.2 (3.2)
12-18	175	19.9 (2.3)
19+	71	9.6 (1.7)
Urbanicity of Workplace		
Urban	454	54.1 (3.1)
Suburban/2nd City	326	36.4 (3.0)
Rural	80	8.8 (1.8)
Home RFEI		
<6	64	11.0 (2.2)
6-11	473	53.8 (3.2)
12+	270	35.1 (3.0)
Body Mass Index		
Normal (18.5-24.99)	200	28.2 (3.0)
Overweight (25.0-29.99)	312	36.0 (2.9)
Obese (30.0+)	348	35.8 (2.9)
Sugar-Sweetened Beverage Consumption		
0	455	54.6 (3.1)
1+	386	45.4 (3.1)
Fast Food Consumption		
0	585	70.5 (2.8)
1+	256	29.5 (2.8)
Daily Fruit & Vegetable Consumption		
<3	318	37.8 (3.0)
3+	521	62.2 (3.0)

Table 4.2: Results of multivariate logistic analyses, Los Angeles Family and Neighborhood Survey, Wave 2 (2006-2008)[a]

	Model 1	Model 2	Model 3	Model 4
Outcome	Obesity (BMI ≥30 kg/m2)	Sugar Sweetened Beverage Consumption (1+ sodas yesterday)	Fast Food Consumption (1+ times yesterday)	Fruit & Vegetable Consumption (3+ times yesterday)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Workplace RFEI				
19+	1.62 (0.59, 4.48)	1.39 (0.52, 3.77)	1.36 (0.50, 3.67)	1.65 (0.63, 4.31)
12-18	**2.31 (0.96, 5.55)***	1.68 (0.73, 3.85)	1.03 (0.44, 2.39)	1.03 (0.48, 2.22)
6-11	**3.93 (1.76, 8.78)*****	1.22 (0.56, 2.63)	1.71 (0.79, 3.69)	1.06 (0.52, 2.12)
<6 (ref)	—	—	—	—
Age	1.01 (0.99, 1.03)	**0.97 (0.95, 0.98)*****	**0.96 (0.95, 0.98)*****	1.01 (0.99, 1.02)
Gender				
Female (ref)	—	—	—	—
Male	0.73 (0.49, 1.09)	**3.41 (2.24, 5.20)*****	**2.27 (1.49, 3.47)*****	**0.44 (0.30, 0.66)*****
Race/ethnicity				
White (ref)	—	—	—	—
Latino	**3.73 (2.07, 6.70)*****	1.33 (0.73, 2.42)	0.76 (0.43, 1.37)	**0.56 (0.31, 0.99)****
Black	**7.46 (3.53, 15.75)*****	0.63 (0.28, 1.43)	0.80 (0.37, 1.74)	**0.38 (0.17, 0.81)****
Asian	**0.41 (0.17, 0.97)****	0.93 (0.44, 1.96)	**0.33 (0.15, 0.74)*****	**2.66 (1.27, 5.59)*****
Multiple Race/Other	4.92 (0.29, 82.08)	0.02 (0, 195782.92)	0.03 (0, 237550.2)	0.32 (0.02, 6.33)
Family Wealth	0.98 (0.81, 1.19)	**0.62 (0.5, 0.77)*****	**0.85 (0.71, 1.02)***	0.92 (0.76, 1.11)
Home RFEI				
<6 (ref)	—	—	—	—
6-11	0.71 (0.26, 1.96)	1.27 (0.42, 3.8)	**0.43 (0.16, 1.16)***	**4.57 (1.7, 12.28)*****
12+	0.56 (0.19, 1.62)	1.11 (0.35, 3.49)	0.42 (0.15, 1.19)	**4.37 (1.53, 12.42)*****

[a]Sample size is 782 adults age 18 and over. Results are weighted to be representative of the population of Los Angeles County and are adjusted for complex survey design effects.

*p<0.10; **p<0.05; ***p<0.01

F&V, fruits and vegetables; OR, odds ratio; CI, confidence interval

Figure 4.1: Retail Food Environment Index Equation

$$\text{RFEI} = \frac{\#\,\text{Fast Food Restaurants} + \#\,\text{Convenience Stores} + \#\,\text{Liquor Stores} + \#\,\text{Dollar Stores} + \#\,\text{Pharmacies} + \#\,\text{Grocery Stores}}{\#\,\text{Grocery Stores} + \#\,\text{Warehouse Stores} + \#\,\text{Produce Stores} + \#\,\text{Farmers' Markets}}$$

Appendix 4.1: Results of multivariate logistic analyses, Los Angeles Family and Neighborhood Survey, Wave 2 (2006-2008) and California Health Interview Survey, 2007

	Obesity	Soda/SSBs Consumption	Fast Food Consumption	Fruit & Vegetable Consumption
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
CHIS 2007	N=11,984	N=11,984	N=11,984	N=11,984
Home RFEI				
12+	1.37 (1.1, 1.7)***	1.08 (0.89, 1.31)	1.41 (1.15, 1.72)***	0.77 (0.63, 0.94)***
6.75-11.99	1.08 (0.88, 1.31)	0.96 (0.81, 1.13)	1.05 (0.88, 1.26)	0.93 (0.79, 1.1)
<6.75 (ref)	--	--	--	--
LAFANS Wave 2	N=1,497	N=1,723	N=1,723	N=1,721
Home RFEI				
14+	1.37 (0.86, 2.17)	1.04 (0.65, 1.66)	1.03 (0.61, 1.76)	1.37 (0.86, 2.17)
7-13.99	1.6 (1.1, 2.32)***	0.93 (0.64, 1.36)	1.47 (0.96, 2.26)*	1.6 (1.1, 2.32)***
<7 (ref)	--	--	--	--

*p<0.10; **p<0.05; ***p<0.01
OR, odds ratio; CI, confidence interval

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