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Individual and neighborhood differences in diet among low-income foreign and U.S.-born women

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Abstract

Background—Research on the "Immigrant," or "Latino health paradox" has demonstrated that Latinos exhibit better health than U.S.-born whites, for multiple health outcomes, despite adjusting for socioeconomic status. However, little empirical research has focused on women and even less has focused on how the neighborhood residential environment is associated with these health differences, particularly in the area of diet.

Methods—We analyzed baseline data from 641 low-income women, nested within 184 census tracts, enrolled in a nutrition intervention trial for postpartum women. Individual-level variables, including race/ethnicity, nativity and duration of time in the United States, language acculturation, emotional and instrumental support, and socioeconomic position, were merged with tract-level variables from U.S. Census data (2000) based on residential address. We assessed daily fruit and vegetable servings through a semi-quantitative food frequency questionnaire. Using MLWin 2.0 software, we employed a 2-level linear regression model to ascertain associations of neighborhood immigrant, racial, and socioeconomic composition with individual diet, adjusting for individual-level socio-demographic characteristics.

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Competing interests
The author(s) declare that they have no competing interests.

Authors' contributions
T. Dubowitz designed the study, performed the analyses, and wrote the article. SV Subramanian, D. Acevedo-Garcia, T.L. Osypuk and K.E. Peterson assisted and guided with decisions regarding the research design, analysis, editing, and interpretation of the findings.

Results—In our fully adjusted model, we observed a statistically significant increase of 1/3 of fruit and vegetable daily servings for each 10 percentage point increase in the tract foreign born population. Each 10 percentage point increase in the tract Black population was associated with a significant 1/5 serving decrease in individual daily fruit and vegetable intake.

Conclusions—Among this population of U.S. and foreign-born women, neighborhood composition was associated with individual diet, above and beyond individual level characteristics, illuminating neighborhood context, immigrant health and diet.

Background

Latinos are the largest and most rapidly growing minority group in the United States (U.S.), and the most current census estimates shows that of the U.S. Latino population, 43% are born outside of the U.S. (Lollock, 2001). Research on the "Immigrant," or "Latino health paradox" has demonstrated that Latinos exhibit better health than U.S.-born whites, for outcomes that include birthweight, infant mortality, and diet, despite adjusting for socioeconomic status (Singh & Siahpush, 2001; Sorlie, Backlund, Johnson, & Rogot, 1993; Abrams & Guendelman, 1995; Norman, Castro, Albright, & King, 1994; Dubowitz, Smith-Warner, Acevedo-Garcia, Subramanian, et al., in press). Little empirical research, however, has focused on women's immigrant health and diet and limited research has examined characteristics of the neighborhood residential environment with respect to health and dietary behaviors across nativity groups (immigrants and U.S.-born populations). This study addresses this gap, and investigates how neighborhood context might be associated with diet above and beyond individual level factors, among a population of predominantly Latina foreign and U.S.-born, low-income women in Massachusetts.

Immigrants and Diet

National and community-based studies have documented health advantages of being foreign born (compared to U.S.-born), a phenomenon that seems to erode the longer an immigrant's residence in the U.S. In a sample of U.S.-born non-Hispanic (NH) white and first and second generation Hispanic women (immigrants and those with an immigrant parent), first-generation Mexican-American women had a higher average intake of protein, vitamins A, C, and folic acid, despite lower socioeconomic status than second-generation or NH White women (Abrams & Guendelman, 1995). Other studies have shown lower fruit and vegetable intake with longer duration in the U.S. and greater acculturation (Jones, 2002; Neuhouser, Thompson, Coronado, & Solomon, 2004; Lin, Bermudez, & Tucker, 2003; Winkleby, Albright, Howard-Pitney, Lin, et al., 1994; Gordon-Larsen, Harris, Ward, & Popkin, 2003). Among immigrants, increasing number of years of residence in the United States is associated with higher body mass index or obesity (Lin, Bermudez, & Tucker, 2003; Winkleby, Albright, Howard-Pitney, Lin, et al., 1994; Gordon-Larsen, Harris, Ward, & Popkin, 2003). These studies, however, have not examined the residential context of immigrants as an independent correlate of diet.

Residential Context and Diet

Spatial separation of population groups along racial/ethnic lines is a central feature of the social organization of U.S. urban areas (Massey & Denton, 1988; Massey, White, & Voon-Chin, 1996; Logan, 2003; Galster, Metzger, Waite, 1999; Acevedo-Garcia, Lochner, 2003). Blacks and, to a lesser extent, Latinos, are segregated residentially in the US. (Jargowsky, 1997; Logan, 2003). Further, there are complex social processes that play into factors such as race/ethnicity, income and wealth and immigrant status/nationality – which can work together – to guide immigrants' place of residence in the U.S. Census data has shown that residential patterns exist among immigrants, and among groups of immigrants (i.e. Mexican, Dominican and Chinese immigrants) (Logan, 2003).

Literature that has linked racial and socioeconomic residential segregation to diet has examined how living in higher or low quality neighborhoods may affect the diet of groups living in those areas (Shohaimi, Welch, Bingham, Luben, et al., 2004; Morland, Wing, & Diez-Roux, 2002; Diez-Roux, Nieto, & Claufield, 1999; Moore & Diez-Roux, 2006; Morland, Wing, Siez Roux, et al., 2002; Block, Scribner, & DeSalvo, 2004; White, Bunting, Williams, Raybould, et al., 2004). Residence in more affluent neighborhoods is associated with increased intake of fruit and vegetables (Shohaimi, Welch, Bingham, Luben, et al., 2004; Morland, Wing, & Diez-Roux, 2002; Diez-Roux, Nieto, & Claufield, 1999), whereas residence in lower socioeconomic status areas (as measured by education level and poverty) is associated with lower consumption (Morland, Wing, & Diez-Roux, 2002; Diez-Roux, Nietom, & Claufield, 1999). Better diet may result from improved access to healthy food, or from exposure to unhealthy food, i.e., fast foods that is systematically patterned across different types of neighborhoods. For instance, low income and minority neighborhoods have higher concentrations of fast food establishments (Moore, & Diez-Roux, 2006; Morland, Wing, Diez-Roux, & Poole, 2002; Block, Scribner, & DeSalvo, 2004). Still, the research has shown that a complex picture exists with respect to access and availability of food purchasing places (White, Bunting, Williams, Raybould, et al., 2004), including that of competing responsibilities such as work and/or access to transportation (Dubowitz, Acevedo-Garcia Salkeld, et al. 2007).

Despite the existence of immigrant enclaves, research has not related diet to the residential context of immigrants (Bartel, 1989). These enclaves may confer benefits such as informational or social networks (Chiswick & Miller, 2002), which may contribute to the structural food environment in that culturally appropriate foods may be more available and/or more easily accessed. This study therefore attempts to fill this gap in the diet literature, by examining how neighborhood residential context affects fruit and vegetable consumption in a sample of predominantly Latina foreign and U.S.-born women living in two urban areas in the Northeast U.S.

Postpartum women, immigrant status and residential context

The period following the birth of a child is a time of exceptional transition in psychosocial and physical needs, time and role conflicts, and self-care and physical health for mother and child (Peterson et al., 2002). Changes in lifestyle and child-rearing responsibilities, alongside of increased risk for social isolation and poor health status can exacerbate already sub-optimal dietary intake among low-income women (Peterson et al., 2002). Research has highlighted the obstacles many low-income mothers face, with limited social support such as childcare, access to transportation, time-management skills, and feelings of depression compared with that of middle-aged employed women (French, Neumark-Sztainer, Story, & Jeffery, 1998). Life-course experiences and family and social roles have been found to contribute toward dietary intake in low to moderate income adults (Devine, Wolfe, Frongillo & Bisogni, 1999). Particularly among immigrant women, there are often cultural, linguistic, and informational barriers that come into play with both their health and nutritional status. Prior research among this sample demonstrated that acculturation was associated with decreased fruit and vegetable intake (Dubowitz et al., in press; Dubowitz, Acevedo-Garcia, Salkeld, et al. 2007).

Methods

Study Population

Our investigation used baseline data from 679 low-income women enrolled in an intervention trial for postpartum women, the primary objective of which was to improve diet and increase physical activity (Peterson, Sorensen, Pearson, Hebert, et al., 2002). Women 18 to 44 years old were enrolled in the trial between March 2001 and January 2003 at between 6 and 20 weeks after delivering a child, had a household income at or below 185% of the poverty line and were

income-eligible for the United States Department of Agriculture (USDA) Special Supplemental Food Program for Women, Infants, and Children (WIC) (Willett, Sampson, & Stampfer, 1985). Other eligibility criteria included: no health condition or psychosocial problem that would limit participation in the intervention, infant birth weight greater than 1500g, and regular access to a working telephone. All women lived in the Boston or Springfield, Massachusetts greater metropolitan areas. Bilingual research staff obtained informed consent and administered baseline surveys in appropriate languages in women's homes, lasting approximately forty-five minutes. The study protocol was reviewed and approved by the Institutional Review Board of the Harvard School of Public Health and other participating institutions.

Individual-level Measures

Daily servings of fruit and vegetables were summed from twelve questions, part of a semi-quantitative 61-item food frequency questionnaire originally described by Willett in 1985 (Willett, Sampson, Stampfer, et al., 1985) and validated in several cohorts (Hu, Rimm, Smith-Warner, Feskanich, et al., 1999). For the present study, in order to increase the salience of the FFQ in low-income, multiethnic women, we added examples of specific fruits and vegetables that were reported as 'regularly eaten', as elicited during focus groups among Latinas and African Americans who came from the same sample pool as women in the original intervention trial.

The questions ascertained usual fruit and vegetable consumption during the past four weeks. Response categories ranged from 'never' to '6+ times/day.' Individual servings of fruits and vegetables were added and averaged over a seven-day period, to calculate average daily servings. Race/ethnicity was self-reported. All women who reported being Latina (or Hispanic) were analyzed as Latina regardless of race. Racial groups, excluding Hispanics, included non-Hispanic (NH) White, NH Black, NH Asian/Pacific Islander, and NH Native American and NH 'other'. The latter three categories were collapsed into 'non-Hispanic other' due to small numbers. Nativity was categorized as foreign or U.S.-born. Women born in any of the U.S. territories, such as Puerto Rico, were analyzed as foreign-born. Nativity and duration of residence in the United States were combined and modeled as U.S.-born, or foreign born living in the U.S. for different lengths of time: fewer than 5 years, 5–9 years, 10–14 years, or 15 years and longer. Language acculturation was captured through the response to "language in which a respondent usually speaks at home," categorized into those who were native English speakers or not, and if not, were further categorized into: speaks Spanish or another language at home, speaks English at home, or speaks both English and Spanish or other language at home. Instrumental and emotional aspects of social support were measured through the subsection of the Medical Outcomes Survey (MOS) scale, consisting of eight questions, each answered on a Likert five-point scale. The questions were combined and scored on a continuous scale, ranging from 8 to 40, where higher values indicated more support[33]. Annual household income was categorized into earning less than but not equal to $10,000, between $10–20,000, and more than but not equal to $20,000 per year; missing values were modeled as a separate category. Education was categorized into four levels: elementary or some high school; completion of high school or GED; vocational school, some college or associate degree; and bachelor degree, post graduate degree, or other. Age was modeled continuously.

Neighborhood-level Measures

We approximated 'neighborhoods' of study participants using tracts defined by the US Census Bureau, containing 4000 persons on average and considered to be "relatively homogenous with respect to population characteristics, economic status, and living conditions"(Lollock, 2001). Residential segregation by both race/ethnicity and nativity was approximated by proportions of the census tract population that were NH black, NH white, Hispanic and foreign-born. Tract-

level socioeconomic measures included proportion of the population under the Federal poverty line, median household income, and median value of owner occupied homes. All proportions were modeled as continuous variables, multiplied by 100 for ease of interpretation. Tract variables were obtained from the Neighborhood Change Database of Census 2000 tract-level data (Geolytics, Inc., 2002).

Data Merge

For each woman enrolled in the trial, residential addresses were geocoded to a latitude/longitude (X/Y) coordinate using the US Census Topographically Integrated Geographic Encoding and Reference System (TIGER) files through Geographic Information Systems (ArcView GIS) and the US Bureau of the Census geocoding Web site. We geocoded 662 (97.5%) of the 679 participants at baseline. The seventeen remaining women were not geocoded because of: lack of a stable address, address of a hotel or non-residential location, or the inability to establish an X/Y coordinate. Each set of the 662 coordinates was then matched to a Census tract identifier, using ArcView GIS and the US Bureau of the Census website.

Women who missed responses to three or more of the twelve questions regarding fruit and vegetable consumption (n=6) or who consumed more than twenty servings per day (n=2) were excluded from the individual-level data. We examined the distribution of number of servings per day of fruits and vegetables and found that those individuals who consumed more than 20 servings of fruits and vegetable per day (n=2) were obvious outliers to the distribution. We then merged tract-level variables from the Neighborhood Change Database, with geocoded coordinates and tracts. Data with both individual-level predictors and tract-level predictors for 641 women comprised our final analytic sample.

Analysis

We examined frequencies and distributions to identify extreme or improbable values for daily servings of all fruit, all vegetables and fruit and vegetable intake combined. We studied the distribution of variables of interest and covariates on both individual-level and tract-levels (See Table 1 for variables) and assessed collinearity between independent variables of interest by computing Pearson and Spearman rank correlations and Chi square tests.

Our model building process began with a null multilevel model of individual level fruit and vegetable consumption, with no predictor variables, of individuals nested within tracts (Model 1). Model specifications allowed the outcome to vary between tracts and between individuals within tracts to estimate the variance of the outcome attributable to each level (random intercept models). Next, we added tract-level variables one at a time (bivariate fixed effect models) to examine associations between individual-level fruit and vegetable consumption and the tract-level demographic and socioeconomic variables (Models 3a–3g).

We then added individual-level demographic characteristics shown in prior analysis with this sample to have statistically significant associations with fruit and vegetable intake, including nativity and duration of time in the United States, language acculturation, race/ethnicity, and age (Dubowitz, Smith-Warner, Acevedo-Garcia, Subramanian, in press). Also included were individual-level factors of conceptual importance, including instrumental/emotional support and education (Model 4a). We retained those tract-level variables with significant associations ($p<.05$) in the presence of individual-level factors (Models 4b and 4c).

Finally, we modeled a cross-level interaction between individual level nativity and significant tract-level variables, e.g. percent of foreign born in the neighborhood. This 2-level linear regression was executed with MLWin Version 2.0 multilevel statistical software.

Results

Table 1 summarizes individual-level descriptive statistics and daily fruit and vegetable intake, adjusted for age and tract level clustering. Among women comprising the analytic sample, 72% were Latina (n=477) and over one half of the women were born outside the U.S. Fifty-seven percent of the women reported a household income of less than $20,000/year.

As shown in table 2, the median household annual income of the census tracts represented was $30,104 and median value of owner-occupied homes was $131,214. Pearson correlations demonstrated significant correlations between individual fruit and vegetable intake and tract: proportion of foreign-born (.28 p<.0001), proportion of Hispanics in poverty (−.11 p<.005) and proportion of Hispanics (.07 p<.10).

As noted in Table 3, in the null model (Model 1), we observed that the women in our sample had an average of 5.2 daily servings of fruit and vegetables, and that 11% of the variance in fruit and vegetable intake occurred at the tract level (intra-class correlation coefficient, ICC = 11.4%), while 89% of variance was at the individual level.

In crude associations of tract-level variables (Models 3a–3g), only proportion of foreign born population demonstrated a statistically significant association with individual fruit and vegetable consumption at p=.05 (Model 3a). Each additional 10% of foreign-born population in the tract was associated with .65 more servings of fruits and vegetables daily. In this model, 3.6% of the variance of fruit and vegetable intake was at the neighborhood level, a reduction from the null model (11.4%) – indicating that entering the tract proportion foreign born variable reduced tract-level variance in fruit and vegetable intake by 68%.

Table 4 shows significant associations between fruit and vegetable intake and age, nativity, native language race/ethnicity, and social support, (Table 4, Model 4a). Foreign-born women living in the U.S. between 0 and 14 years had significantly higher consumption than the U.S.-born, although foreign-born living in the U.S. for more than 14 years did not have significantly different consumption. We found that older women had higher consumption, as did Latina women, compared with White women. Women with higher levels of social support had higher fruit and vegetable intake. After inclusion of individual-level factors, tract-level variance was not significant (variance=.31, standard error=.26). Thus, the significant variance we observed in the null model may have been due to the differential demographic and socioeconomic composition of women across neighborhoods.

In our models with both individual-level and tract-level variables, we found that each additional 10 percentage points of foreign born population in the tract translated to an individual increase in 0.3 fruit and vegetable servings daily. We observed a significant inverse association between proportion of Black population in the census tract and individual-level daily servings of fruit and vegetables (Models 4c and 4d). For each additional 10 percentage points of black population as a proportion of the tract, individual fruit and vegetable consumption decreased by approximately 0.2 servings per day. Nativity and duration of time in the U.S., language acculturation, age, race/ethnicity, and social support continued to have significant associations with fruit and vegetable intake at p<.05 in the presence of tract-level variables, as exhibited in Table 4, Models 4b– 4d.

When we examined the cross-level interaction effect between tract-level proportion of foreign-born and individual level nativity, we observed a non-significant association of .2 more per daily servings for foreign-born individuals for each additional 10 percentage points of foreign-born in their neighborhood, as compared with US-born individuals (model not shown).

Discussion

In this population of foreign and U.S.-born women of reproductive age, after accounting for individual-level factors of nativity and duration of time in the U.S., language acculturation, race/ethnicity, and education, we found that higher proportions of foreign-born and Blacks on the tract-level, were both independently associated with individual dietary intake. We also observed that compared with U.S.-born women, foreign-born women had higher fruit and vegetable consumption; recent immigrants (<14 years) had higher fruit and vegetable intake than those in the US for longer periods of time (15 years or more). Our research did not show significant associations between individual-level fruit and vegetable consumption and tract-level measures of area socioeconomic position (tract-level poverty rate, owner-occupied median housing price, median household income). However, we note that the socioeconomic status (income level) of our population was relatively homogeneous, as all women were low-income. Therefore, as might be expected, there was limited variation in tract-level measures of area socioeconomic position.

Emphasis on diet and nutrition for women has highlighted the importance of adequate nutrition especially for pregnancy outcome. Although the postpartum period is equally noteworthy (and programs such as Special Supplemental Program for Women Infants and Children continue to stress the importance of diet during this period to facilitate adequate nutrition of the mother and her child), numerous studies have found that there is a negative impact on dietary behaviour when women transition from pregnancy to postpartum (George, GC et al 2005; Baric L and MacArthur C, 1977; Guendelman S and Abrams B, 1994). Research that reviewed the nutritional status of WIC Participants revealed that pregnant and post-partum women were not consuming the recommended amount of several important nutrients, including iron, calcium, folic acid, zinc, and magnesium (Kramer-LeBlanc et al 1999). Thus, the postpartum life period of women in this study adds a unique and important perspective to our overall findings.

Our results expand literatures of residential segregation and health to incorporate immigrant enclaves, and expand the immigrant-health literature to incorporate neighborhood context. We found that women who lived in immigrant neighborhoods demonstrated higher fruit and vegetable intake, regardless if they themselves were immigrants. Thus, one important question that emerges from this work is what it might be about immigrant neighborhoods that may improve diet. We hypothesize that immigrant neighborhoods may have differential material resources that improve diet (e.g. better supply or availability of produce, or fewer unhealthy resources like access to fast foods high in added sugars and fats). Immigrants may settle near other immigrants for many reasons, including location of family and friends from earlier migrations, language, or employment opportunities (Chiswick & Miller, 2002). Language networks preserve cultural norms of healthier diet, or increased fruit and vegetable intake, which could explain better diets in immigrant neighborhoods, regardless of nativity. Wilson and Portes have posited that enclave economies promote immigrant socioeconomic advancement by increasing social capital (Wilson & Portes, 1980) or collective efficacy (Browning, Cagney 2002). Thus, social capital built by immigrants in immigrant neighborhoods may benefit not only immigrants, but also U.S.- born, for instance by building an infrastructure of immigrant-run food purchasing points, that stock culturally-appropriate foods (i.e. higher amounts of produce). Additionally, research has shown that acculturation, particularly in Latino populations in the U.S., is associated with less healthy behaviors and health outcomes (Abraido-Lanza, Chao, & Florez, 2005).

We observed that as the proportion of black population in a neighborhood increased, women had lower average of fruit and vegetable consumption. Much of the racial segregation literature has shown how differential neighborhood risks and resources are distributed across racial lines, which often operate in conjunction with concentrated poverty to influence health (Massey,

Denton, 1988; Williams, Collins, 2001; Williams, 1996; Williams, 1997, Williams, 1998, Massey, Denton, 1993). We might have found a detrimental diet effect in black neighborhoods due to increased presence of fast food, or decreased presence of healthy food. For instance, some studies have documented presence of fewer grocery stores/supermarkets (Moore, Diez-Roux, 2006; Morland, Wing, Diez-Roux, 2002) in black neighborhoods, compared to white neighborhoods. Alternately, there may be other neighborhood characteristics, such as less developed transportation infrastructure, or lower neighborhood walkability and access to services, which facilitate women's shopping at healthier venues outside of their own neighborhood.

Limitations and Conclusion

In addition to the cross sectional nature of our study, the selection process of individuals' residence into neighborhoods is challenging to all neighborhood observational studies, and limits our ability to draw causal inferences. Our modeling strategy used methods that allowed intercepts of our outcome to vary across neighborhoods, forcing an equivalent slope between each variable and the outcome across all neighborhoods, which may be an unrealistic assumption. However, because of sample size limitations within tracts, we had limited power to estimate differential slope models. Research on 'neighborhoods' is additionally limited by the way in which such geographic spaces are conceptualized and operationalized (Macintyre, Ellaway, & Cummins, 2002).

Our results are generalizable to a specific population: low-income immigrant and U.S.-born women of reproductive age. Yet, pregnancy and postpartum periods are of substantial public health consequence (for both mother and child). Additionally, our sampled population represents a substantial and growing population in the U.S.

The nativity composition of our sample complicates the interpretability of our results. The U.S. born women were drawn mostly from one metropolitan area while the foreign-born women were drawn mostly from another metropolitan area. Thus, our nativity effects may actually be place-specific effects of different metropolitan areas. However, if we had stratified on metropolitan area, we would not have had power to test nativity, which was the main motivation for this analysis. A further limitation regarding nativity is that all Latino women were grouped together as 'first, second or third generation immigrants' despite their country of origin. We know that there is incredible heterogeneity within the United States Latino population and most notably – Puerto Rican women were grouped as 'foreign-born.' However, the original questionnaire was worded so that women born in Puerto Rico list themselves as 'foreign-born,' and the birthplace is not specified in the data.

Our analysis found associations on both individual *and* neighborhood levels with individual diet. The findings highlighted potential mechanisms such as social and language networks in different racial and nativity groups. Women living in neighborhoods with higher proportions of foreign-born individuals exhibited higher fruit and vegetable consumption independent of other individual level factors. Women living in neighborhoods with higher proportions of Black individuals exhibited lower fruit and vegetable consumption. Our results expand the residential segregation and Latino health literature, to suggest that immigrant neighborhoods may be beneficial to the diet of women who live there, regardless of whether the women themselves are U.S. or foreign born.

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Table 1

Selected sociodemographic characteristics and age-adjusted mean daily fruit and vegetable servings (n=662)

Variable	n	Percentage	Mean Daily Servings of Fruit and Vegetables	Confidence Interval
Overall	662	100	5.2	(5.0, 5.5)
Race/ethnicity				
Latina	477	72	5.7	(5.4, 6.0)
Black	49	7	4.8	(3.8, 5.8)
White	103	16	3.5	(2.8, 4.1)
Other	33	5	4.3	(3.2, 5.5)
Nativity/Duration of Time in U.S.				
Native Born	294	44	4.0	(3.7, 4.4)
Foreign born, in US 15+ yrs	87	24	4.9	(4.3, 5.6)
Foreign born, in US 10 – 14 yrs	81	22	5.8	(5.1, 6.5)
Foreign born, in US 5– 9 yrs	84	23	7.0	(6.3, 7.7)
Foreign born in US ≤4 yrs	107	29	7.0	(6.4, 7.6)
First/native language				
English	219	33	3.8	(3.4, 4.3)
Spanish	436	67	6.0	(5.6, 6.3)
Language at home (among Spanish native speakers)*				
Speak English	32	8	3.6	(2.3, 4.9)
Speak Spanish	271	64	6.3	(5.8, 6.7)
Speak both	122	29	5.9	(5.3, 6.6)
Income category				
<$10,000	229	36	4.9	(4.4, 5.3)
$10,000 – $20,000	133	21	5.1	(4.5, 5.6)
>$20,000	161	25	5.2	(4.7, 5.8)
Missing	118	18	5.8	(5.2, 6.4)
Education				
Less than HS	221	34	5.6	(5.1, 6.1)
Completed HS or GED	231	35	5.1	(4.6, 5.5)
Vocational, some college	171	26	5.0	(4.5, 5.5)
Bachelors, postgraduate, other	30	5	4.3	(3.1, 5.6)

Note: ‘Language at home (among Spanish native speakers)’ contains 9 missing responses, modeled as floating missing reponses in the models.

Table 2

Census Tract-Level Variables, U.S. Census 2000 (n=184)

	Mean Value	St. Deviation	Median	* Pearson Correlation with fruit and vegetable intake
Proportion NH Black	.20	.22	0.11	−0.06
Proportion White	.54	.24	0.55	0.01
Proportion NH White	.42	.28	0.38	−0.05
Proportion Hispanic	.36	.25	0.29	0.07*
Proportion foreign-born	.18	.14	0.13	0.28***
Proportion of the population under the poverty line				
Proportion of Whites under Poverty	.23	.14	0.19	−0.01
Proportion of Blacks under poverty	.30	.16	0.35	−0.04
Proportion of Hispanics under poverty	.36	.16	0.35	−0.11**
Median Household Annual Income	30,104	11,626	31,516	0.01
Median Value Owner-occupied homes	131,214	99,350	105,200	0.01

* Correlations are crude i.e. unadjusted for clustering or tract level and/or individual level variance.

* p<.10

** p<.005

*** p<.0001

Table 3

Null and Bivariate Two-Level Linear Regression Results of Tract-level variables Predicting Number of Daily Fruit and Vegetable Servings.

	Null model	**Bivariate models**					
	Model 1	**Model 3a**	**Model 3b**	**Model 3c**	**Model 3d**	**Model 3e**	**Model 3f**	**Model 3g**
	Parameter Estimate (standard error)	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**	**Parameter Estimate (standard error)**
FIXED PART								
Intercept	5.186 (.163)	3.97 (.238)	5.28 (.304)	5.29 (.226)	4.95 (.26)	5.18 (.334)	5.03 (.47)	4.95 (.33)
Tract-level variable								
Proportion Foreign Born		.065 (.011)***						
Proportion NH White			−.003 (.006)					
Proportion Black				−.007 (.007)				
Proportion Hispanic					.006 (.007)			
Proportion below Poverty						−.002 (.012)		
Median Household income							.032 (.138)	
Median value owner-occupied homes								.013 (.023)
RANDOM PART								
Individual Level Variance	9.77 (.61)	9.88 (.60)	9.77 (.61)	9.77 (.61)	9.78 (.61)	9.77 (.61)	9.76 (.61)	9.73 (.61)
Tract Level Variance	1.26 (.46)	.37 (.30)	1.19 (.45)	1.17 (.44)	1.17 (.44)	1.21 (.45)	1.21 (.45)	1.23 (.45)
TOTAL VARIANCE	11.04	10.25	10.96	10.94	10.95	10.98	10.97	10.96
Intraclass Correlation Coefficient (ICC)	11.4%	3.6%	10.9%	10.7%	10.7%	10.2%	11.0%	11.0%

*** p<.0001

NOTE:All proportions (i.e. proportion foreign born; proportion NH white; proportion black, etc) were multiplied by 100 for ease of interpretation, so that each unit increase is equivalent to an increase of 1 percent. For median household income and median value of owner-occupied homes, each unit increase represents an increase in $10,000

Table 4

Two-Level Multiple Linear Regression Results, Predicting Number of Daily Fruit and Vegetable Servings.

	Model 4A	*Model 4B*	*Model 4C*	*Model 4D*
	Individual- level Variables	**Final Model with Individual + Tract-level Variables**	**Final Model with Individual + Tract-level Variables**	**Final Model with Individual + Tract-level Variables**
Intercept	2.912(.729)***	2.521 (.751)***	3.202 (.747)***	2.794 (.754)***
Fixed Effects – Individual Level				
Age (centered on its mean)	.055(.023)*	.055 (.023)*	.055 (.023)*	.052 (.023)*
Ethnicity				
Latina	Ref	Ref	Ref	Ref
Black	.272 (.515)	.258(.511)	.408 (.516)	.447 (.513)
White	−.940 (.422)*	.866 (.420)*	−1.057 (.423)*	−.981 (.420)*
Nativity and Duration				
Native Born	Ref	Ref	Ref	Ref
Foreign born, in US 15+ yrs	−.438 (.690)	.016 (.528)	−.015 (.527)	.035 (.526)
Foreign born, in US 10 – 14 yrs	1.3 (.53)*	1.236 (.546)*	1.422 (.549)**	1.388 (.547)*
Foreign born, in US 5– 9 yrs	2.1 (.56)***	2.071 (.572)***	2.129 (.569)***	2.036 (.569)***
Foreign born in US ≤ 4 yrs	2.04 (.533)***	2.036 (.549)***	2.098 (.546)***	1.974 (.547)
Language spoken at home				
Speak Spanish as native language	Ref	Ref	Ref	Ref
US Born - speak English	−.133 (.548)	.189 (.573)	−.066 (.562)	.186 (.571)
Speak English	−.438 (.690)	−.206 (.692)	−.258 (.690)	−.146 (.689)
Speak Both	.950 (.405)*	1.172 (.417)**	.976 (.414)*	1.111 (.416)**
Education				
Some high school	Ref	Ref	Ref	Ref
High school grad or GED	−.242 (.296)	−.236 (.295)	−.172 (.296)	−.173 (.295)
Some college, associate degree or technical	−.315 (.338)	−.315 (.340)	−.229 (.343)	−.229 (.341)
Bachelors or post grad	−.454 (.619)	−.466 (.615)	−.385 (.616)	−.397 (.613)
Instrumental/emotional support	.053 (.017)***	.046 (.017)**	.049 (.016)**	.044 (.017)**
Fixed Effects – Tract Level				
Proportion of Foreign Born Population in Tract (×100)		.024 (.011)*		.029 (.011)**
Proportion of Black population (×100)			−.014 (.006)*	−.016 (.006)*
Random Effects				
Individual Level Variance	9.052 (.553)	9.080 (.553)	8.957 (.550)	9.026 (.213)
Tract Level Variance	.306 (.264)	.138 (.225)	.271 (.254)	.094 (.213)
TOTAL Variance	9.358	9.218	9.228	9.12
Intracluster Coefficient (ICC)	0.033	.01497	.0294	.0103

*** $p < .0001$

** p<.005

* p<.05