MEASURING FOOD ACCESS TO IMPROVE PUBLIC HEALTH
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Measuring Food Access to Improve Public Health

• Identify critical gaps in food access
• Develop models to understand the connection between socioeconomic variables and access to food
• Engage stakeholders in focus groups to identify ways to improve food access
  • Deerfield
  • Amherst
• Determine targeted actions that can be made by public officials to address inequities

Source: https://www.goodfoodla.org/food-security-and-access
Outline

• Literature on Food Access
• Spatial and Equity Analysis of Food Access Data
• Focus Groups: Deerfield and Amherst
• Recommendations
Literature: Food Access Definitions

Consistent access to healthy food is strongly associated with health. Food insecurity affects 15% of US households (Nord et al., 2018). 53.6 Million Americans live in a food desert (Rhone & Ver Ploeg, 2017).

**Food Desert**
Combined measure of [distance to healthy food] & [income or vehicle availability] & [transit availability]
(USDA, 2021)

**Food Swamp**
Abundance of unhealthy food options in a food desert
(Behrens et al., 2015)

**Food Hinterlands**
Low food access in less dense, dispersed suburban and rural communities
(Leete et al., 2012)
Literature: Metrics of Food Access

Travel time/distance to food stores
- distance or travel time to the nearest store (Chavis et al., 2018)
- mean distance to food stores (Leete et al., 2012)
- maximum time to reach grocery store by mode (Bhuyan et al., 2020)

Density of food stores
- number of stores within a walkable or drive-able distance (Fanoush et al., 2016)

Prices/cost of available food
- using Standard Price Index (Ghosh-Dastidir, 2014)
- travel cost (Losada-Rojas et al, 2021)

Frequency of grocery store visits (Bhuyan, 2020; Chavis & Jones, 2020)
Data for Massachusetts

Demographics

• US Census (1472 census tracts in MA): population, income, race
• MAPC Demographic Data – poverty rate, household size, vehicle ownership

Food

• MAPC Food Retailers in Massachusetts: store location and type
• Farmers market location data
Population Density by Census Tract

Total Population per Area (mi$^2$)

*Boston, MA*
Vehicles per Person by Census Tract

Number of Vehicles / Total Population
Percent of Population Identifying as Minority by Census Tract

Percent of Population Identifying as Minority:
- Latino/Hispanic
- Black/African
- American Indian and Alaska Native
- Asian
Percent of Population in Poverty by Census Tract

Percent of Population in Poverty
e.g., Annual Income $22,050 for a family of 4

Boston, MA
Spatial Analysis of Food Access

Defining Access as Reachable Opportunities
Distance vs. Travel Time Measures
Walking (10 min), Bicycling (10 min), Driving (10 min), Walk/Transit (30 min)

Types of Food Stores
Farmer’s Markets
Convenience Stores
Supermarkets
Reachable Stores Within 1 Mile

Farmers Markets
Healthy but sometimes limited

Convenience Stores
Abundant unhealthy foods

Supermarkets
Most varied selection of foods
Accessible Square Footage of Supermarkets by Mode

10 min Walk

30 min Walk/Transit

10 min Bike

10 min Drive

Legend

0
1 - 200000
200001 - 400000
400001 - 600000
600001 - 500000

0 12.5 25 50 Miles
Equity Analysis of Food Access

In absolute terms, the measure of accessible square footage of supermarkets is an indicator of food accessibility for each census tract.

To compare across the state, an aggregate view is to look at the distribution of food access using Lorenz Curve and Gini Coefficient.

The relevant metric for total food accessibility is the product of population and accessible square footage (person-foot^2), because we want measure the food access experienced by each individual person.
Lorenz Curve and Gini Coefficient

\[ Gini = \frac{A}{A + B} = 0.601 \]
Equity of Food Access by Mode

Lorenz Curve Analysis

- Line of Equality
- 10 min Drive (Gini = 0.582)
- 10 min Bike (Gini = 0.659)
- 30 min Walk/Transit (Gini = 0.718)
- 10 min Walk (Gini = 0.857)
Comparison of Total Food Access by Mode

- **10 min Walk/Transit**
- **30 min Walk/Transit**
- **10 min Biking**
- **10 min Driving**

Total Measured Food Access (10^9 population x sq. footage)
Modeling Analysis of Food Access

The number and square footage of supermarkets varies across the state depending on characteristics of the communities, as expected.

Model to Identify Statewide Patterns

Predict: Square Footage of Accessible Supermarkets

Explanatory Factors: Population Density, Vehicles per Person, % Minority Population, % in Poverty

We can use the model to look for communities that have low food access relative to statewide patterns.
Data Visualization for Modeling

Non-linear relationships between number of grocery stores and:

- Vehicle ownership
- Percent in Poverty
- Percent Minority
- Population Density
Gradient Boosted Model (GBM)

- Non-linear method that leads to models with high flexibility
- Machine learning technique combines multiple simple models into a single composite model
Residuals from Model

**Measured Food Access** – What people can actually reach

**Modeled Food Access** – Estimating what people can reach based on socio-economic characteristics of the census tract and statewide patterns

**Residual = Observation – Model Prediction**

How different is food accessibility in a census tract from what we would expect from statewide patterns

For analysis, we use a bounded residual (truncating model predictions to non-negative values) in proportion to the model prediction.
Model Residuals of Relative Food Access

10 min Walk

10 min Bike

30 min Walk/Transit

10 min Drive

Legend
-1.00 - 0.50
-0.49 - 0.00
0.01 - 35.00
35.01 - 235.00

Relatively Less Access

Relatively More Access
Deerfield and Amherst were identified as Western Massachusetts communities with food access gaps and environmental justice populations.

Invitations to the focus groups were extended to relevant organizations in each community:

- Regional Transit Authorities
- Mass in Motion Coordinators
- Councils on Aging/Senior Centers
- Food Banks/Food Charities
Measured Food Access in Amherst, MA

10 min Walk

10 min Bike

30 min Walk/Transit

10 min Drive

Legend
- Non Amherst area
- 0
- 1 - 200000
- 200001 - 400000
- 400001 - 600000
- 600001 - 5082500

World Street Map
Relative Food Access (Model Residual) in Amherst, MA

Legend
- Non Amherst area
-1.00 - -0.50
-0.49 - 0.00
0.01 - 35.00
35.01 - 235.00

World Street Map

10 min Walk
30 min Walk/Transit

10 min Bike

10 min Drive

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Focus Group Questions

Discussion Questions:

1. Are there known food access gaps in your community?
2. Are statewide analyses consistent with your understanding of your community?
3. What role does transportation play as a barrier to food access?
4. What programs have been tried or should be implemented to improve food access.
Focus Group Summary

• Both Deerfield and Amherst groups noted the importance of transit for accessing food
• Both communities have some mobile markets or pop-up food pantries, which bring food closer to the people who need it
• Some policies and regulations restrict the transportation of food or people carrying food.
Recommendations

Measuring Statewide Food Access

1. Track food access in a census tract by travel time constraint
2. Measure average statewide food access
3. Measure Gini Coefficient as an indicator of food access equity
4. Coordinate with other efforts to measure and analyze food access
Recommendations

Moving Food to People

5. Coordinate with municipal and regional planning agencies to:
   a. Analyze candidate locations for new supermarkets in underserved communities.
   b. Identify locations that may be candidates for pilot projects that involve delivering fresh/healthy foods to smaller stores.
   c. Identify locations that may be good candidates for establishing mobile or pop-up food pantries.
   d. Identify locations where the direct delivery of food to households should be prioritized.
Recommendations

Moving People to Food

6. Expand transit services in communities with low food access, especially by the following strategies:
   a. Extend hours of transit operation
   b. Extend/redesign transit routes
   c. Expand microtransit services

7. Include data on food access in the evaluation criteria for the MassDOT Community Transit Grant Program
Recommendations

Moving People to Food

8. Improve integration/coordination between transit agencies

South Deerfield lacks supermarkets

Hadley has the largest number of supermarkets in the regions

- 17 mins (10 miles) by car
- 1hr 10 min by transit during a weekday
- Not possible by transit on evenings/weekends
Recommendations

Moving People to Food

9. Improve pedestrian and bicycle connectivity

The speed limit on this road is 50 mph.
Recommendations

Changes in Policies or Regulations

10. Increase carry-on limit for transit

11. Allow vehicles to be used flexible for passenger and food transportation
Conclusions

Methodological Contributions

• A replicable process has been established, using statewide data sources and Conveyal, to measure food access by mode

• Gini Coefficient can be used as a statewide equity metric

• Models show food access relative to similar communities in Massachusetts

Limitations

• The spatial methods represent availability of food but do not account for affordability or whether foods are culturally appropriate

• Spatial analysis using Conveyal accounts for fixed route transit but not emerging microtransit programs.
Future Research – Phase II

• Developing a method to incorporate microtransit services into the analysis, so that the effect on food access can be quantified

• Analysis of where spatial gaps in access align with vulnerable and food-insecure populations

• Expand scope to consider access to other determinants of public health:
  • Health/Medical Care
  • Education
  • Recreation Facilities
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