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# Mapping Food Stores & People at Risk for Food Insecurity in Lewiston, Maine

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**Abstract:** Food insecurity threatens health. To understand how food store location contributes to food insecurity in Lewiston, Maine, we visited all city food stores, determined availability and cost of healthy food in each, and mapped the stores against residence locations of at-risk groups (households with a single-parent, without a car, or with income

# Introduction

Food insecurity, when a household lacks uninterrupted access to sufficient amounts of safe, nutritional food in socially acceptable ways for any part of the year (Keenan, Olson, Hersey, & Parmer, 2001), exists in the U.S. for 12% of households (Nord, Andrews, & Carlson, 2009) and threatens the health of both children (Cook et al., 2004; Skalicky et al., 2006) and adults (Stuff et al., 2004; Hanson, Sobal, & Frongillo, 2007; Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007) who experience it. Not all households are at equal risk for food insecurity. Households with low income and single-parent households with children have higher risk (Nord, Andrews, & Carlson, 2009), as do those without a car (Martin, Rogers, Cook, & Joseph, 2004). Urban and rural households have higher risk than those in suburbs (Nord, Andrews, & Carlson, 2009).

A community's built environment (the human-made surroundings) also affects food access (a requirement of food security) and the health of community members. Convenience stores (Liese, Weis, Pluto, Smith, & Lawson, 2007) and local markets (Jetter & Cassady, 2006) generally have fewer healthy food choices and more expensive food than do supermarkets. Unsurprisingly, access to a supermarket is negatively correlated with obesity in adults (Morland, Diez Roux, & Wing, 2006) and adolescents (Powell, Auld, Chaloupka, O'Malley, & Johnston, 2007) and is of particular importance in poor communities where smaller stores are prevalent and supermarkets scarce (Jetter & Cassady, 2006).

Here we discuss a community food assessment conducted in Lewiston, Maine (a small urban setting) as a collaboration between two groups with outreach education missions, The Nutrition Center of Maine (NCM) and the Downtown Educational Collaborative (DEC). We visited all Lewiston food stores and determined the variety and cost of food in each. Then we mapped the stores' locations in a Geographic Information System (GIS) along with the residence locations of single-parent households, households without a car, and people in households with incomes < 150% of the poverty level.

Our goal was to identify barriers to food security and healthy eating imposed by the location of food stores that could inform the outreach educational mission of DEC and NCM. This community-academic collaboration has similar goals to previous projects (Greder, Garasky, & Klein, 2007) and reports findings of interest to outreach educators in small urban settings. The methodology will be of interest those interested in the impact of a city's geography on its residents.

# Methods

## Study Site

- Lewiston, in central Maine, is the state's 2nd largest population center when combined with its bordering city, Auburn (total population 60,000).

- NCM includes St. Mary's Food Pantry, an emergency food resource; Lots to Gardens, which uses urban gardens to improve access to fresh food; and the Nutrition Kitchen, a provider of outreach education on wellness, nutrition, and fitness.

- DEC is a collaborative of Lewiston colleges and other educational organizations dedicated to community-based outreach education.

We chose to assess food insecurity in Lewiston because this city faces challenges similar to other cities that have lost manufacturing base and because Maine has a high rate of food insecurity (Nord, Andrews, & Carlson, 2009).

## Stores Data

We obtained a list of licensed Lewiston food stores from the City Clerk, visited all stores selling processed and prepackaged food during August, 2008, and completed a questionnaire based on the Nutrition Environment Measures Survey in Stores (Glanz, Sallis, Saelens, & Frank, 2007). The survey determined the presence, variety, and price of food in seven categories: fresh fruit; fresh vegetables; whole grain bread, pasta, and rice; frozen vegetables; lean meats; canned and dried peas and beans; and low-fat diary. It also recorded the store type (convenience store, local market, or supermarket) and availability of soda and beer. Convenience stores are part of a chain and often sell gasoline, while local markets are locally owned stores that focus on selling food.

For each store we determined the categories of food offered, the number of items available in each category, and the items' cost. We then established these definitions:

**Stores with most food categories**â stores carrying at least one item from at least six food categories,

**Cost of a food basket**â price of food basket containing the most common items from each category for the stores with most food categories (Table 1). (In two cases where the number of categories present was six, we used the mean item cost), and

**Inexpensive stores with most food categories**â the three stores with most food categories and lowest cost for the food basket.

**Table 1.**
Foods Included in Food Basket

| Food Group | Items Included |
|---|---|
| Fruits | Bananas |
| Fresh Vegetables | Carrots, Tomatoes, Peppers |
| Whole Grains | Whole wheat bread |
| Frozen Vegetables | Frozen peas |
| Lean Meats | Whole chicken, Chicken breasts |
| Low Fat Dairy | Skim milk |
| Canned/ Dry Vegetables | Canned peas, Canned corn, Split peas |

## Map Layers and Demographics

- Digital maps of Lewiston streets, census blocks, and tracts were obtained from the Maine Office of GIS (Maine.gov, 2008).

- Demographic information from the 2000 Census (U.S. Census Bureau, 2008) included: (by census block percent) single-parent households and (by census tract percent) households without a car and percent people in households with income <150% federal poverty level. There are 634 populated census blocks in Lewiston's nine census tracts. For variables available only by census tract, we assigned the census tract value to blocks in that tract.

## GIS Analysis (ArcMap, ESRI, 2008)

- Electronically mapped store locations using Lewiston street map and store addresses

- Determined by census block: population density (people/km$^2$), number of people living within 1 km, distance to the closest store with most food categories and the price of our food basket at that store, number of stores selling soda and beer within 1 km, and distance to the closest inexpensive store with most food categories

## Statistics

We compared the number of single-parent households, households without a car, and people in households with incomes < 150% of the poverty level living within 1 km of stores selling most food groups to the number living further away by chi-square analysis. We chose 1 km as a generous estimate of maximum walking distance to a store (Algert, Agrawal, & Lewis, 2006).

We determined the predictors of these dependent variables by census block: cost of food at the closest store with most food categories, distance to the closest inexpensive store with most food categories, number of stores within 1 km selling soda, and number of stores within 1 km selling beer. The independent variables for the analysis included numbers in the demographic groups at risk for food insecurity and the population density variables above. We performed linear regression analysis and multiple analysis of variance (MANOVA) with interactions considered using SAS software (SAS, SAS/STAT Software, 2010) and accepted statistical significance at $p<0.05$.

# Results

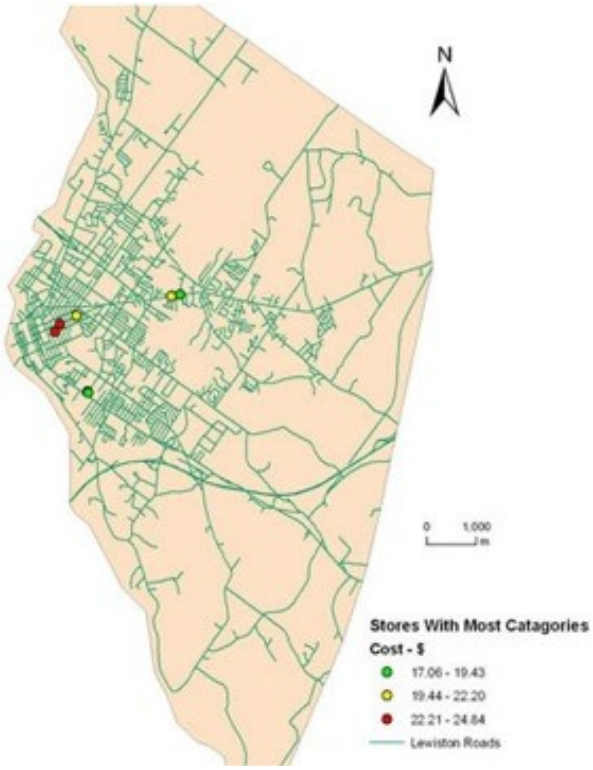
## Store Offerings

The 64 food stores (6% supermarkets, 52% local markets, and 42% convenience stores) differed greatly in the number of categories of food items they sold (Figure 1). There were seven stores with most food categories, including three supermarkets and four local markets. These seven stores accounted for most of the variety within many food categories. For instance, they included six of the seven stores selling â ¥4 types of fresh fruit and seven of the nine stores selling â ¥4 types of fresh vegetables. The food basket price in these seven stores ranged from $17.06 to $24.84 (Figure 2).

**Figure 1.**
All Stores by # Healthy Food Groups Sold


Map of Lewiston, Maine showing the 64 food stores with the number of healthy food categories sold in each. Note that even one item from a particular category is recorded as the category being sold in that store.

**Figure 2.**
Stores with Most Food Categories by Cost




Map of Lewiston, Maine showing the seven food stores in which most of the food categories are available symbolized by the cost of a food basket in that store. Two of these stores are located so close to each other that they appear as a single symbol on this map.

## Walking to Food Stores

Comparing households living within 1 km of a store with most food categories to households further away, we found that the percent households in groups at risk for food insecurity was higher in the <1 km group. For instance, 11.5% of the households living <1 km from a store with most food categories are single-parent households, compared to 9.6% of the households further away (Table 2).

**Table 2.**
People Living Within 1 Km of a Store Selling Most Healthy Food Groups

| Group | %< 1 km | %> 1 km | p |
|---|---|---|---|
| Single Parent HH | 11.5 | 9.6 | **0.0001** |
| People<150% Poverty | 38.5 | 16.5 | **0.0001** |
| HH No Vehicle | 27.9 | 6.4 | **0.0001** |

## Food Environment

In univariable analysis we found a higher cost of food at the closest store with most food categories, a larger

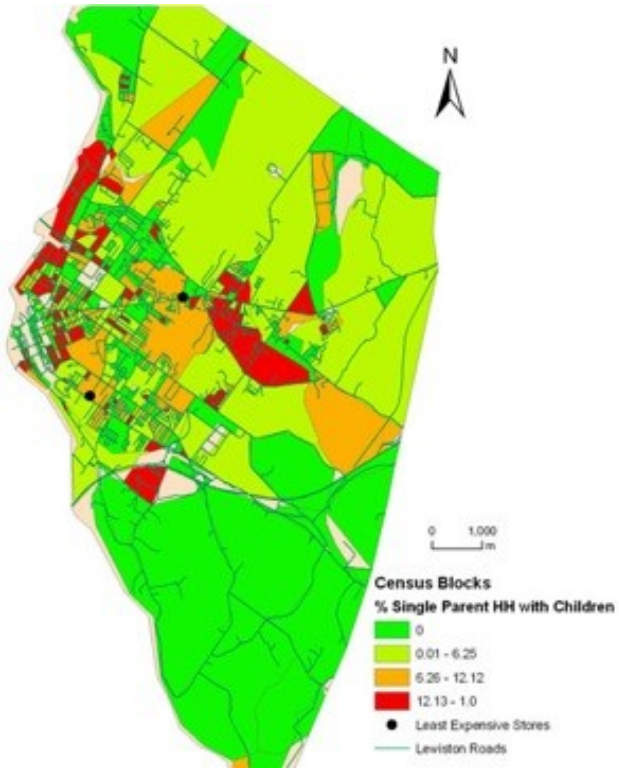
number of stores within 1 km selling soda and beer, and a shorter distance to the closest inexpensive store with most food categories predicted for census blocks with high percent of: single-parent households, households without a car, and people living in households with income <150% of poverty (Table 3). To understand how a household could both have a higher cost at the closest store with most food categories and a shorter distance to the closest inexpensive store with most food categories, compare downtown (west central) to suburban (north and south) parts of Lewiston (Figure 2).

**Table 3.**
Predictors by Census Block of Food Environment

| | **Food Cost** | | | **# Stores Selling Soda** | | |
|---|---|---|---|---|---|---|
| **Group** | **Coef** | **p** | **R-sq** | **Coef** | **p** | **R-sq** |
| 1 Parent | 2.0397 | **0.019** | 0.011 | 12.3980 | **0.000** | 0.038 |
| Poverty | 9.4539 | **0.000** | 0.439 | 37.5680 | **0.000** | 0.670 |
| No Vehicle | 10.2369 | **0.000** | 0.456 | 39.9830 | **0.000** | 0.672 |
| Pop Density | 0.0003 | **0.000** | 0.176 | 0.0014 | **0.000** | 0.358 |
| Pop < 1 km | 0.0004 | **0.000** | 0.291 | 0.0001 | **0.000** | 0.657 |
| | **# Store Selling Beer** | | | **Distance to Inexpensive Store** | | |
| **Group** | **Coef** | **p** | **R-sq** | **Coef** | **p** | **R-sq** |
| 1 Parent | 7.1730 | **0.000** | 0.033 | -1351 | **0.005** | 0.015 |
| Poverty | 22.9252 | **0.000** | 0.648 | -1362 | **0.000** | 0.030 |
| No Vehicle | 24.4444 | **0.000** | 0.652 | -1931 | **0.000** | 0.053 |
| Pop Density | 0.0008 | **0.000** | 0.326 | 0.0947 | **0.000** | 0.058 |
| Pop < 1km | 0.0012 | **0.000** | 0.720 | -0.1876 | **0.000** | 0.226 |

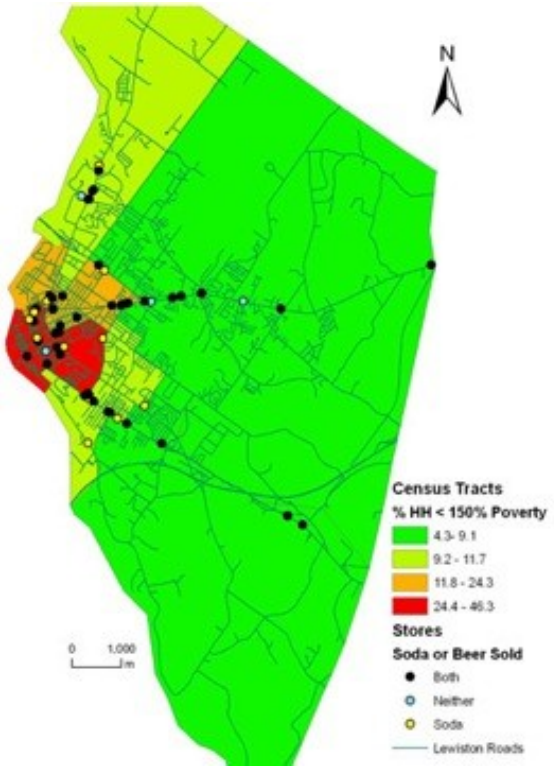
Most of the independent variables auto-correlate (Appendix 1). Multi-variable analysis suggests that the correlations in Table 3 may reflect these autocorrelations and interactions among variables (Appendix 2). Figures 3 and 4 map the relationship between single-parent households with children and inexpensive stores with most food categories and that between people in households with income <150% of poverty and stores selling soda and beer respectively.

**Figure 3.**
Inexpensive Stores with Most Food Categories & Single-Parent Households




Map of Lewiston, Maine showing the percent of the households that are single-parent households with minor children (as a decimal) and the 3 least expensive stores at least 1 item form most healthy food categories can be purchased. Two of these stores are located so close to each other that they appear as a single symbol on this map.

**Figure 4.**
Stores Selling Soda and Beer and Poverty




Map of Lewiston, Maine showing the percent of the people living in households with income < 150% of the poverty level (as a decimal) and the locations of the stores selling soda, both soda and beer, or neither.

# Discussion

Demographic and geographic aspects of food insecurity are not addressed by healthcare interventions, but may fall within the purview of outreach educators using community organizing approaches (Fitzgerald & Spaccarotella, 2009). Here we discuss implications of our findings useful to these educators.

1. *In a small urban setting, members of at-risk groups are likely to live where they are surrounded by stores with less variety and higher price and by stores offering unhealthy food options*. These results parallel those from larger urban centers showing that poor neighborhoods often have more local markets with fewer healthy food items and higher cost (Jetter & Cassady, 2006). People usually consume the food to which they have ready access (Popkin, Duffey, & Gordon-Larsen, 2005). Thus educating individuals about healthy food choices is not sufficient to allow people to overcome food insecurity. Outreach educators should also explicitly discuss the challenges the built environment provides to healthy eating.

2. *Inexpensive stores with good food selections may be close to some at-risk households, but members of these households may have difficulty accessing them*. In Lewiston, at-risk households are more likely to be located within 1 km of stores selling most food categories and, on average, are closer to an inexpensive store selling most food categories. Similarly, results from New Zealand showed a shorter travel distance to supermarkets from low-income neighborhoods (Pearce, Blakely, Witten, & Bartie, 2007). However, in a large U.S. metropolitan area (Detroit), supermarkets were located further from poor neighborhoods. Thus, efforts to address food insecurity by advocating for a

downtown supermarket, as has been proposed for Detroit (Zenk et al., 2005) are probably not appropriate for smaller cities, including Lewiston, Maine.

To assess how society can meet everyone's healthy food needs, outreach educators may consider distance to a supermarket as a socially defined variable. A poor household living downtown without a car may still have less access to a supermarket than does a more affluent household with a car, even though the poor household is closer to the store. Thus, a shuttle bus to help people without a car reach supermarkets, as has been proposed in California (Cassady & Mohan, 2004), may improve food access even though the supermarkets are closer to the poor neighborhoods than to more affluent ones.

3. *Providing access to a supermarket is not necessarily the goal.* Some local markets have a good food selection and people may shop there for many reasons. A resident of long standing may use a neighborhood market because she knows the owners or because the market will deliver her purchases when she is ill. Further, thriving small stores are a community resource, and improving access to supermarkets may deprive smaller stores of much-needed business. Thus, outreach educators should aim to improve healthy food selection at local stores rather than just supplanting them with supermarkets. The idea of improving offerings at local stores is one aspect of "community-based food systems" currently being implemented elsewhere (Conner, Cocciarelli, Mutch, & Hamm 2008).

In conclusion, our findings suggest that the location of food stores may impose a barrier to food security and healthy eating in a small urban setting. This fact may inform the activities of outreach educators.

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**Appendix 1**
**Autocorrelations of independent variables â p-values**

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **1) Single-Parent HH** | | .0001 | .0001 | .0001 | .0070 |
| **2) HH < 150% Poverty** | 0001 | | .0001 | .0001 | .0001 |
| **3) HH No Vehicle** | .0001 | .0001 | | .0001 | .0001 |
| **4) Population Density** | .0001 | .0001 | .0001 | | .0001 |
| **5) Population < 1 Km** | .0070 | .0001 | .0001 | .0001 | |
| P-values for autocorrelations between independent demographic and population density variables. Almost all of these variables correlate strongly with almost all of the other variables. The coefficients for all the significant correlations were positive. | | | | | |

**Appendix 2**
**MANOVA results**

**Food Cost**

| Dependent Variable | Estimate | SEM | p |
|---|---|---|---|
| **Intercept** | 13.2 | 0.59 | <0.0001 |
| **HH<150% Poverty** | 40.2 | 4.96 | <0.0001 |
| **No Vehicle** | -19.04 | 5.83 | 0.0012 |
| **Population Density** | -0.00039 | 0.00015 | 0.0072 |
| **Population Within 1 km** | 0.0010 | 0.0001 | <0.0001 |
| **Poverty x No Vehicle** | -11.30 | 4.45 | 0.0113 |
| **Poverty x Pop Within 1 km** | 0.0071 | 0.0008 | <0.0001 |
| **No Vehicle x Pop Within 1 km** | 0.0063 | 0.0009 | <0.0001 |

MANOVA results showing variables and interactions among variables that predict a high cost of food at the closest store selling most food categories. Interactions as shown with an x (e.g. Poverty x No Vehicle) mean that the interaction between the percent of people in families < 150% of the poverty level and the percent of households with no vehicle interact to significantly predict the price of food at the closest store. SEM indicates the standard error of the estimate of the corresponding coefficient. The R-sq value for this model is 0.59.

**Stores Selling Soda**

| Dependent Variable | Estimate | SEM | p |
|---|---|---|---|
| **Intercept** | -3.48 | 1.13 | 0.0024 |
| **HH<150% Poverty** | 27.03 | 9.55 | 0.0048 |
| **Population Within 1 km** | 0.0012 | 0.0002 | <0.0001 |
| **Single-Parent HH x Pop Within 1 km** | -0.000079 | 0.00023 | 0.0006 |
| **Poverty x No Vehicle** | 17.29 | 8.56 | 0.044 |
| **Poverty x Pop Within 1 km** | 0.0043 | 0.0016 | 0.0058 |
| **Pop Within 1 km x Pop Density** | 0.00000008 | 0.00000002 | <0.0001 |

MANOVA results showing variables and interactions among variables that predict a high number of stores selling soda within 1 km of a census block. SEM indicates the standard error of the estimate of the corresponding coefficient. The R-sq value for this model is 0.85.

**Stores Selling Beer**

| Dependent Variable | Estimate | SEM | p |
|---|---|---|---|
| **Intercept** | -2.25 | 0.67 | 0.0009 |
| **HH<150% Poverty** | 16.56 | 5.65 | 0.0035 |
| **No Vehicle** | -13.50 | 6.65 | 0.043 |
| **Population Within 1 km** | 0.00084 | 0.00011 | <0.0001 |
| **Single-Parent HH x Pop Within 1 km** | -0.00038 | 0.00013 | 0.0046 |
| **Poverty x Pop Within 1 km** | -0.0025 | 0.00093 | 0.0071 |
| **No Vehicle x Pop Within 1 km** | 0.0032 | 0.00010 | 0.0017 |
| **Pop Within 1 km x Pop Density** | 0.00000003 | 0.00000001 | 0.0092 |

MANOVA results showing variables and interactions among variables

that predict a high number of stores selling beer within 1 km of a census block. SEM indicates the standard error of the estimate of the corresponding coefficient. The R-sq value for this model is 0.87.

**Distance to Closest Inexpensive Store**

| Dependent Variable | Estimate | SEM | p |
|---|---|---|---|
| **Intercept** | 2123 | 347 | <0.0001 |
| **HH<150% Poverty** | 21348 | 2912 | <0.0001 |
| **No Vehicle** | -22827 | 3427 | <0.0001 |
| **Population Density** | -0.33 | 0.086 | 0.0002 |
| **Population Within 1 km** | -0.24 | 0.059 | <0.0001 |
| **Single-parent x Poverty** | -25246 | 12687 | 0.047 |
| **Single-Parent x Pop within 1 km** | 0.41 | 0.16 | 0.013 |
| **Poverty x No Vehicle** | -9949 | 2610 | 0.0003 |
| **Poverty X Pop within 1 km** | -2.43 | 0.48 | <0.0001 |
| **No Vehicle x Pop within 1 km** | 3.62 | 0.53 | <0.0001 |
| **Pop Density x Pop within 1 km** | 0.00003 | 0.0001 | <0.0001 |

MANOVA results showing variables and interactions among variables that predict a high distance to the closest inexpensive store selling most food categories. SEM indicates the standard error of the estimate of the corresponding coefficient. The R-sq value for this model is 0.54.

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