EXAMINING SPATIAL CLUSTERING PATTERNS AND REGIONAL VARIATIONS FOR HEALTHY EATING ENVIRONMENTS IN THE UNITED STATES

Marilyn Wende, Andrew T. Kaczynski, Ellen W. Stowe, Jan M. Eberth, Alexander C. McLain, Angela D. Liese, Charity Breneman, Michele Josey
Childhood obesity is a major health concern in the United States, with increasing trends in the last three decades.1-3

Childhood obesity is a risk factor for high blood pressure, high cholesterol, type 2 diabetes, and overall mortality in adulthood.2,4-7

Individual and behavioral risk factors for obesity were the main focus of research in the past.8-10 but research now suggests that the environment is the key factor contributing to physical inactivity and unhealthy diets.11-12
OBESOGENIC ENVIRONMENTS

Defined as the sum of influences that the surroundings, opportunities, or conditions have on promoting obesity in individuals or populations, and focuses on the environmental level for obesity risk. 

13-17
Spatial clustering analyses have been used to track health outcomes, such as obesity, diabetes and cancer. Used to identify determinants of these outcomes, such as healthy and unhealthy food sources. Can examine how environments become centralized according to rurality and region.
NUMBER OF FAST FOOD STORES PER 1000 PEOPLE
GAPS

- Data & maps available for separate food measures, but no country-wide representation of a composite, food environment measure.
- Clustering of these food environments
- Research on geographic distribution of childhood obesogenic environments focuses on local levels.
OBJECTIVES

The purpose of this study was to examine county-level spatial patterns of obesogenic environments across the United States.

Objective 1 ➔ To examine the spatial clustering of positive and negative food environments across the United States.

Objective 2 ➔ To explore differences in food environments between regional and rurality divisions of the United States.
Obesogenic environment index data were collected for all counties across the United States (N=3,142).

Census regions were used to classify counties into four regional distinctions: **Northeast, Midwest, South and West**.

Urban influence codes, were collected from the United States Department of Agriculture, and categorized into: **Metropolitan, Micropolitan and Rural** (consisting of Small Adjacent and Remote Rural).
DEVELOPING THE OBESOGENIC ENVIRONMENT INDEX

A search on PubMed was conducted for review articles on environmental factors related to youth PA, nutrition, and overweight/obesity.

100 unique variables identified during the review were partitioned into categories to create a final list of 24 variables to share with expert reviewers.

Experts reviewed and rated the perceived importance of each variable, resulting in a final list of 10 variables: 6 related to food and 4 related to PA environments.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Measure</th>
<th>Source</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grocery stores and super centers</td>
<td>Number of grocery stores/supermarkets and supercenters/warehouse club stores in the county per 1,000 county residents</td>
<td>United States Department of Agriculture</td>
<td>2014</td>
</tr>
<tr>
<td>Farmers markets</td>
<td>Number of farmers markets in the county per 1,000 county residents</td>
<td>United States Department of Agriculture</td>
<td>2016</td>
</tr>
<tr>
<td>Fast food restaurants</td>
<td>Number of fast food restaurants in the county per 1,000 county residents</td>
<td>United States Department of Agriculture</td>
<td>2014</td>
</tr>
<tr>
<td>Full-service restaurants</td>
<td>Number of full-service restaurants in the county per 1,000 county residents</td>
<td>United States Department of Agriculture</td>
<td>2014</td>
</tr>
<tr>
<td>Convenience stores</td>
<td>Number of convenience stores in the county per 1,000 county residents</td>
<td>United States Department of Agriculture</td>
<td>2014</td>
</tr>
<tr>
<td>Births at baby-friendly facilities</td>
<td>Percent births at baby-friendly facilities at the state level</td>
<td>Centers for Disease Control and Prevention</td>
<td>2016</td>
</tr>
</tbody>
</table>

CREATING FOOD ENVIRONMENT SCORES

The values for each variable were ranked, and a percentile value was assigned to each county ranging from 0 to 100.

Negative environmental features, such as fast food restaurants, full-service restaurants, and convenience stores were reverse-scored.

Food environment variables were averaged to create a composite score out of 100 (higher = better).
Objective 1 ➔ To examine the spatial distribution of positive and negative food environments across the United States

- Use of choropleth maps
- Spatial analytic techniques
  - Global Moran’s I
  - Anselin’s Local Moran’s I
FOOD ENVIRONMENT ACROSS UNITED STATES COUNTIES, N=3142
CLUSTER AND OUTLIER ANALYSIS FOR THE FOOD ENVIRONMENT SCORES, N= 3142

Local Moran’s I

<table>
<thead>
<tr>
<th>Cluster Type</th>
<th>County Count</th>
<th>County %</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-High Cluster</td>
<td>407</td>
<td>13.0%</td>
</tr>
<tr>
<td>High-Low Outlier</td>
<td>110</td>
<td>3.5%</td>
</tr>
<tr>
<td>Low-Low Cluster</td>
<td>434</td>
<td>13.8%</td>
</tr>
<tr>
<td>Low-High Outlier</td>
<td>39</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

Global Moran’s I

<table>
<thead>
<tr>
<th>Index</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food environment score</td>
<td>.19</td>
</tr>
</tbody>
</table>

*significant with a = .05

Local Moran’s I

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*significant with a = .05
Objective 2 → To explore differences in food environments between regional and rurality divisions of the United States.

- ANOVA
- Tukey’s Standardized Range
Region of United States Counties

- The West
- The Midwest
- The Northeast
- The South
### Average Percentile Rank (SD)

<table>
<thead>
<tr>
<th>Region</th>
<th>Average Percentile Rank (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>65.7 (15.1)</td>
</tr>
<tr>
<td>Midwest</td>
<td>54.0 (15.6)</td>
</tr>
<tr>
<td>South</td>
<td>46.1 (17.5)</td>
</tr>
<tr>
<td>West</td>
<td>50.6 (18.1)</td>
</tr>
</tbody>
</table>

### ANOVA F statistic and p-value

<table>
<thead>
<tr>
<th>ANOVA F statistic</th>
<th>ANOVA p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.06</td>
<td>&lt;.0001*</td>
</tr>
</tbody>
</table>

Overall, there were significant differences in food environment scores according to region.

Looking at individual differences between the regions, each region was significantly different from the others.
RURALITY OF UNITED STATES COUNTIES, N=3142
<table>
<thead>
<tr>
<th></th>
<th>Average Percentile Rank (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan Counties</td>
<td>49.9 (9.8)</td>
</tr>
<tr>
<td>Micropolitan Counties</td>
<td>49.3 (10.6)</td>
</tr>
<tr>
<td>Rural Counties</td>
<td>52.8 (13.4)</td>
</tr>
<tr>
<td>ANOVA F statistic</td>
<td>27.16</td>
</tr>
<tr>
<td>ANOVA p-value</td>
<td>&lt;.0001*</td>
</tr>
</tbody>
</table>

Overall, there were significant differences in food environment scores according to rurality.

Metropolitan and Micropolitan counties had similar food environment scores, but were significantly lower (worse) than rural counties.
Food environment score values were not randomly distributed across the U.S.

More low-low clusters compared to high-high clusters.

Clusters of high food environment scores were located along coastal regions of the Northeast and West.

Significant differences based on region and rurality.
LIMITATIONS

- No outcome measure
- Key food environment variables may not be included/available
- May need smaller scale studies to inform interventions
**IMPLICATIONS**

Results can inform future public health initiatives by demonstrating the geographic distribution of environments that promote obesity.

Similar methods can be used in future efforts to track obesogenic environments and illustrate their widespread impact on health.

Future research can examine the impact of policy on these food environments to understand reasons behind observed clustering.
REFERENCES

ACKNOWLEDGEMENTS

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