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Fruit and Vegetable Intake and Food Store Access: A Cross-Sectional Survey Study in Ypsilanti, Michigan

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Abstract

Given declines in supermarkets in Washtenaw County, Michigan (MI), we aim to characterize the relationship between food store access and fruit and vegetable intake in Ypsilanti, MI. A cross-sectional, convenience sample survey was conducted in March 2011 at the Ypsilanti District Library (n=83). Self-reported food store access, perceived food environment, and fruit and vegetable intake were assessed. Linear and logistic regressions were performed between store access, fruit and vegetable intake, and meeting dietary recommendations. Perception was evaluated for effect modification. Adjusting for demographics, each food store within one mile of participants' homes increased odds of meeting recommended intake by 105% (OR 2.05, 95% CI: 1.02, 4.10). However, contrary to previous literature, each additional minute to the food store was associated with consumption of 0.37 (95% confidence interval [CI]: 0.10, 0.64) more servings of fruits and vegetables per day. Perception was not a statistically significant effect modifier, but data suggest differences for those with divergent perceptions. Food environment is associated with fruit and vegetable intake in Ypsilanti, MI. Inconsistent findings suggest that programs should focus on enhancing the food environment within the context of perceptions and preferences.

Keywords : Vegetables; Fruits; Dietary Requirements; Food Intake; Environment and Public Health; Environment Design; Neighborhood; Residence Characteristics

Introduction

As the result of the growing obesity epidemic among Americans (Flegal, Carroll, Ogden, & Curtin, 2010), factors related to food access have received increasing attention (Baker, Schootman, Barnidge, & Kelly, 2006; Hendrickson, Smith, & Eikenberry, 2006; Jetter & Cassady, 2006; Moore & Diez Roux, 2006; Morland, Wing, & Diez Roux, 2002). The "food environment," refers to environmental influences on nutritional behavior and has been hypothesized as a mechanism linking neighborhood characteristics to nutrition-related diseases (Glanz, Sallis, Saelens, & Frank, 2005). Current research demonstrates a negative association between presence of food stores, fruit and vegetable intake and cardiovascular disease risk factors (Bodor, Rice, Farley, Swalm, & Rose, 2010; Michimi & Wimberly, 2010; Morland, Diez Roux, & Wing, 2006). With only an estimated 32.5% of U.S. adults consuming two or more servings of fruit per day and 26.3% consuming three or more vegetable servings per day (Grimm et al., 2010), the food environment may play a key role in increasing healthful eating, decreasing obesity, and reducing cardiovascular risk (He, Nowson, Lucas, & MacGregor, 2007).

Despite national research focusing on food environments and the low levels of fruit and vegetable intake (Serdula et al., 2004), there is little data investigating this relationship in the Midwest state of Michigan (MI). Obesity rates in MI rose 21.8% between 2001 and 2008, resulting in the 8^{th} highest prevalence in the U.S. (Anderson, Lyon-Callo, Monje, Boivin, & Imes, 2009). One study in the urban city of Detroit, MI found that having a neighborhood supermarket was associated with a 69% increase in the number of daily fruit and vegetable servings (Zenk et al., 2009). Washtenaw County, approximately fifty miles west of Detroit, has had no research on these relationships. In 2008, the Washtenaw County Department of Public

Health (WCDPH) reported a decreasing availability of supermarkets (Washtenaw County Department of Public Health [WCDPH], 2008). Between 1950 and 2005, the number of supermarkets per capita in Washtenaw County decreased by 56% (Waller, 2005). In Ypsilanti, MI, a city in Washtenaw County, the Public Health Department reported that only 12% of adults eat the recommended amount of fruits and vegetables (Bacolor, Guzmán, & Waller, 2007). These findings may be linked to the food environment and have important implications for cardiovascular risk factors and subsequent health outcomes.

In addition to the physical characteristics of the food environment, perceptions of the local food environment influence dietary patterns (Moore, Diez Roux, Nettleton, & Jacobs, 2008). Researchers have shown that perception is associated with physical food environments but is not identical (Freedman & Bell, 2009; Moore, Diez Roux, & Brines, 2008). In addition to the physical presence or absence of a store, perceiving that one does not have food store access may play a role in determining health behavior. Currently, no research has investigated whether perception changes the influence of the physical environment on health behavior.

To increase the understanding of the food environment in MI, we investigated the association between food store access and fruit and vegetable consumption in Ypsilanti, MI. Secondly, we investigated whether perceptions of the food environment modified the association between food store access and fruit and vegetable consumption. We hypothesized that participants with greater food store access will consume more fruits and vegetables. We also hypothesized that those with a positive perception of their food environment will be impacted differently by food store access than those with a negative perception.

Method

Study Design: We conducted a cross-sectional, in-person survey investigating the association between food store access, measured as travel time to the preferred food store and number of food stores within one mile of home, and fruit and vegetable intake in Ypsilanti, MI. Participants were recruited using convenience sampling from the Ypsilanti District Library Whittaker branch [YDL-Whittaker] on three separate days (two weekend days and one weekday) during March 2011. Potential participants were approached in the library foyer; those that refused were asked to complete a brief form for demographic data collection. Informed consent was provided prior to the survey. The University of Michigan Institutional Review Board approved this study's protocol and materials.

Study Population: In the 2005-2009 American Community Survey (U.S. Census Bureau, 2011), Ypsilanti township had 32,693 adults older than 25. Of those, 86.4% have a high school education or higher and 30.1% have a bachelor's degree or higher. Ypsilanti consists of 61.9% white, 30.1% black, 1.9% Asian, 0.5% American Indian, and 3.8% two or more races. Additionally, 5.5% of the total population identify as Hispanic or Latino. Roughly 69.4% are in the workforce, with a mean travel time to work of 24.1 minutes. The median household income of Ypsilanti is $46,944, lower than the U.S. median of $51,425. Potential participants were excluded from the study if they were under 18 years of age, not a resident of Ypsilanti, or were pregnant or unsure of their pregnancy status. Figure 1 illustrates the recruitment process and exclusion criteria for study participants.

Fruit and Vegetable Intake: The primary outcome variables were average daily fruit intake, average daily vegetable intake, and combined fruit and vegetable intake over the past year. Food frequency questions were modified from the 2007 Harvard Grid Food Frequency Questionnaire (FFQ) (Rimm et al., 1992). The Harvard FFQ has been validated in a range of populations including the elderly, young adults and minority groups (Field et al., 1998; Willett et al., 1985). The fruit and vegetable portions of the Harvard Grid FFQ are semi-quantitative and cover a broad variety of fruits, vegetables and juices. The FFQ asks respondents to indicate for each food item how often they have consumed the specified serving size, averaged over the past year. Eight responses are possible, ranging from never or less than once per month to four or more servings per day. Pictures and descriptions of the serving size for each item on the FFQ were provided to study participants as visual cues. We calculated the total number of fruits and vegetables consumed per month and determined the average number of servings consumed per day. Lastly, we created a binary variable indicating whether a participant met the recommendations of the United States Department of Agriculture (Thompson & Veneman, 2005) for daily fruit and vegetable intake of nine servings per day (based on a 2000 calorie diet).

Food Store Access: The first measure of food store access was self-reported average time in minutes needed to reach the most frequented food store. Participants were asked, “How much time, in minutes, would you estimate it takes you to get to the grocery store or supermarket that you use most frequently, if travelling by your usual transportation?” Since 98.8% of participants (n=82) reported that they usually use a car to get to the grocery store and supermarket, and only one participant (1.2%) reported use of a taxi/hack, this variable was not converted into a distance measure using average estimated speeds for different transportation modes. The second measure, food store density, was obtained by asking participants the number of food stores within one mile or a twenty-minute walk of their home. This measure is analogous to GIS-created measures of the density of supermarkets within 1 mile (Moore, Diez Roux, Nettleton, et al., 2008) and with perceived food environment questions (Moore, Diez Roux, & Brines, 2008). While neither of these specific questions have been used in previous literature, they are substitutes for more objective GIS measures of accessibility and density used in several studies (Inagami, Cohen, Finch, & Asch, 2006; Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008; Rose & Richards, 2004; Zenk, et al., 2009). To validate travel time, we tested self-reported time for a separate sample of non-participants against timed trips. There was no substantial difference between the self-reported time and the validated timed measures in these non-participants (correlation coefficient of 0.908).

Food Environment Perception and Demographics: We used five questions from an eight-item questionnaire developed by Freedman and Bell (2009) to assess participants' perception of their food environment. Since we were not interested in substance use, we eliminated two questions pertaining to cigarettes or alcohol. One question about the perceived ability to purchase healthy foods was removed to avoid redundancy between perception and food store access. Each question was scored on a Likert scale (1 = strongly disagree to 5 = strongly agree) and the arithmetic mean of the five scores was calculated. Using the median (perception=3), we created a binary variable representing negative perception (3 or less, where 3 = neutral) and positive perception (greater than 3) to facilitate interpretation.

To control for possible confounding demographic and socioeconomic status (SES) variables, we collected data on participants' age (continuous), sex (male/female), race (Black, White, Asian, Native Hawaiian or Pacific Islander, American Indian or Alaskan Native, Other, Refuse), ethnicity (Hispanic, Non-Hispanic), highest education level attained (none, elementary, some high school, high school graduate, some college or technical school, college graduate, graduate or professional degree), household income (less than $10K, $10K to less than $15K, $15K to less than $20K, $20K to less than $25K, $25K to less than $35K, $35K to less than $50K, $50K to less than $75K, $75K or more), and employment status (employed for wages, self-employed, out of work for less than one year, out of work for more than one year, homemaker, student, retired, unable to work).

Statistical Analysis: A researcher other than the interviewer entered completed surveys into a Microsoft Access database. Variables from the FFQ were double entered and compared to original surveys to avoid data entry error. All surveys had complete data and a final data set including all subjects was compiled for analysis.

We compared the study population's demographic characteristics with those who refused participation using Student's t-test (age), Pearson's chi-square (race, sex), and Fisher's exact test (ethnicity). We used simple linear regression to investigate the crude relationship between time to preferred food store and density of food stores with fruit and vegetable intake alone and combined (model 1). Logistic regression was used to investigate the relationship between food store access measures and whether subjects met recommendations for food and vegetable intake (yes/no). The variables annual household income, age, race, sex and education were then incorporated into a fully adjusted model (model 2).

A stratified analysis was done using a model fully adjusted for the demographics and SES to examine whether the effects of food store access on fruit and vegetable intake varied by food environment perception. Results are shown stratified by negative perception (Model 3-*NP*) and positive perception (Model 3-*PP*). All analyses were performed using SAS Version 9.2 (SAS Institute, Inc., Cary, NC).

Results

Ninety-one people agreed to participate in our study, of which 83 met eligibility criteria. Of those who refused to participate, 69 people completed refusal forms. Our study population consisted of 48 women (57.8%) and 35 men (42.2%) with a mean age of 43.6 years (SD=12.8). Table 1 compares baseline demographic characteristics of our study participants to Ypsilanti demographic statistics taken from the American Community Survey (2005-2009). Participants were similar to residents of Ypsilanti, with the exceptions that they were more highly educated and less likely to be Hispanic. Demographic characteristics of those who refused to participate were similar to study participants (data not shown).

Descriptive statistics of food store access and fruit and vegetable consumption can be found in Table 1. Participants traveled an average of 9.9 minutes (SD=6.7) to their preferred store and had an average of 1.3 stores (SD=1.3) within one mile of their homes. Overall, participants reported eating more vegetables than fruits. A higher percentage of females (37.5%) and those with some college (36.7%), college (34.8%) and graduate degrees (35.0%) met dietary recommendations compared to males (25.7%) or those with high school degrees or less (10.0%).

Table 2 displays the results of the linear regression analysis of fruit and vegetable intake. The simple linear regression (model 1) revealed a positive association between travel time and fruit and vegetable intake. For each additional minute of travel time to the food store, fruit and vegetable consumption increased by 0.18 fruits or vegetables per day (β=0.18; 95% CI: -0.02, 0.39). Vegetable intake alone was positively associated with distance (β=0.16; 95% CI: 0.01, 0.31), while fruit intake alone was not associated with distance (β=0.02; 95% CI: -0.06, 0.10).

There was no association between reported food store density with fruit and vegetable intake, either separately or combined. The addition of demographic and SES variables to our model (model 2) strengthened the relationship between travel time and fruit and vegetable intake, while the relationship between food store density and fruit and vegetable intake remained unchanged.

There was no statistically significant effect modification by perceived food environment. However, the relationship between travel time and fruit and vegetable intake (model 3) was different for those with negative versus positive perceptions. For participants with a negative perception of their environment, controlling for demographics and SES, each additional minute of travel led to an increased consumption of fruits and vegetables per day (0.56 95% CI: 0.25, 0.88) while those with a positive perception had no association between distance and fruit and vegetable intake (0.37 95%CI: -0.47, 0.1.20). A similar pattern emerged with vegetable intake but perception did not differentially affect fruit intake (Table 2). The association between density and fruit and vegetable intake was also not statistically different between those with negative and positive perceptions of their food environment. After controlling for demographic and SES covariates, those with negative perception had a positive relationship between density and fruit and vegetable intake (0.19 95% CI: -1.32, 1.71) while those with positive perception had an inverse relationship between density and fruit and vegetable intake to -1.38 (95% CI: -3.88, 1.11).

In the logistic regression models, travel time was not associated with the odds of meeting recommendations for fruit and vegetable intake (OR 1.03, 95% CI: 0.96, 1.10), even after controlling for potential confounding variables (OR 1.10, 95% CI: 0.94, 1.29). The density of food stores, however, was associated with the odds of meeting recommendations. For every additional store within one mile of participants' homes, the odds of meeting the recommended intake of fruits and vegetables increased 52% (OR 1.52, 95% CI: 1.04, 2.12). Controlling for confounding factors, each additional store within one mile of participants' homes increased the odds of meeting recommendations by 105% (OR 2.05, 95% CI: 1.02, 4.10).

Discussion

Using self-reported measures of food store access and fruit and vegetable intake, we found that the food environment is associated with fruit and vegetable intake in Ypsilanti, MI. We observed increasing fruit and vegetable intake with increasing travel time to the food store, driven primarily by vegetable intake. The odds of meeting recommended daily levels of fruit and vegetable intake approximately doubled for each additional food store within one mile of participants' homes. Perception of the food environment did not statistically modify the effect of food store access on fruit and vegetable intake.

The positive relationship between travel time and fruit and vegetable intake is contrary to our initial hypothesis and previous research (Inagami, et al., 2006; Laraia, Siega-Riz, Kaufman, & Jones, 2004; Morland, et al., 2006; Rose & Richards, 2004). This may be due to the slight difference between food store access and food store preference. While our measure was intended to capture distance to food stores, a measure of neighborhood food environment, it more accurately reflects the store most frequently used. This may not be the nearest store or even be in the same neighborhood that a participant resides in. It may be possible that individuals who visit food stores outside of their local neighborhood do so to gain access to specific offerings at their preferred store, such as availability and quality of fresh produce. Thus, reverse causation may have occurred in which increased fruit and vegetable intake may actually result in farther drives to seek produce. Since a higher percentage of our participants (32.5%) met the required fruits and vegetables compared to the percentage reported by the Washtenaw County Department of Health (Bacolor, et al., 2007), it is plausible that reverse causation played a role in our findings.

The difference in percentage of our participants meeting required intake compared to Washtenaw County overall may also suggest that our sample is not representative of the broader Ypsilanti population, although Table 1 shows that our sample was equivalent to the Ypsilanti, MI American Community Survey in all demographic characteristics with the exception of education and Hispanic ethnicity. According to previous research, Hispanic individuals are equally likely to consume fruits and vegetables (Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008) and should not have caused any additional bias. The higher education level of participants compared to Census data for Ypsilanti residents is a limitation of the non-random sample, and may be a source of bias among our study, since fruit and vegetable consumption is patterned by education (Blanck, et al., 2008; Cooke et al., 2004). Within the context that individuals of higher education may be better informed about the importance of fruit and vegetable intake, or have more material resources to seek out and purchase fruits and vegetables, findings on increased travel time may make sense. Since participants' knowledge of the number of fruits and vegetables they should eat or the importance participants attach to consuming fruits and vegetables were not assessed, we are unable to evaluate whether these factors drive findings. Future research should gauge participants' knowledge and beliefs regarding fruit and vegetable consumption when assessing the effects of the food environment.

The increased odds of meeting recommended daily levels of fruit and vegetable intake with increased food store density is consistent with our hypothesis and previous literature (Moore, Diez Roux, Nettleton, et al., 2008; Rose & Richards, 2004). Individuals with more stores around their homes may have increased options, wider variety, or varying quality of produce. An increase in stores may benefit participants by increasing ease of access to produce. Additional qualitative research on store preference and produce options should be done to explore why this relationship exists.

Although perception of the food environment did not statistically modify the effect of food store access on fruit and vegetable intake, patterns that arose in our research suggest that this modification should be explored further. Previous research has investigated the accuracy of individuals' perceptions of their food environment (Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008), but has failed to investigate whether perception changes the effect of the physical food environment on health behaviors. In our study, the association between food store access and intake were stronger for those with a negative perception of their local food environment. It is possible that those who have a negative view of the food choices available locally are more willing to travel farther to a food store and could have a higher priority placed on consuming fresh produce. Shopping preferences should be explored as a possible mechanism in this relationship. Our results indicate that attention should be paid to perception of the food environment in the role of determining store choice and ultimately fruit and vegetable intake, but additional research is necessary to confirm the moderating role of perceived food environment.

The cross-sectional design limits our ability to make causal inferences from our data and a small sample size restricts power to detect associations. The reliance on a convenience sample may have introduced selection bias and prevents generalization to the broader population. As previously noted, while many sample demographics were consistent with Ypsilanti Census data, the higher educational status and lack of Hispanic respondents in our study indicate that our study population may not be representative. Moreover, YDL-Whittaker is not accessible by public transportation, which may narrow our sample to those who have cars and can use them to access food stores. Patrons of a library may also represent a subgroup of the population with atypical characteristics and health behaviors. Restaurant use and frequency of eating out was not evaluated in our study and may be unmeasured factors influencing fruit and vegetable intake. Specifically, concentration, access, and use of fast food establishments has been shown to be important to eating habits (Ford & Dzewaltowski, 2008) but was not measured in our study.

The use of self-reported exposures, outcomes, and third variables results in the possibility of measurement error. Participants who consume more fruits and vegetables could potentially be more familiar with their local food stores and likely to report a more accurate account of the food environment, while participants who consume less fruits and vegetables may underreport food stores due to lack of use. However, utilizing self-report may provide insight into the true influence of the environment, especially when the perceived and physical food environments are disparate. More research synthesizing both constructs is necessary to better tease apart these relationships (Moore, Diez Roux, & Brines, 2008).

Our study suggests that individuals in Ypsilanti with higher food store density are more likely to meet recommendations for fruit and vegetable intake. As a decrease in fruit and vegetable intake is associated with a multitude of chronic diseases, increasing the number of food stores has the potential to reduce disease burden within the community. Contrary to our hypothesis, people who travel longer to their preferred food store consume more fruits and vegetables. Further investigation as to the directionality of this relationship should be conducted. Continued research should focus on the complex interplay between a person's built food environment, their perception, and ultimately fruit and vegetable intake.

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Table 1: Demographic information and descriptive statistics for Ypsilanti, MI[a] and Study Participants recruited in Whittaker Branch Library Ypsilanti, MI (n=83)

	Ypsilanti	Study Participant
Demographics:		
Race (%)[b]		
White	61.9	61.7
Black or African American	30.1	25.9
Asian	1.9	3.7
American Indian	0.5	1.2
Multiracial	3.8	7.4
Hispanic/Latino (%)	5.5	0.0
Median Household Income	$46,944	$35,000-$50,000[c]
Employed (%)	69.4	67.1
Education (%)		
Less than High School	13.6	1.2
High School to bachelors	56.3	47.0
Bachelors or higher	30.1	51.8
Food Environment:		
Mean time to supermarket in minutes (SD)	----[d]	9.9 (6.7)
Mean density of food stores within one mile (SD)	----	1.3 (1.3)
Perception of food environment		
Number with positive perception (%)	----	49 (59.0)
Number with negative perception (%)	----	34 (41.0)
Fruit and Vegetable Consumption:		
Mean fruit and vegetable intake (SD)	----	8.4 (6.3)
Mean fruit intake (SD)	----	3.4 (2.4)
Mean vegetable intake (SD)	----	5.1 (4.7)
Number meeting recommended daily intake[e] (%)	----	27 (32.5)

[a]American Community Survey 2005-2009 (U.S. Census Bureau, 2011)
[b]Percentages for race may not sum to 100% due to rounding and the possible use of "other" race category.
[c]Survey used income categories for privacy. This represents the median income category.
[d]Values not reported because they represent the entire base population rather than study sample
[e]Eating nine servings per day for a 2000 calorie diet considered meeting recommended daily intake of fruits and vegetables.

Table 2: Effect estimates of food environment measures (distance and density) on fruit and vegetable intake among study participants in Ypsilanti, MI (n=83). Models unadjusted, adjusted for demographics and stratified by perceived food environment.

Predictor and Outcomes	**Model 1[a]**	**Model 2[b]**	**Model 3-*NP*[c]**	**Model 3-*PP*[c]**
Time (minutes) to the most frequently used food store				
Fruit and Vegetable Intake	0.18 (-0.02, 0.39)*	0.37 (0.10, 0.64) **	0.56 (0.25, 0.88)**	0.37 (-0.47, 1.20)
Fruit Intake	0.02 (-0.06, 0.10)	0.02 (-0.08, 0.13)	0.07 (-0.04, 0.19)	0.23 (-0.16, 0.62)
Vegetable Intake	0.16 (0.01, 0.31)**	0.35 (0.14, 0.55) **	0.49 (0.22, 0.76)**	0.14 (-0.44, 0.72)
Density (1 store) of food stores within one mile of participants' homes				
Fruit and Vegetable Intake	0.61 (-0.47, 1.70)	0.48 (-0.72, 1.67)	0.19 (-1.32, 1.71)	-1.38 (-3.88, 1.11)
Fruit Intake	0.23 (-0.18, 0.63)	0.27 (-0.16, 0.71)	0.14 (-0.31, 0.59)	-0.29 (-1.54, 0.97)
Vegetable Intake	0.38 (-0.44, 1.20)	0.20 (-0.74, 1.15)	0.06 (-1.26, 1.38)	-1.09 (-2.73, 0.55)

NP= Negative perception of the food environment
PP= Positive perception of the food environment
*Statistically significant at the $P<0.10$ level
** Statistically significant at the $P<0.05$ level
[a]Unadjusted model: only including food store access measure
[b]Demographics/Socioeconomic status adjusted model: includes age, race, income, sex, education
[c]Fully adjusted model: includes age, race, income, sex, education, and stratified by perceived food environment.

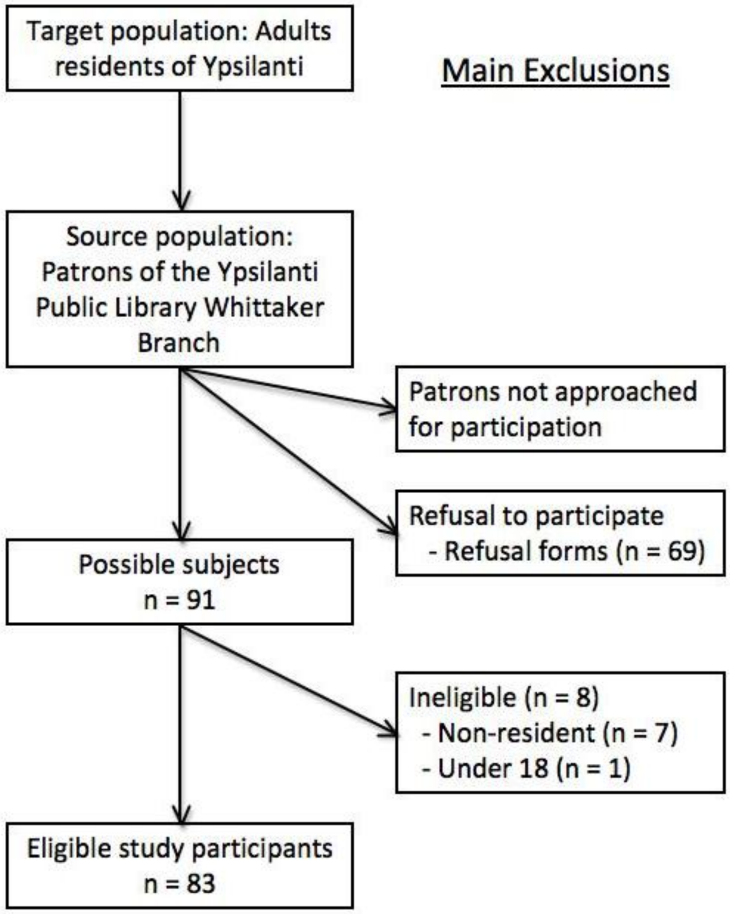

Figure 1: Selection of study participants from the Whittaker Branch Public Library in Ypsilanti, MI. Recruitment and study completed during March 2011.