

Neighborhood health effects: methodologic considerations for integrating neighborhood, place, and person

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2004 Health Disparities Symposium
University of Washington
April 2004

Neighborhoods and health

- Evidence
- Limitations of past work and challenges

Evidence

- Contextual and multilevel studies relating area deprivation to health
- Differences across neighborhoods in attributes potentially related to health or health behaviors

Multilevel and contextual studies of neighborhood effects on health

- Context and composition
- Allow for the examination of neighborhood-level factors, individual-level factors, and their interaction
- Account for residual within neighborhood correlations
- Simultaneously examine between and within neighborhood variability

Multilevel (and contextual) studies

- Census areas as proxies for neighborhoods
- Aggregate socioeconomic measures of areas
- Adjustment for individual-level factors
- Variety of health outcomes

Multilevel and contextual studies of neighborhoods and health: United States

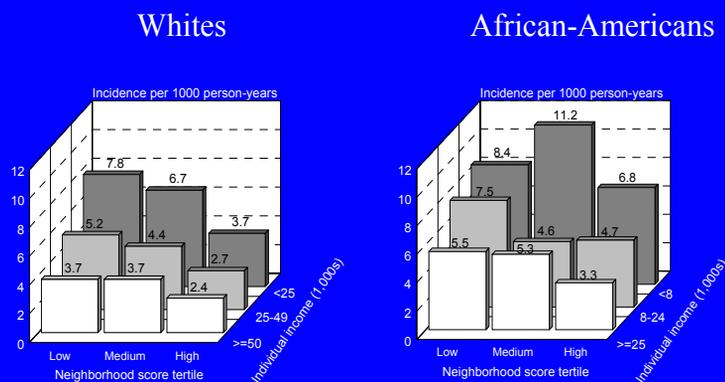
	Outcome	Area unit	Individual-level variables	Area variables investigated
Haan et al 1987	Mortality	Census tracts	Income, employment	Poverty area
Krieger 1992	Blood press.; smoking, height, pregnancies	Block-groups	Working class	% working class
O'Campo et al 1995	Domestic violence	Census tracts	Educat, income, employment	Income; home ownership; unemployment; crime rate
Anderson et al 1996	Mortality	Census tracts	Income	Income
Diez-Roux et al 1997	CHD; CHD risk factors	Block-groups	Education; income; occup.	Education; income; occupation; house value
O'Campo et al 1997	Low birthweight	Census tracts	Education	Income; wealth; housing; home ownership; community groups; crime
Roberts E 1997	Low birthweight	Community areas	Education	SES score; economic hardship score; stability; rent; crowding
Smith et al 1997	Mortality	Enum. districts	Household poverty	Poverty area (interaction marital status)
Diez-Roux et al 1998	Diet	Block-groups	Income	Income
LeClere et al 1998	CHD mortality	Census tracts	Income; education; employment	%female headed hh; income; public assist.;poverty; unemployment; race/ethnicity.
LeClere 1998	Mortality	Census tracts	Education, income	Income, education, ethnic concentration female-headed households
Matteson et al 1998	Infant mortality	County	Education, insurance	Urban, poverty, health care resources
Roberts S 1998	Self-rep. health;chronic conditions;function	Census tracts	Education;income;assets	Public assist.; income; unemployment
Waitzman et al 1998	Mortality	Census tracts	Income, education	Poverty area
Yen and Kaplan 1998	Phys. Activity change	Census tracts	Education;income	Poverty area
Yen and Kaplan 1999	Depression;perceived health	Census tracts	Education;income	Poverty area
Diez Roux et al 2001	CHD incidence	Block-groups	Education, income, occup.	Summary socioeconomic score

Incidence rates of coronary heart disease by race-specific tertiles of neighborhood score: the ARIC Study 1987-1997

Neighborhood tertile†	Men			Women		
	Events	Rate	95% CI	Events	Rate	95% CI
Whites						
I (Low)	119	9.5	7.7-11.5	68	3.9	2.9-5.1
II	109	8.3	6.8-10.0	45	2.6	2.0-3.6
III (High)	70	4.9	3.8-6.3	24	1.5	1.0-2.3
African-Americans						
I (Low)	38	9.8	7.0-13.7	40	5.1	3.7-7.2
II	27	7.5	5.1-11.0	34	5.1	3.6-7.2
III (High)	26	6.4	4.3-9.4	15	2.7	1.6-4.5

Diez Roux et al NEJM

Incidence of coronary heart disease by neighborhood characteristics and individual-level income: The ARIC Study 1987-96



Hazard ratios of coronary heart disease by race-specific tertiles of neighborhood score before and after adjustment: the ARIC Study 1987-96

	Race-specific tertiles of neighborhood score*	Adjusted for age & center	Adjusted for age, center, income, education & occupation†	+ behavioral and biomedical risk factors‡
Whites	I (Low)	2.1 (1.6-2.8)	1.7 (1.3-2.3)	1.6 (1.1-2.2)
	II	1.7 (1.3-2.3)	1.5 (1.2-2.1)	1.5 (1.1-2.0)
	III (High)	1.0	1.0	1.0
	P trend	<0.001	<0.001	0.008
African-Americans	I (Low)	1.7 (1.2-2.3)	1.4 (0.9-2.0)	1.5 (1.0-2.3)
	II	1.4 (1.0-2.1)	1.3 (0.9-1.9)	1.5 (1.0-2.4)
	III (High)	1.0	1.0	0.09
	P trend	0.003	0.1	0.1

Hazard ratios of cardiovascular and cancer death by race-specific categories of neighborhood score: ARIC

	CVD mortality			Cancer mortality	
	Adjusted for age, gender and center	+ personal socioeconomic indicators	+ personal socioeconomic indicators, CVD prevalence, and risk factors	Adjusted for age, gender and center	+ personal socioeconomic indicators
Whites					
1 (Low)	1.9 (1.4-2.7)	1.5 (1.0-2.1)	1.5 (1.1-2.2)	1.5 (1.2-2.0)	1.1 (0.9-1.6)
2	1.3 (0.9-1.8)	1.1 (0.8-1.6)	1.1 (0.8-1.6)	1.1 (0.8-1.4)	0.9 (0.7-1.2)
3 (High)	1.0	1.0	1.0	1.0	1.0
P for Trend	<0.0001	0.01	0.01	0.001	0.20
African Americans					
1 (Low)	1.5 (1.0-2.1)	1.2 (0.8-1.6)	0.9 (0.7-1.3)	1.4 (1.0-2.1)	1.3 (0.9-1.9)
2	1.3 (0.9-1.8)	1.1 (0.8-1.5)	1.0 (0.7-1.4)	1.0 (0.7-1.5)	0.9 (0.6-1.4)
3 (High)	1.0	1.0	1.0	1.0	1.0
P for Trend	0.02	0.27	0.66	0.03	0.10

Hazard ratios of cardiovascular and cancer death by race-specific categories of neighborhood score: CHS

	CVD mortality			Cancer mortality	
	Adjusted for age, gender and center	+ personal socioeconomic indicators	+ personal socioeconomic indicators, CVD prevalence and risk factors	Adjusted for age, gender and center	+ personal socioeconomic indicators
Whites					
1 (Low)	1.9 (1.5-2.4)	1.5 (1.2-1.9)	1.3 (1.0-1.7)	1.2 (1.0-1.4)	1.0 (0.8-1.3)
2	1.4 (1.1-1.8)	1.2 (1.0-1.6)	1.2 (0.9-1.5)	1.0 (0.8-1.2)	0.9 (0.7-1.1)
3 (High)	1.0	1.0	1.0	1.0	1.0
P for Trend	<0.0001	0.001	0.03	0.11	0.8
African Americans					
1 (Low)	1.5 (0.9-2.7)	1.2 (0.7-2.2)		1.3 (0.8-2.3)	1.4 (0.8-2.4)
2	1.8 (1.1-3.0)	1.7 (1.0-2.8)		1.3 (0.7-2.1)	1.4 (0.8-2.4)
3 (High)	1.0	1.0		1.0	1.0
P for Trend	0.2	0.5		0.3	0.3

Summary

- Effects of aggregate neighborhood/area socioeconomic characteristics persist after controlling for individual-level socioeconomic indicators
- Effects of neighborhood socioeconomic characteristics often (but not always) weaker than effects of individual-level SES
- Small between neighborhood variability relative to total variability
- Mixed results regarding interactions

Differences across neighborhoods in potentially health-relevant attributes

Area characteristics potentially relevant to health

- Resources and physical characteristics
 - Resources to promote/maintain health lifestyles
 - Health care availability/accessibility/cost
 - Services
 - Physical exposures/pollution/traffic/noise
- Social environment
 - Sources of stress
 - Social cohesion/networks/organizations
 - Norms/prevalence of behaviors

Area resources in Northwest and Southwest localities of Glasgow, Scotland 1989-90

	Northwest	Southwest
Recreation facilities		
Number of:		
Athletic tracks	2	1
Boating ponds	3	0
Bowling greens	12	8
Cycle tracks	1	0
Playing fields	15	1
Transport statistics		
% households no car	53%	75%
# ordinary bus routes	3	3
# shoppers' bus routes	3	0
# hospital bus service routes	2	0
Peak trains per hour	65	8
Off peak trains per hour	44	5
Sunday trains per hour	20	<1
Taxi stances	8	5
Primary care		
Health centers	1	2
Clinics	4	2
GP practices	36	12
Dental practices	24	10
Opticians	18	5
Pharmacies	29	17

Adapted from Macintyre et al 1993

Population-density adjusted prevalence ratios of food stores and food places by neighborhood racial segregation: The ARIC Study Communities

	Predominantly black	Mixed	Predominantly white
Food stores			
Supermarkets	1.0	3.6	5.3
Grocery stores	1.0	0.7	0.4
Convenience stores	1.0	0.4	0.2
Specialty foods	1.0	1.6	1.1
Food service			
Full service	1.0	3.7	2.7
Fast food	1.0	2.5	1.6
Carry out	1.0	3.1	2.3
Bars/Taverns	1.0	1.4	0.6

Adapted from Morland et al. AJPH

TABLE 1—Tobacco Ad Characteristics on Billboards in Four Predominantly Ethnic Neighborhoods: Los Angeles, Calif, 1993 and 1994

	African American	Hispanic	Asian	White
Tobacco ad density	1.46 a	.87 b	.65 b	.21 c
Tobacco ad concentration	.10 b	.13 b	.65 b	.03 b
% of ads with characters	0.79 b	0.58 b	0.27 a,b	0.63 b
Race/ethnicity of central character				
African American	0.91 a	0.00 b	0.00 b	0.00 b
Asian	0.00 b	0.00 b	0.00 b	0.00 b
White	0.09 a	1.00 b	1.00 b	1.00 a
Mixed ethnicities	0.00 b	0.00 b	0.00 b	0.00 b
Gender of central character				
Male	0.30 b	0.69 a,b	0.58 a,b	0.67 a
Female	0.34 a	0.16 a,b	0.42 a	0.08 a
Both genders	0.36 a	0.14 a,b	0.00 b	0.25 a,b
Age of central character				
18–29	0.89 a	0.48 b	0.32 b	0.25 b
30–49	0.02 a	0.27 a,b	0.18 a,b	0.33 b
Mixed ages	0.03 b	0.09 b	0.05 b	0.42 a
Cartoon	0.06 b	0.16 b	0.45 a,b	0.00 b

Note. Different letters represent significantly different ($P < .05$) values within a row.

Am J Public Health 1997:1232

Associations between grocery store shelf-stocking measures and self-reported individual dietary practices, by geographic unit of analysis

	Communities (n=12)	Zip codes (n=34)
Days eating red meat vs. Percent store red meat	0.27	0.44
Percent drinking reduced-fat milk vs. Percent store reduced fat milk	0.69	0.63
Percent eating dark bread vs. Percent store non-white bread	0.58	0.29
Percent calories from fat vs. <u>Store healthfulness scale</u>	-0.52	-0.41

Adapted from Cheadle et al 1991

Relative probabilities of meeting dietary guidelines by presence of a supermarket in the census tract of residence: The ARIC Study

	African-Americans	Whites
Fruits and vegetables	1.54 (1.11-2.12)	1.08 (0.89-1.30)
Saturated fat	1.30 (1.07-1.56)	1.09 (0.99-1.20)

Morland et al AJPH 2002

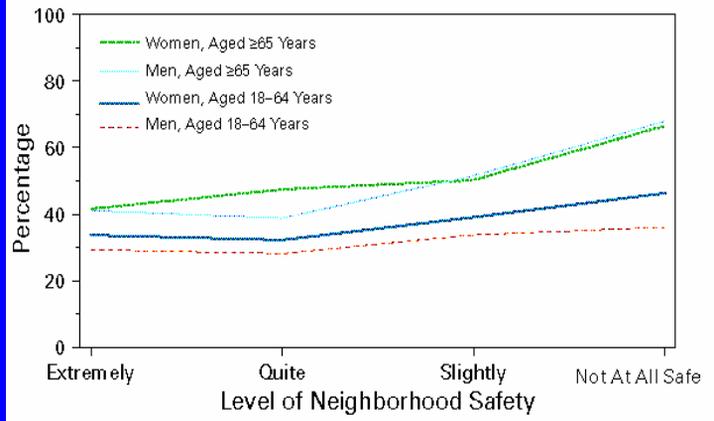
Adjusted* Odds Ratios of Being Physically Active by Perceived Environmental Characteristics

	OR	95% CI
Indoor or Outdoor Place to Exercise	1.85	(1.39, 2.47)
Walking/Jogging Trail	1.55	(1.19, 2.02)
Park	1.95	(1.52, 2.52)
Enjoyable Scenery	1.46	(1.13, 1.88)

*Adjusted for socio-demographic characteristics; Referent is No Access or No Enjoyable Scenery

Source: Brownson, R.C., Baker, E.A., Housemann, R.A., et. al. (2001)

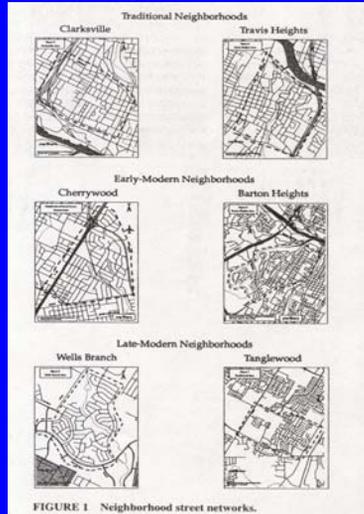
FIGURE 1. Percentage of respondents who reported physical inactivity, by sex, age group, and perceived neighborhood safety level — Maryland, Montana, Ohio, Pennsylvania, and Virginia, Behavioral Risk Factor Surveillance System, 1996



Urban Planning and Public Health

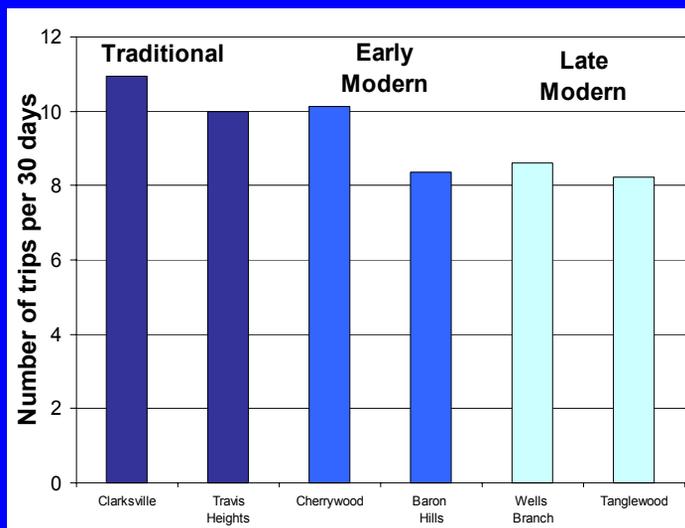
- Land development patterns
 - Density
 - Land use mix
- Transportation systems
 - Transit availability
 - Street characteristics
- Urban design
 - Street scale
 - Aesthetic features

Comparison of three types of neighborhoods



Source: Handy (1996)

Strolling Trips by Type of Neighborhood



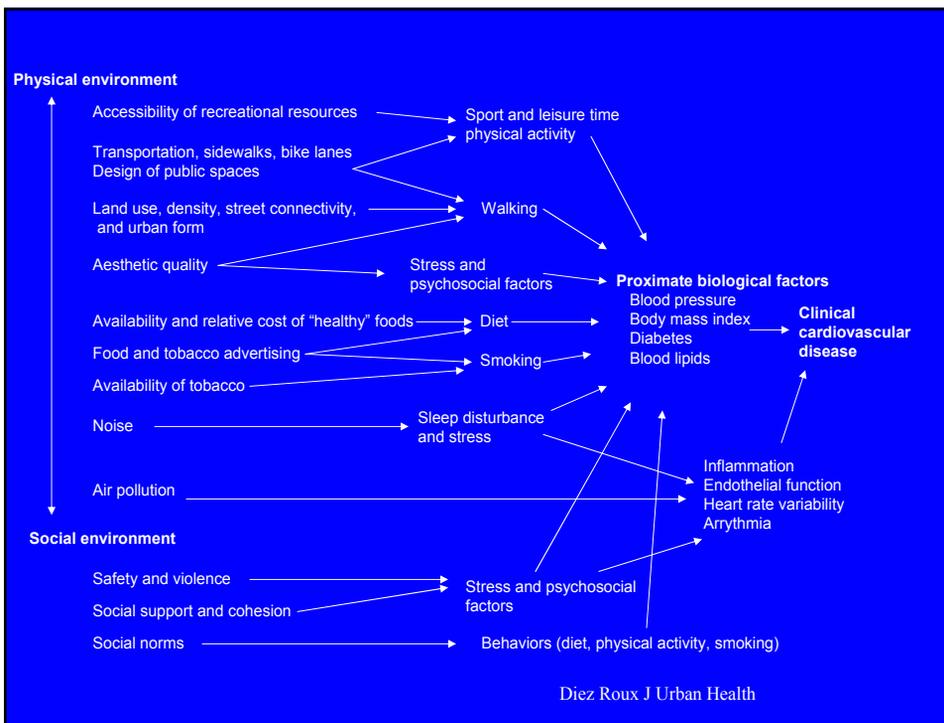
Source: Handy (1996)

Do the associations observed reflect
causal processes?

- Theory-driven study design/data collection approaches
- Methodological refinement

Theoretical models linking neighborhoods or areas to health

- Models of causal processes linking specific area characteristics to specific health outcomes
- Processes may differ for different health outcomes and different populations
- Hypotheses that can be operationalized and tested



MESA Neighborhood Study

- Longitudinal study of 6800+ participants in six sites
- Detailed measures of subclinical disease, biologic markers, and behaviors
- Neighborhood-level data
- Stress hormone data

Methodological Refinement

- Defining “neighborhoods”
- Measuring neighborhood-level properties
- The role of individual-level variables
- Complex causal systems

Defining neighborhoods or relevant areas

- Multiple possible definitions of “neighborhoods”
- Area size, processes, and outcomes as linked
- Operationalization
- Spatial dependencies

MESA Neighborhood Study

- Obtain information from participants on where they carry out daily tasks
- Construction of neighborhood clusters using GIS and spatially constrained clustering algorithm
- Variety of different neighborhood definitions possible (census, clusters, radius)
- Time spent in “neighborhood”

Neighborhood or area characteristics

- Limitations of aggregate measures as proxies
- Specific characteristics linked to specific outcomes
- Interrelationships between area-level variables
- Measurement
 - Surveys of area residents
 - GIS based measures: distance and density measures
 - Systematic social observation
 - Expert surveys

MESA Neighborhood Study

- Self-reported characteristics (scales to measure various domains)
- Residential surveys
- GIS-based density and distance measures

AESTHETIC ENVIRONMENT	WALKING/ EXERCISE ENVIRONMENT	SAFETY	ACCESS to HEALTHY FOODS	SOCIAL COHESION	VIOLENCE IN PAST 6MONTHS
<ul style="list-style-type: none"> -My neighborhood is attractive -There is a lot of trash and litter on the street in my neighborhood -There are interesting things to do in my neighborhood -There is enjoyable scenery in my neighborhood -There is a lot of noise in my neighborhood -In my neighborhood the buildings and homes are well maintained -The buildings and houses in my neighborhood are interesting 	<ul style="list-style-type: none"> -My neighborhood offers many opportunities to be physically active -Local sports clubs and other providers in my neighborhood offer many opportunities to get exercise -It is pleasant to walk in my neighborhood -There are enough trees in my neighborhood to provide shade -My neighborhood has heavy traffic -There are busy roads to cross when out for walks in my neighborhood -In my neighborhood it is easy to walk to places -There are stores within walking distance of my home -In my neighborhood, the streets and sidewalks are in good condition -I often see other people walking in my neighborhood -I often see other people exercise (for example jog, bicycle, play sports) in my neighborhood 	<ul style="list-style-type: none"> -I feel safe walking in my neighborhood during the evening -My neighborhood is safe from crime -Violence is a problem in my neighborhood 	<ul style="list-style-type: none"> -It is easy to purchase fresh fruits and vegetables in my neighborhood -There is a large selection of fresh fruits and vegetables available in my Neighborhood -The fresh produce in my neighborhood is of high quality -It is easy to purchase low fat products (such low fat milk or lean meats) in my neighborhood -There is a large selection of low fat products available in my neighborhood -The low fat products in my neighborhood are of high quality 	<ul style="list-style-type: none"> -This is a close-knit or unified neighborhood -People around here are willing to help their neighbors -People in this Neighborhood generally don't get along with each other -People in this neighborhood can be trusted -People in this neighborhood do not share the same values 	<ul style="list-style-type: none"> During the past six months, how often was there a fight in this neighborhood in which a weapon was used? -Any gang fights? -A sexual assault or rape? -A robbery or mugging?

PRESENCE OF RECREATIONAL FACILITIES INDEX	ACTIVITIES WITH NEIGHBORS INDEX	NEIGHBORHOOD PROBLEMS INDEX
<ul style="list-style-type: none"> -Public park -Public sports field, basketball court or tennis court -Public pool or beach -Schools, colleges, or community centers with recreational facilities that are free and open to the public -Gyms, health /fitness clubs or pools that you have to join and pay for -YMCA's or YWCA's -Bicycle path in the street or park -Are there sidewalks in your neighborhood? 	<ul style="list-style-type: none"> -A neighborhood association like a block association, a homeowner or tenant association or a crime watch group -Religious groups or charitable organizations -Parent-teacher associations or other school support or service groups -Youth organizations such as a youth sports league or the scouts -Clubs or associations for senior citizens or older people -A labor union -A professional, trade, farm or business association -Adult sports clubs or leagues or an outdoor activity club -A literary, art, discussion or study group or a musical, dancing or singing group -Any other hobby club or society -Ethnic, nationality or civil rights organizations -Other public interest groups, political groups or party committees 	<ul style="list-style-type: none"> -Trash or litter in the streets -Noise from traffic, other homes, airplanes or businesses -Smells or fumes -Lack of safety for walking around after dark -Lack of places to go for entertainment (restaurants, movie theatres, cafes, bars) -Poor traffic and road safety -Lack of places to shop -Vandalism, like people breaking windows or spray painting buildings -Vacant housing -Vacant lots with trash or junk -Assaults, muggings or burglaries -Lack of trees or green spaces -People who don't keep up their property or yards -No sidewalks or sidewalks in bad condition -Problems with public services such as street lighting, garbage pick-up and police -Lack of public transportation -People fighting or arguing -People selling illegal drugs

Construct	Number of Items	Cronbach's Alpha	Test-Retest ICC (95% confidence interval)
Aesthetic quality	7	0.89	0.91 (0.85-0.95)
Walking/ exercise environment	11	0.78	0.88 (0.79-0.93)
Access to Healthy Foods	6	0.91	0.88 (0.79-0.83)
Safety from crime	3	0.77	0.80 (0.67-0.88)
Violence	4	0.85	0.78 (0.64-0.87)
Social cohesion	5	0.82	0.90 (0.84-0.94)
Recreational facilities index	8		0.85 (0.75-0.92)
Social participation index	12		0.73 (0.56-0.84)
Problems index	18		0.91 (0.84-0.95)

Echeverria et al.

Ecometrics

Level 1 (item responses within individuals)

$$Y_{ijk} = b_{ojk} + \sum_{p=1}^{p=n} \pi_p D_{pijk} + e_{ijk} \quad \text{var } e_{ijk} = \sigma^2$$

- Y_{ijk} is response to i th scale item in respondent j living in neighborhood k
- D_{pijk} is an indicator variable taking on a value of unity if response i is to item p in the scale and zero if response is to some other item.

Level 2 (individuals within neighborhoods)

$$b_{ojk} = \lambda_{00k} + \lambda_{01k} x_{jk} + \alpha_{0jk} \quad \text{var } \alpha_{0jk} = \tau_b$$

- x_{jk} represents an individual-level characteristics (grand mean centered) for person j in neighborhood k (e.g. age)
- λ_{00k} represents the mean value for the scale in neighborhood k , adjusted for variations in scale responses based on individual characteristics of respondents such as age.

Level 3 (neighborhoods)

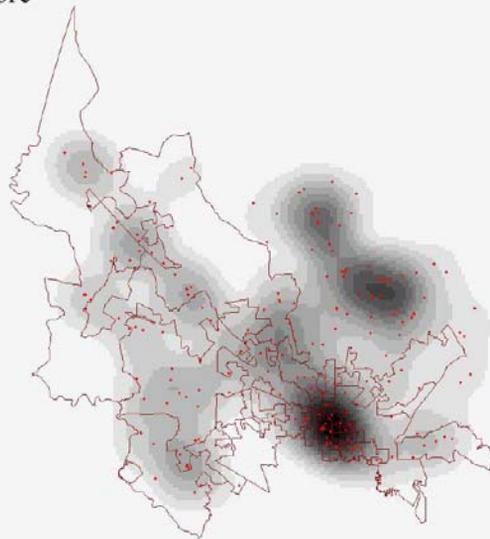
$$\lambda_{00k} = \gamma_{000} + U_{00k} \quad \text{var } U_{00k} = \tau_\lambda$$

- γ_{000} represents the mean value for the neighborhood-level measures across neighborhoods and U_{00k} represents a random neighborhood effect (which captures the dependence in scale responses for persons living in the same neighborhood).

GIS approaches

- Simple density measures
- Distance measures
- Smooth density kernel maps

Baltimore



- More flexibility regarding specification of area size
- Hypotheses!

“Exposure” in studies of neighborhood effects

- Definition
- Variable across individuals
- Variable over time
- Lagged effects

Individual-level variables in studies of neighborhood effects

- The selection problem/exchangeability assumption
- Extrapolations beyond support in the data

Individual-level covariates for white participants in lowest and highest neighborhood score groups for the full sample and for propensity score matched pairs: CHS

	Full sample (n=2890)		Propensity score matched pairs (n=1010, 505 matched pairs)	
	Group 1 (Lowest) N=1390	Group 3 (Highest) N=1434	Group 1 (Lowest) N=505	Group 3 (Highest) N=505
% Female	59	56	58.2	57.2
Mean age	72.7	72.9	72.6	72.7
Income (% distribution)				
<\$5,000	5.9	0.8	1.0	1.8
\$5,000-\$7,999	11.0	2.4	5.9	4.6
\$8,000-\$11,999	14.8	5.3	9.9	9.5
\$12,000-\$15,999	19.6	8.9	14.1	16.0
\$16,000-\$24,999	20.7	14.9	25.7	24.6
\$25,000-\$34,999	14.0	15.3	16.4	18.2
\$35,000-\$49,999	4.9	14.6	9.7	10.3
>=\$50,000	4.5	28.8	10.5	8.3
Education (% distribution)				
Less than complete high school	42.0	10.6	20.0	22.4
Complete high school/GED	39.2	33.0	48.3	46.9
1-3 years college	8.9	18.1	16.4	13.5
Complete 4 year college	5.4	20.0	8.1	11.1
Graduate school	4.5	18.3	7.1	6.1
Occupation (%distribution)				
Profess/technical/managers	25.3	47.2	37.4	36.1
Sales/clerical/service	13.9	18.3	17.6	21.4
Craftsmen/Machine operators/ Farming/Forestry	25.0	6.4	12.9	14.9
Homemaker	24.5	21.7	22.0	19.3
Other/missing	11.3	6.4	10.1	8.3

RH (controlling for income, education, and occupation): 1.6 CL 1.1-2.5)

Individual-level variables in studies of neighborhood effects

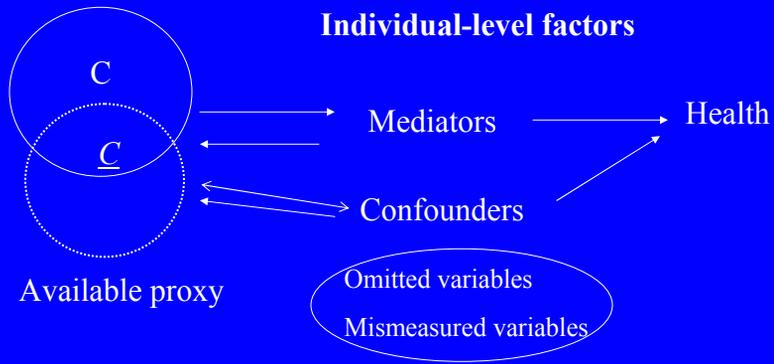
- Understanding residential choice/mobility
- Specification of individual vs. neighborhood variables
- Interactions

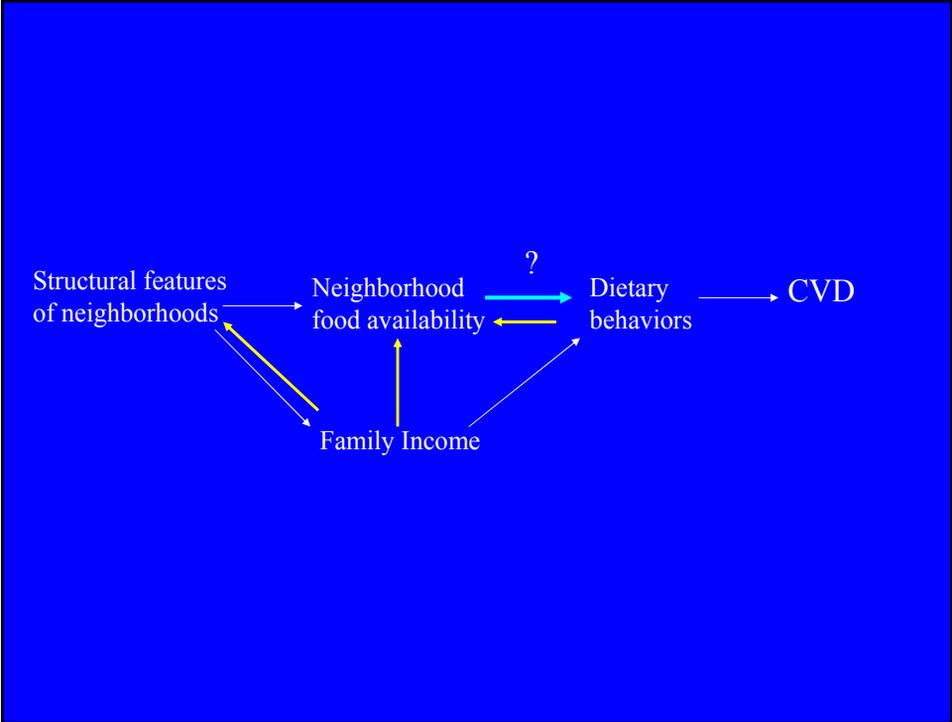
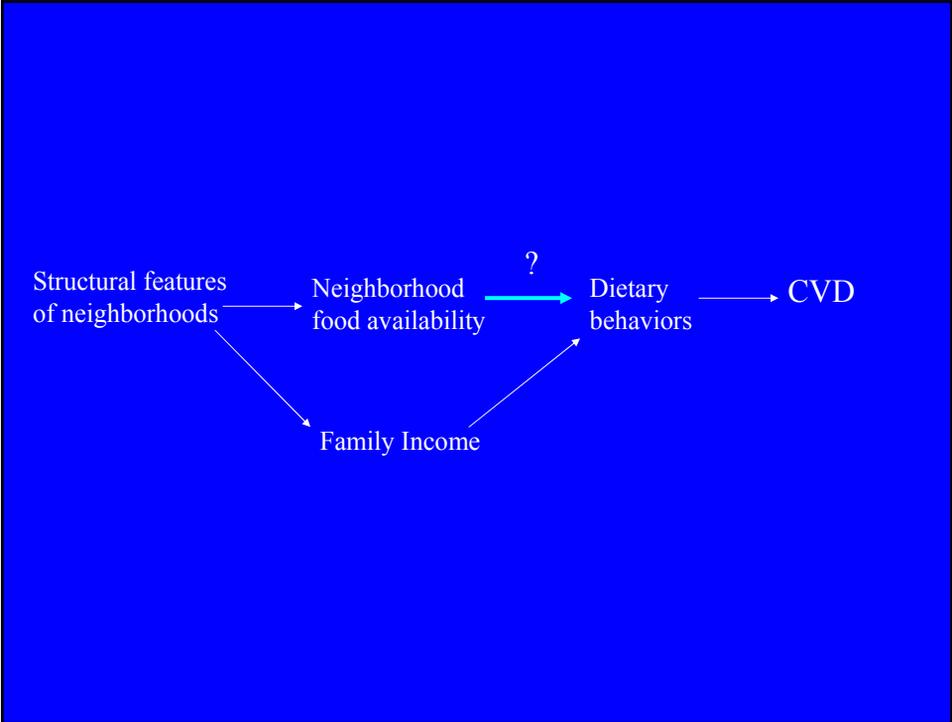
Pathways and complex causal systems

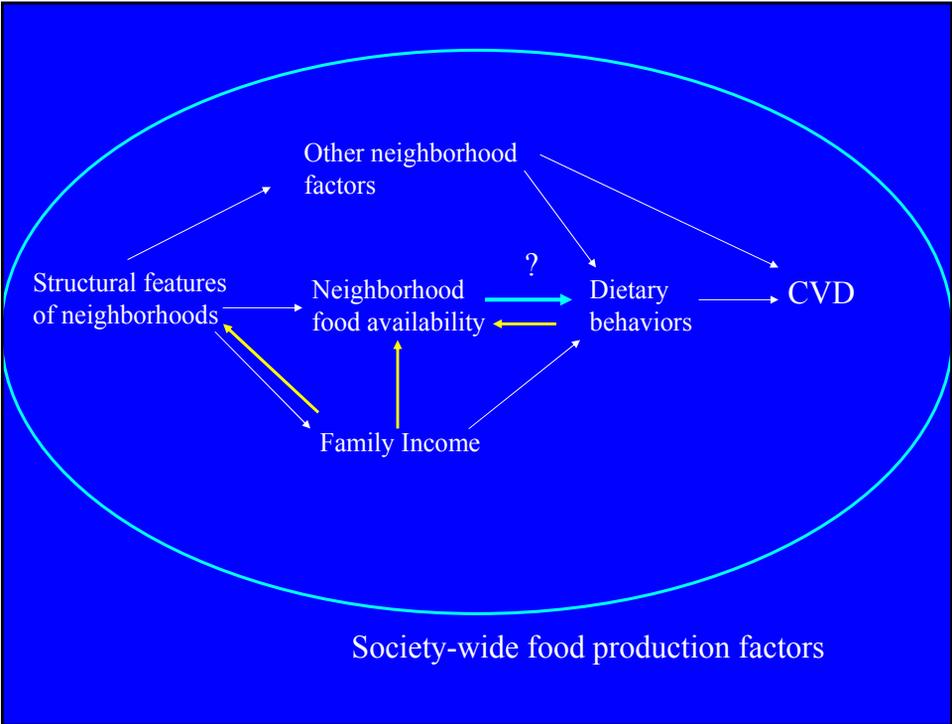
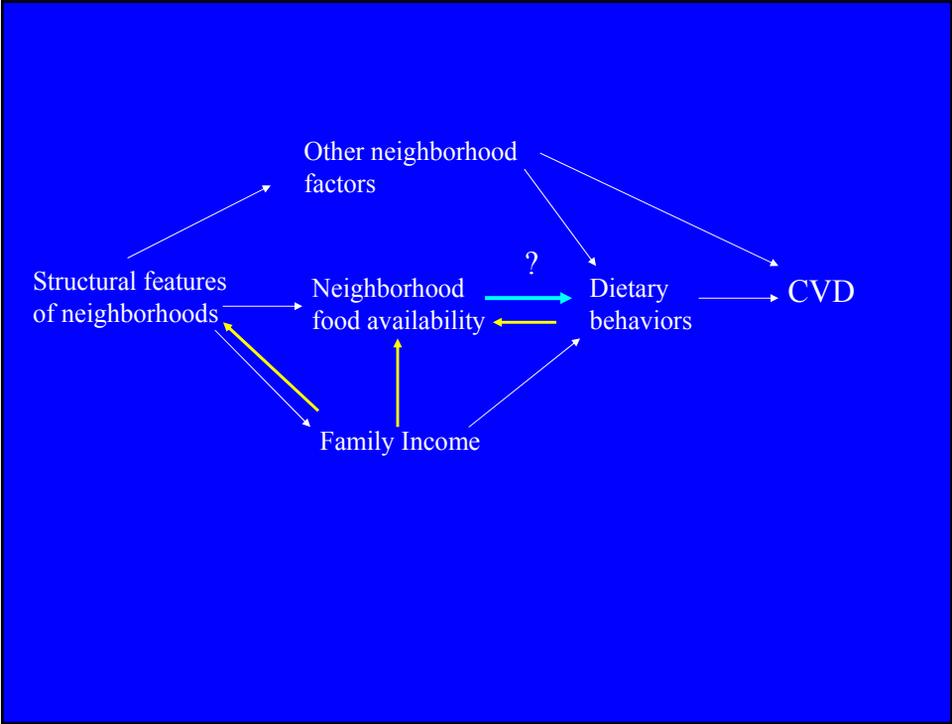
- Direct and indirect effects
- Reciprocal and dynamic relationships

Contextual factors

“True” relevant area







Study designs for neighborhood or area effects

- Sampling frame
 - National or multisite
 - Regional/city
 - Neighborhood-based
- Time AND space
 - Residential history of participants
 - Historical information on neighborhoods
- Change
 - Health consequences of neighborhood change (natural experiments and interventions)
 - Change in neighborhood vs. moving
 - Evaluation of interventions vs. understanding causal processes

- Multiple analytical approaches
- Multiple study designs
- Multiple sources of evidence

Multiple nested and non-nested
contexts

Spatial and non-spatial contexts

Why focus on neighborhoods?

- Neighborhood differences not “naturally” determined
- Result from specific policies
- Amenable to intervention
- Changes in neighborhood environments likely to have multiple health and non-health benefits

