2011 MCRSA Conference
Session 4: SPATIAL ANALYSIS

A Spatial Analysis of County-level Obesity Prevalence in Michigan

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Obesity Epidemic

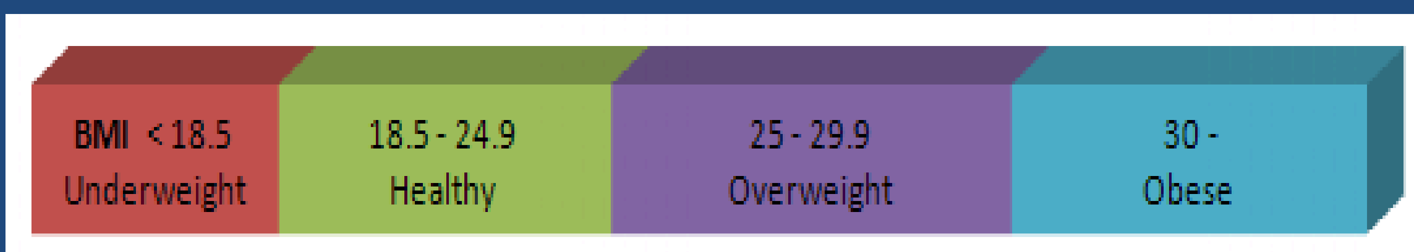
- Obesity and its co-morbidities including diabetes and hypertension are major threats to public health all around the world.
- Globally, in 2008 (WHO, 2010; WFP, 2010);

1.5 billion
People with Overweight or Obese

>

925 million
People in Undernourishment

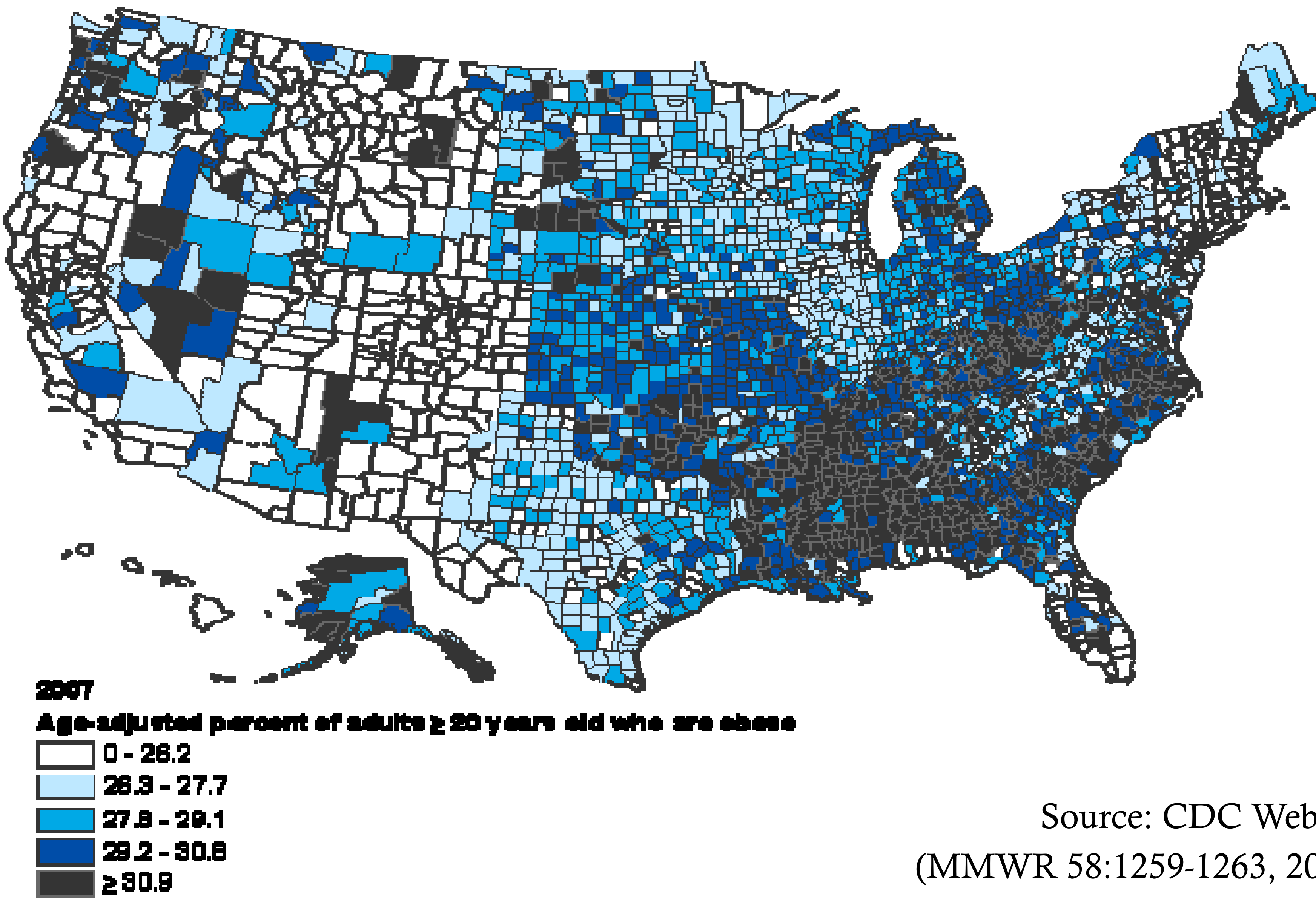
- Obesity is measured by a Body Mass Index (BMI) which is calculated by dividing one's weight in kilogram by one's height square in meter.



Obesity in the US

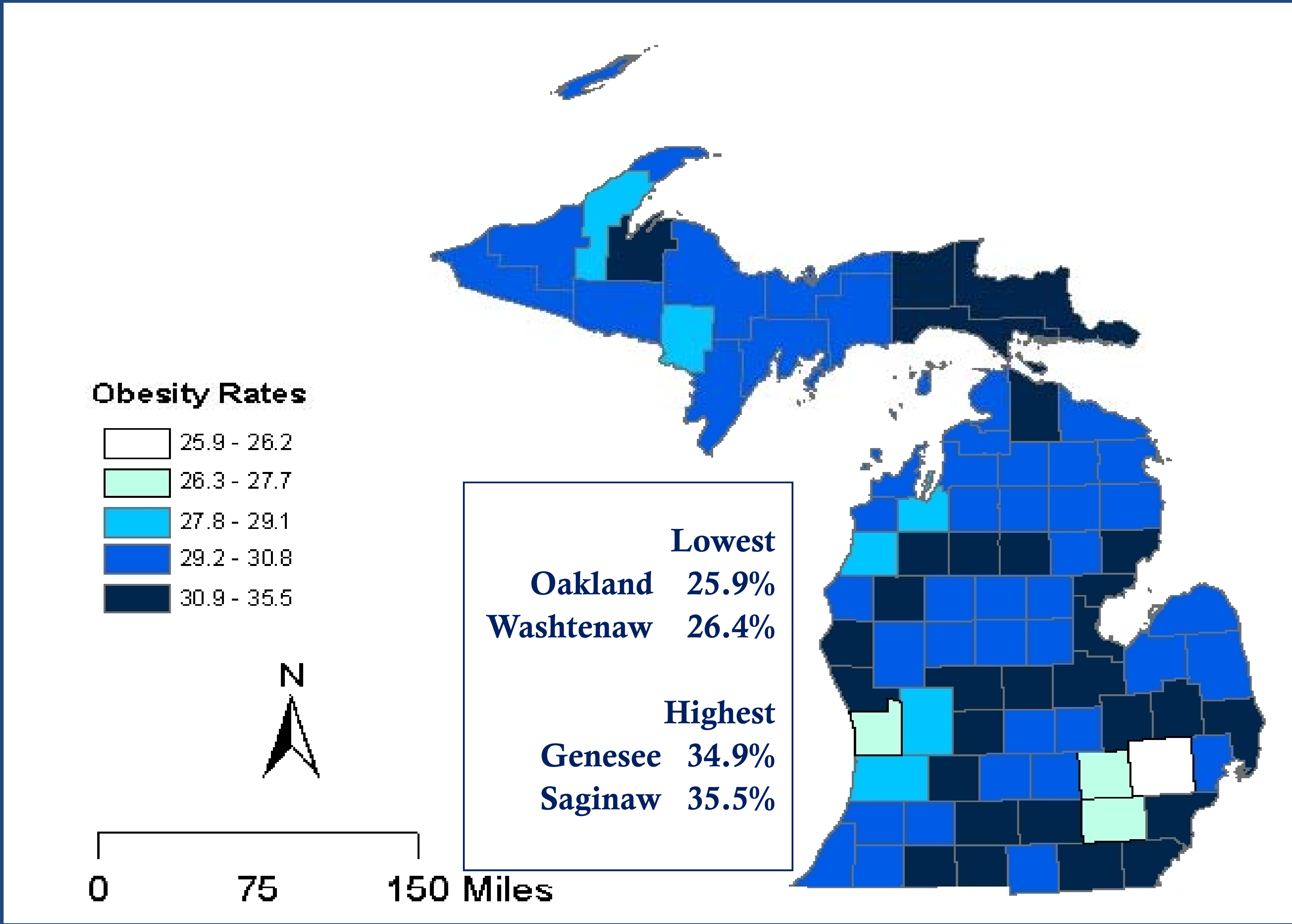
- Adults obesity prevalence has doubled in the past two decades; 12% in 1991 → 27% in 2009 (Mokdad et al., 2001; Flegal, 2002; Chou, 2004; CDC, 2010).
- In Michigan, 30.9% (95% CI: 29.6-32.3) of Michiganders were obese in 2009, compared with 22.5% (95% CI: 20.7-24.3) in 2000 (MDCH, 2009).
- It is interesting that there is a substantial variability in obesity prevalence across counties in the US.

Obesity in the US



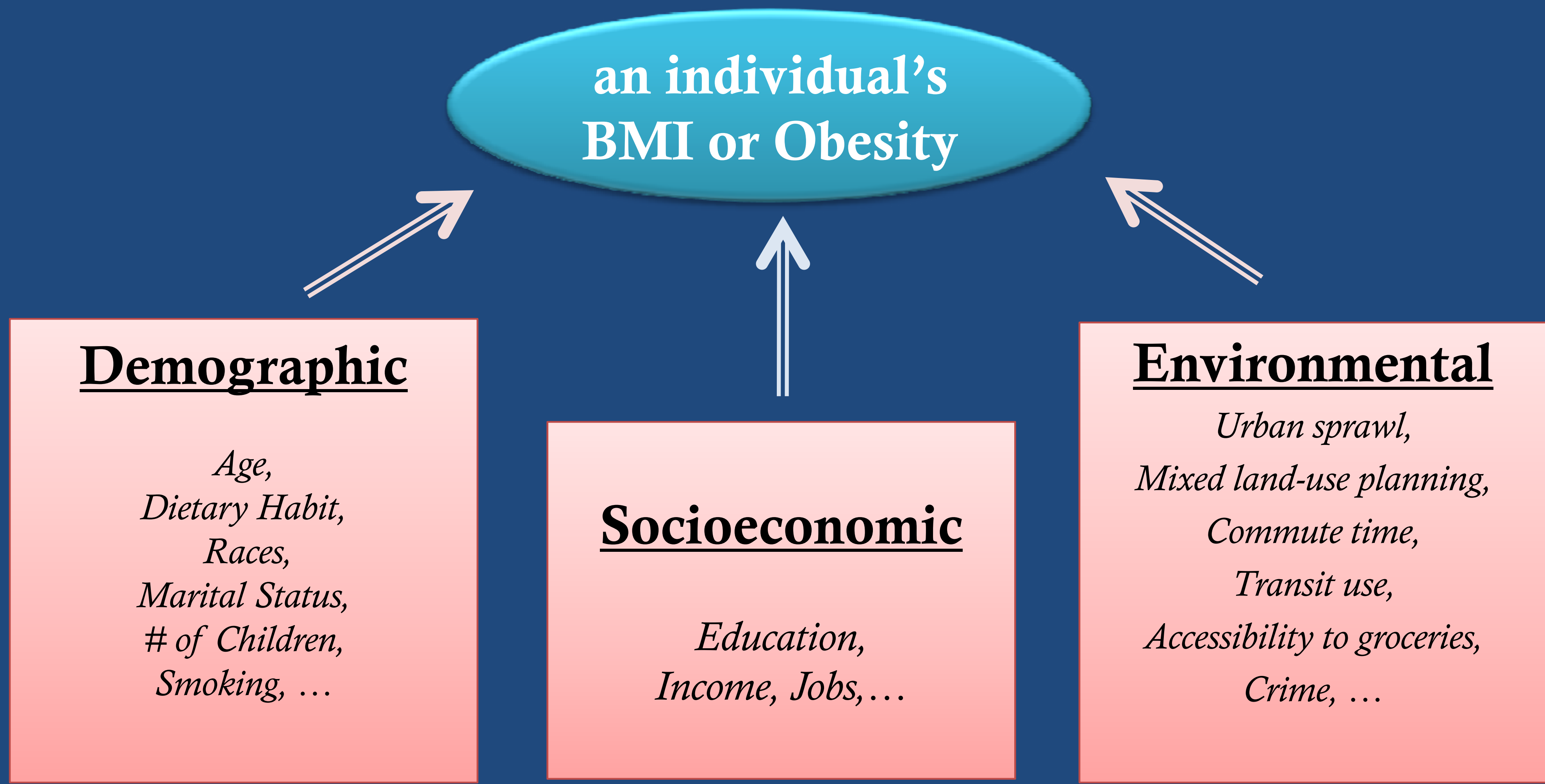
Source: CDC Website
(MMWR 58:1259-1263, 2009)

Obesity Rates in Michigan



Created by the author
using 2008 NDSS

The Obesity Literature



→ Most previous studies have analyzed the association between an individual's obesity status and risk factors.

Why County-level Study?

1. There are noticeable health disparities across US counties (Joins et al, 2003; Soobader et al., 2006; Sparks et al, 2010)
2. There are only a handful of studies on the county-level obesity prevalence and risk-factors (Amarasinghe et al., 2006; Chen et al., 2009).
3. Spatial dependence/autocorelation problems (Anselin, 1988; LeSage, 1998; LeSage & Pace, 2008).
4. Recent progresses in spatial modeling

→ This study aims to examine ***what makes the variability in obesity prevalence among Michigan counties*** and to discuss subsequent policy implications.

Methodology

- OLS $$O = \beta X + \varepsilon$$

- SAR $$O = \rho WO + X\beta + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

O: county level obesity prevalence in Michigan

X: a set of independent variables

β: parameters

ε: error term

ρ: the parameter of the spatially lagged variable

W: a spatial weight matrix

Methodology

- SEM

$$O = \beta X + \mu$$
$$\mu = \lambda W \mu + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

- SAC

$$O = \rho W_1 O + X\beta + \mu$$
$$\mu = \lambda W_2 \mu + \varepsilon$$
$$\varepsilon \sim N(0, \sigma_\varepsilon^2 I_n)$$

λ: the coefficients of spatial errors

W_1 & W_2 : spatial weight matrices

Methodology

- Data Sources:

(1) Obesity rates: 2008 National Diabetes Surveillance System (NDSS) from CDC

(2) Contextual data: 2000 Census, 2002 Economic Census, 2008 Michigan Incident Crime Reporting

- Software: ArcGIS 9.3 (ESRI, 2008), SAS 9.2 (SAS Institute, 2008), Matlab 7 (MathWorks, 2010)
- Variables: VIF (Variance Inflation Factor) & CI (Condition Indices) checked for multicollinearity, z-scores for normalization

Methodology

Classification	Variables	Explanation	Mean	SD	Expectation
Dependent Variable	OBESITY	County-level Obesity Prevalence	30.42	1.58	
Independent Variables	***Demographic***				
	INCOME	Median Household Income	$38,493	$7,735	-
	% BLACK	% Blacks	3.92	5.98	+
	% FOREIGN	% Foreign-born Population	2.23	1.93	-
	% UNIV	% College Graduates	16.37	7.25	-
	Environmental				
	COMMUTE	Daily Travel Time to Work	23.03	3.93	+
	HOMEOWN	% Homeownership	79.56	5.97	-
	% POVERTY	% People under Federal Poverty Line	14.75	3.8	+
	CRIME	Crime Incidence Rate (per 100,000 people)	8716.73	3148.43	+
	FOORSTR	Rate of Food and Beverage Stores (per 100,000 people)	71.86	189.49	-

Results

	OLS		Spatial Models					
			SAR		SEM		SAC	
Variables	Coefficient	Pr>|t|	Coefficient	Pr>|t|	Coefficient	Pr>|t|	Coefficient	Pr>|t|
CONSTANT	0.0000		0.0175		0.3040		0.1094	
Demographic								
INCOME	-0.0403		-0.0727		-0.1031		-0.1282	
% BLACK	0.6341	***	0.6472	***	0.7477	***	0.6913	***
% FOREIGN	-0.4720	***	-0.3710	***	-0.3577	**	-0.1743	
% UNIV	-0.4496	***	-0.4210	***	-0.4371	***	-0.2260	**
Environmental								
COMMUTE	0.1121		0.0602		0.0118		-0.0342	
HOMEOWN	-0.2695	*	-0.2020		-0.1549		0.0102	
POVERTY	-0.1272		-0.1593		-0.1467		-0.1715	
CRIME	0.0615		0.0803		0.1295		0.1907	**
FOODSTR	-0.1146		-0.1436		-0.2755	**	-0.3021	**
ρ (rho)			0.6610	***			3.5670	***
λ (lambda)					0.7970	***	1.3660	***
Adj R-square	0.5221		0.4792		0.6353		0.7749	
σ^2	0.4779		0.3462		0.3208		0.1980	
Log-Likelihood			-47.5182		-45.9766		-50.9665	

***p< .01 **p< .05 *p< .1

Results

- Better model explanation in two spatial models (SAC & SEM), compared to OLS model
- Impacts from *demographic variables* are consistent with previous studies: %BLACK, %UNIV
- Stronger effects from *environmental variables*: CRIME, FOODSTR
- Positive spatial dependence in Michigan's county-level obesity rates: significant values of ρ & λ

Policy Implications

1. Preventing crime
2. Enhancing food environment in terms of the numbers of stores
3. Educating higher risk population or counties
4. Understanding the effect from spatial dependence or autocorrelation

Limitations

1. Which 'neighborhood' level of study is best?
2. Data collected at different time
3. Inconsistency with spatial autocorrelation statistical tests and spatial model

→ Statistically insignificant Moran's I yet significant values of ρ & λ

Suggestions

1. More advanced spatial models or Bayesian modeling should be applied.
2. Different scales needed: e.g. zip code, census tract, census subdivisions, inter-state, or international levels.
3. More environmental variables should be investigated.

Q & A

Thank You!

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