Common Predictors of Lead-Based Paint Hazards and Elevated Levels of Biological Contaminants From the National Survey of Lead and Allergens in Housing

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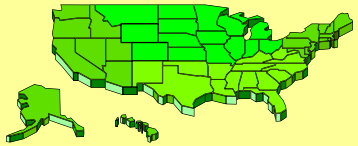
The National Survey of Lead and Allergens in Housing (NSLAH)

- A nationally representative survey of 831 homes in the U.S. by HUD and the National Institute of Environmental Health Sciences (NIEHS) (completed in 2000)
- Main objectives were to determine the prevalence of lead-based paint (LBP) hazards and concentrations/distributions of common allergens in house dust
- Data collected via resident questionnaire, visual assessment, and dust collection with vacuum (allergens) and wipe samples (lead)

Survey Design

- Target Housing: permanently occupied, non-institutional housing units (HUs) where children could reside
- HUs selected via three-stage cluster sampling process
  - Probability Sampling Units (PSUs) (Metropolitan Statistical Areas, single or grouped counties): selected with probability proportional to Census population
  - 4 - 12 “segments” randomly selected per PSU with selection probability based on number of HUs (e.g., ~ 3 city blocks)
  - 4 – 5 HUs randomly selected from all HUs per segment

Multi-Stage Area Sample - NSLAH



Nation

Sample of PSUs

Sample of Segments

Sample of Housing Units

- **96 M homes (= 1,404 PSUs)**
- **75 PSUs chosen**
- **10-13 segments per PSU (= 39K HUs)**
- **2-3 HUs per segment (831 HUs completed)**

Data Collection

- Collected by two-person team per PSU (Interviewer and Certified LBP Risk Assessor)
  - Resident Questionnaire
    - HU age, residency period, cleaning habits, heating system, pest problems, pets, musty odor, demographic information for household, asthma diagnosis in household
  - Visual Assessment
    - Paint condition, water damage, musty odor, cleanliness

Environment Sampling

- Dust samples: Vacuum sample collected from kitchen floor; TV/family room floor and furniture; bedroom floor and bed
- Lead: XRF for lead in paint; deteriorated LBP; wipe samples for dust-lead; and soil-lead (based on federal definitions)
- Allergens: dust mite (Der p1 and Der f1); cockroach (Bla g1); cat (Fel d1); dog (Can f1); mouse (MUP); *Alternaria*
- Endotoxin: inflammatory agent from gram negative bacteria (in dust)

Room Sampling

- Inventory of rooms conducted and 4-5 rooms selected, 1 from each stratum:
  - Kitchens
  - Common living areas
  - Bedrooms (children's only if present)
  - All other rooms
  - Basement (if present, largest room selected)

Purpose of Analysis

- Identify common predictors of LBP hazards and elevated allergen/endotoxin taking into account different patterns of association with housing/demographic variables.

- Compare findings with a subsequent national survey: the American Healthy Homes Survey (2006).

Methods

- Data analyzed by logistic regression using post-stratified survey weights
- Determined the odds of exceeding selected thresholds for the dependent variables: dust mite (Der p1, Der f1); dog (Can f1); cat (Fel d1); mouse (MUP); cockroach (Bla g1); endotoxin and an interior LBP hazard (dust or deteriorated paint)
- Thresholds for allergens were: detection limit, allergic sensitization, and exacerbation of symptoms; for endotoxin: 75^{th} and 90^{th} percentiles.

Allergen Thresholds (ug/g)

	Dog Can f1	Cat Fel d1	Mouse MUP	Cockroach Bla g1	Dust mite Der f1/p1
Allergic Sensitization	2	1	1.6	2 (U/g)	2
Asthma Exacerbation	10	8	1.6	8 (U/g)	10
Detection Limit	--	--	--	--	--

Independent Variables

Age of house	1978-98; 60-77; 40-59; pre-40
Region of country	NE, MW, S, W
Housing type	Single or multifamily
Poverty status	Yes/no
Race	White, African American, Other
Government support	Housing subsidized or not
Tenure	Owner occupied or rented
Ethnicity	Hispanic or non-Hispanic
Cleanliness	Clean/some evidence/no evidence
Clutter	Organized/ave clutter/lack of org.
Cat present	
Dog present	
Cockroaches	Seen in last 12 months

Independent Variables, contd.

Mice	Mice or evidence of in last 12 months
Musty/moldy	Frequent musty/moldy smell
Smoker in home	Yes/no
Presence of child < 18	Yes/no
Metropolitan Statistical Area	Yes/no
Summer	Ave. daily temps > 60˚ (yes/no)
Humidity	≥ 60% RH (yes/no)
AC Use	≥ 20 days in last month; 1-19 days; none

Interpreting Results

- Results: Odds of exceeding thresholds for independent variables while controlling for other independent variables in the analysis
  - Examples:
    - Interior lead hazard: odds for the presence of a hazard are 2.9x greater for a home in the Northeast vs. the West ($p < 0.05$)
    - Exceeding exacerbation t-hold for Can f1: odds are 108x greater for homes with a dog
    - Exceeding Der f2 t-hold: 0.4x for homes that used AC ≥ 20 days in last month (reduced by 60%)

Variables Associated with Significantly Higher or Lower Odds Ratios for Conditions*

Can f1	↑Single family; ↓*Af. American*; ↑***Dog***
Fel d1	↓*Af. American*; ↓*Hispanic*; ↑***Cat***
MUP	↓1978-98 vs. 1940; ↑*Af. American*; ↑***Mice***; ↓*Clean*; ↑Musty/moldy
Bla g1	↑*pre-1940*; ↓Single family; ↑*Af. American;* ↓*Cat;* ↓*Clean;* ↑***Cockroach***
Int LBP Hazard	↑*pre-1940;* ↑Northeast or Midwest vs. West; ↓Gov. support; ↓*Clean*; ↑Musty/moldy (for det'd int. LBP)

*Italicized = sig. for higher threshold

Variables Associated with Significantly Higher or Lower Odds Ratios for Conditions

Der f1	↓1978-98 vs. 1940; ↑*all regions vs. West*; ↓Hispanic; ↓*Dog*; ↑*Summer or ≥ 60% RH;* ↓AC use ≥ 20 days
Endotoxin 75th percentile	↓Gov. support; ↓Clean; ↑*Dog or Cockroach or Mice*

Variables Associated with Significantly Higher or Lower Odds Ratios: Condition Clusters

Any 4 allergens exceeding threshholds	↑Northeast or Midwest vs. West; ↓*Af. American;* ↓Hispanic; ↑*Dog;* ↑*Cockroach*
Dust mite + cat + dog + endotoxin75 (higher SES)	↑Midwest or South vs. West; ↓*Clean;* ↑*Dog;* ↑*Cat;* ↑Mice; ↓*child*
Mouse + cockroach + LBP hazard (lower SES)	↑*pre-1940*; ↑*Other race*; ↓*child;* ↓*Clean*

Selected Findings

- Older (pre-1940) homes are associated with increased levels of cockroach, mouse, dust mite, and LBP hazards (and lower SES cluster).
- Cleaner households are associated with lower levels of endotoxin, mouse, cockroach, LBP hazards and both condition clusters.
- Presence or visual evidence of dog, cat, mice, or cockroaches is strongly associated with elevated concentrations of the associated allergens.
- Homes with dogs, cockroaches or mice have higher levels of endotoxin.

Selected Findings, contd.

- Higher dust mite levels were associated with summer and higher relative humidity and negatively associated with more frequent AC use.
- Minority households had lower odds of exceeding thresholds for “any four allergens”.
- When controlling for other factors, poverty was not associated with higher levels of mouse or cockroach allergen, or LBP hazards.
- Government subsidized housing had lower odds for presence of a LBP hazard.
- The observed clustering of conditions supports the “healthy homes” approach of integrated interventions.

Predictors of high allergen levels (NSLAH): NIEHS analysis

Predictor	Percentage (SE)	OR (95%CI)[†]	p-value[‡]
Race			
White	19.84 (2.14)	2.64 (1.50, 4.63)	<0.01
Other	10.94 (1.80)	1.00	
Family income			<0.01
$0 - 19,999	22.56 (4.71)	1.84 (0.85, 3.98)	
$20, 000 - 39,000	23.87 (3.46)	2.44 (1.14, 5.22)	
$40,000 - 59,000	11.53 (2.96)	0.72 (0.30, 1.74)	
$60,000+	12.12 (2.96)	1.00	
Housing type			0.04
Single family home	19.06 (2.01)	1.94 (1.02, 3.67)	
Multi-family home	11.36 (2.32)	1.00	
Child resident(s)			0.01
No	19.43 (1.92)	1.65 (1.16, 2.34)	
Yes	15.95 (2.36)	1.00	
Smoker(s) in the household			<0.01
Yes	23.47 (2.01)	1.74 (1.19, 2.53)	
No	13.23 (2.01)	1.00	
Mold/moisture problems[§]			<0.01
Yes	24.21 (2.63)	2.06 (1.28, 3.30)	
No	11.76 (1.80)	1.00	
Pets in the household			<0.01
Yes	24.82 (2.55)	2.98 (1.67, 5.31)	
No	11.31 (2.19)	1.00	
Cockroaches[§]			0.05
Yes	24.12 (4.65)	1.80 (1.00, 3.24)	
No	16.73 (16.73)	1.00	
Rodents[§]			0.01
Yes	26.01 (4.33)	1.75 (1.15, 2.66)	
No	16.55 (1.77)	1.00	

Salo, P. et al., 2008. J. Allergy Clin Immun

[*] 4 or more allergens exeeding high levels in the household; cut points for high allergen levels:
10 μg/g for Der f 1, Derp 1, and Can f 1; 8 μg/g for Fel d 1; 8 U/g Bla g 1; 1.6 μg/g for MUP; and 7 μg/g for *Alternaria*

Thank You!

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A HOUSING AND NEIGHBORHOOD INDEX SCORES FOR PREDICTING DISPARITIES IN CHILDHOOD LEAD POISONING AND ASTHMA

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Specific Study Objectives

1) Develop a household hazard index (HHI) and neighborhood hazard index (NHI) and combined household and neighborhood (HNI) rating scale.

2) Evaluate the associations of HHI and NHI with elevated blood lead (ebl) and asthma in children.

Household Hazard SCALES

Structural	18 Items
Mold	8 Items
Pets	4 Items
Pests	6 Items
Ventilation	6 Items
Fire	6 Items
Electrical	7 Items
Lifestyle and Behavioral	12 Items

NEIGHBORHOOD HAZARD SCALE

Neighborhood Satisfaction	(12 Items)
Perception of Neighborhood Condition	(6 Items)
Exterior Housing Observation	(13 Items)
Neighborhood Hazards (Observational)	(21 Items)

Study Site

Demographics	City of Saginaw	Saginaw County	MI
Population [1]	51,508	200,169	9,883,640
% Hispanic/Latino Population [2]	12.1%	7.3%	4.0%
% African American Population [2]	42.8%	18.3%	14.0%
% White Population [2]	50.5%	76%	79.7%
Jobless Rate Calendar Year 2010 [3]	19.75%	11.8%	12.5%
% of individuals living below poverty [2]	36.5%	18.9%	14.5%
- with related children < 5 years [2]	48.6%	30.6%	22.7%
Median household income [2]	$27,271	$42,244	$48,700
Population ≥ 25 years with a Bachelor's degree or higher [2]	10.4%	17.9%	24.5%
Housing Units [1]	23,574	79,011	4,532,233
Pre-1950 Housing [2]	57.3%	29.0%	25.3%

Source: [1]U.S. Census Bureau, 2010 Census. [2]U.S. Census Bureau, 2005-2009 American Community Survey. [3]Michigan Department of Labor & Economic Growth Bureau of Labor Market Information Unemployment Statistics, 2010 Jobless rates.

Recruitment & Public Awareness

- Healthy Homes Demonstration Grant to University of MI & Saginaw County Department of Public Health
- Public awareness activities included:

1) Kick-off Press Event: http://www.connectmidmichigan.com/news/story.aspx?id=417822;

2) Web Page: http://www.healthyhomessaginaw.com/

3) Creation of an informational brochure;
   - ✓ mailed announcement to random addresses;
   - ✓ dissemination at church events;
   - ✓ disseminated in Health Department clinics.

Grant Overview

15,351 Households Screened

642 Households Surveyed

Household Members:
- ≤ 12yrs; or
- Pregnant; and
- Resident > 3 months

no

Household HHI Score ≥ 53

no

NO Intervention

Exclusion

Does Child Have Asthma or Blood Lead Level ≥ 10µg/dL

no

yes

Basic Interventions 200

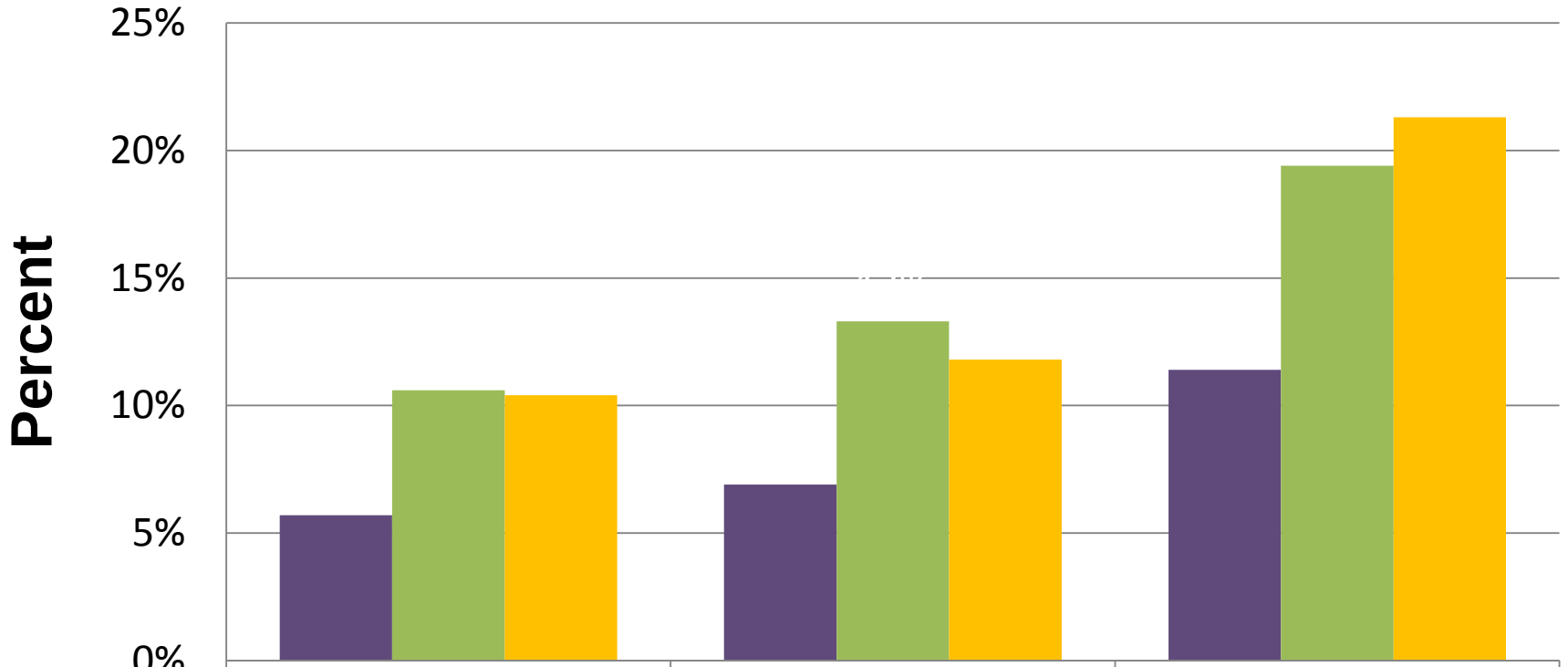
Basic + Extensive Interventions ~20

Findings – Child Health Outcome

Children (n=1211)	number	%
Children w/Asthma	212	17.8%
Initial BLL ≥ 10µg/dL	18	1.5%
Households (n=642)	number	%
Households with One Asthmatic Child	144	23%
Households with Two Asthmatic Children	21	3.4%
Households with 3-4 Asthmatic Children	8	1.3%

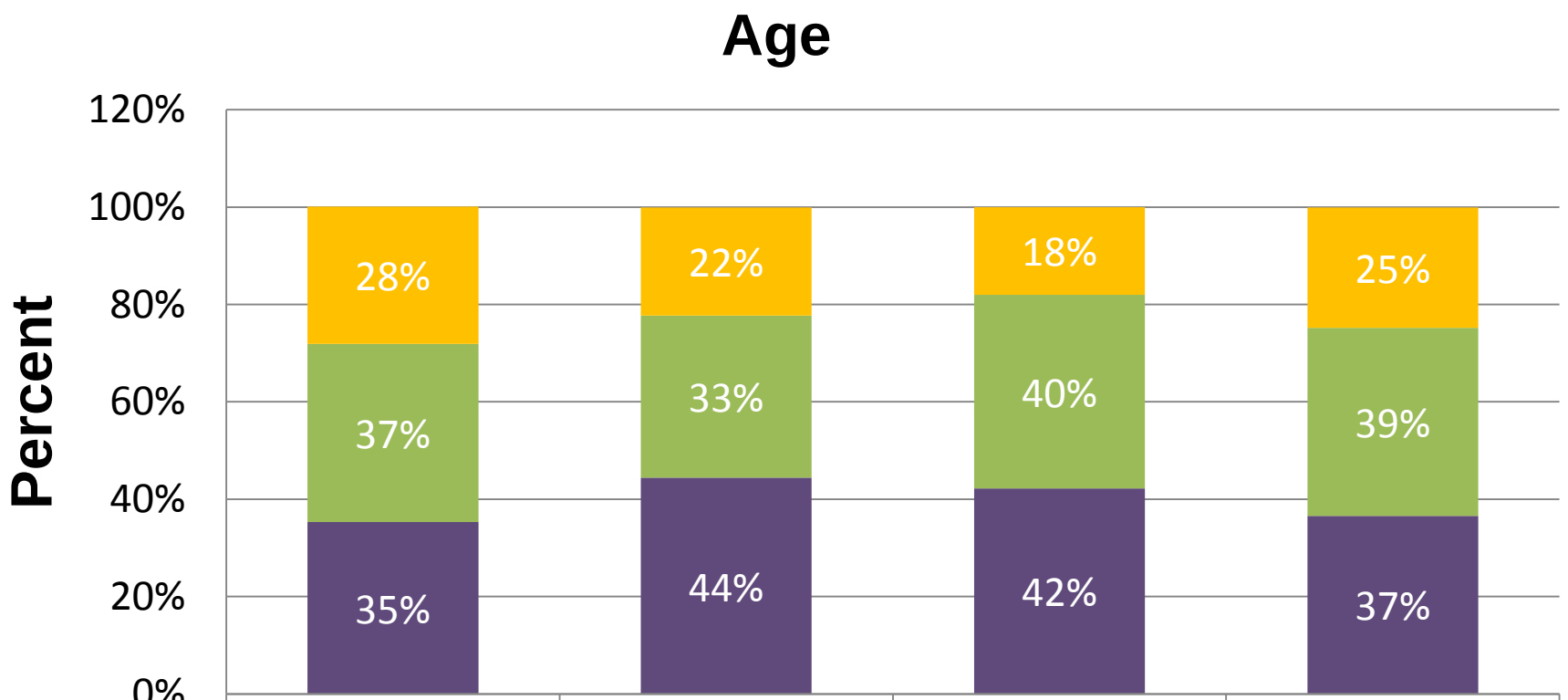
Prevalence Rates

Asthma Rate in Comparison



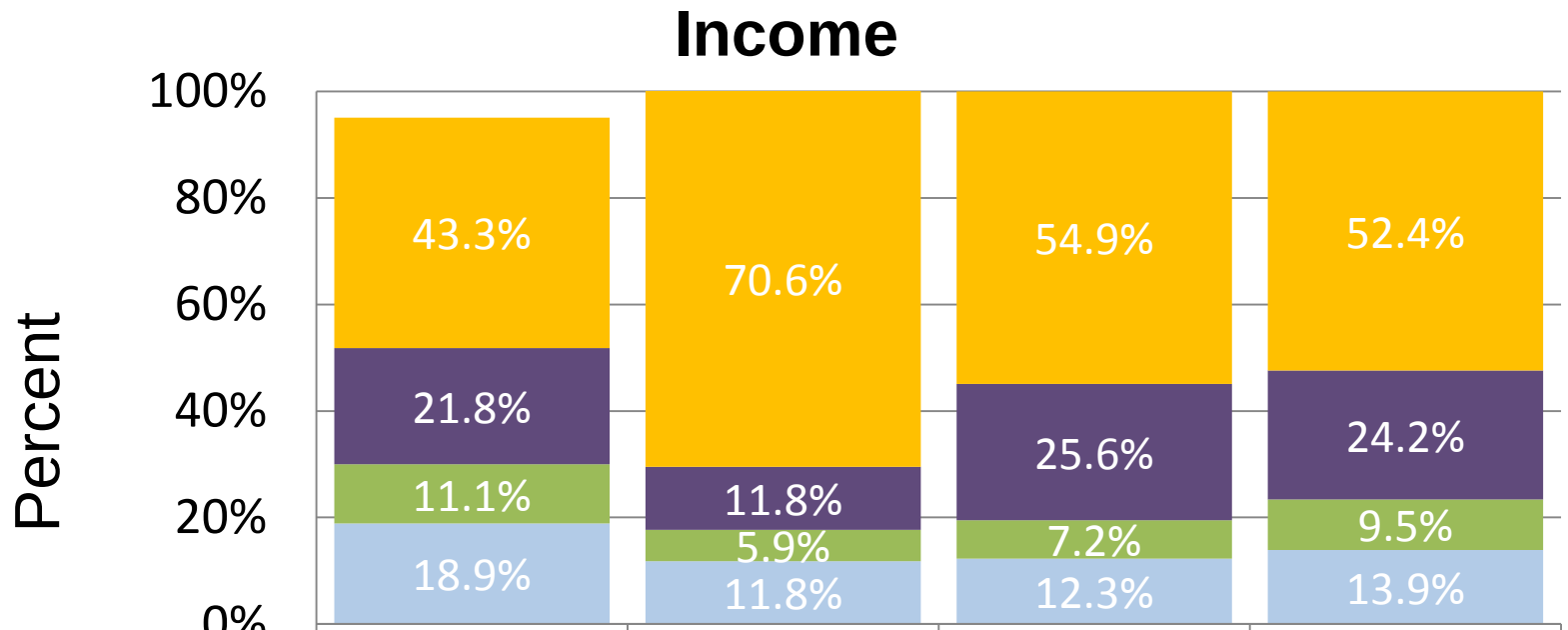
	U.S.	MI	Study Population
Age 0-4	5.7%	6.9%	11.4%
Age 5-9	10.6%	13.3%	19.4%
Age ≥ 10	10.4%	11.8%	21.3%

Prevalence Rates



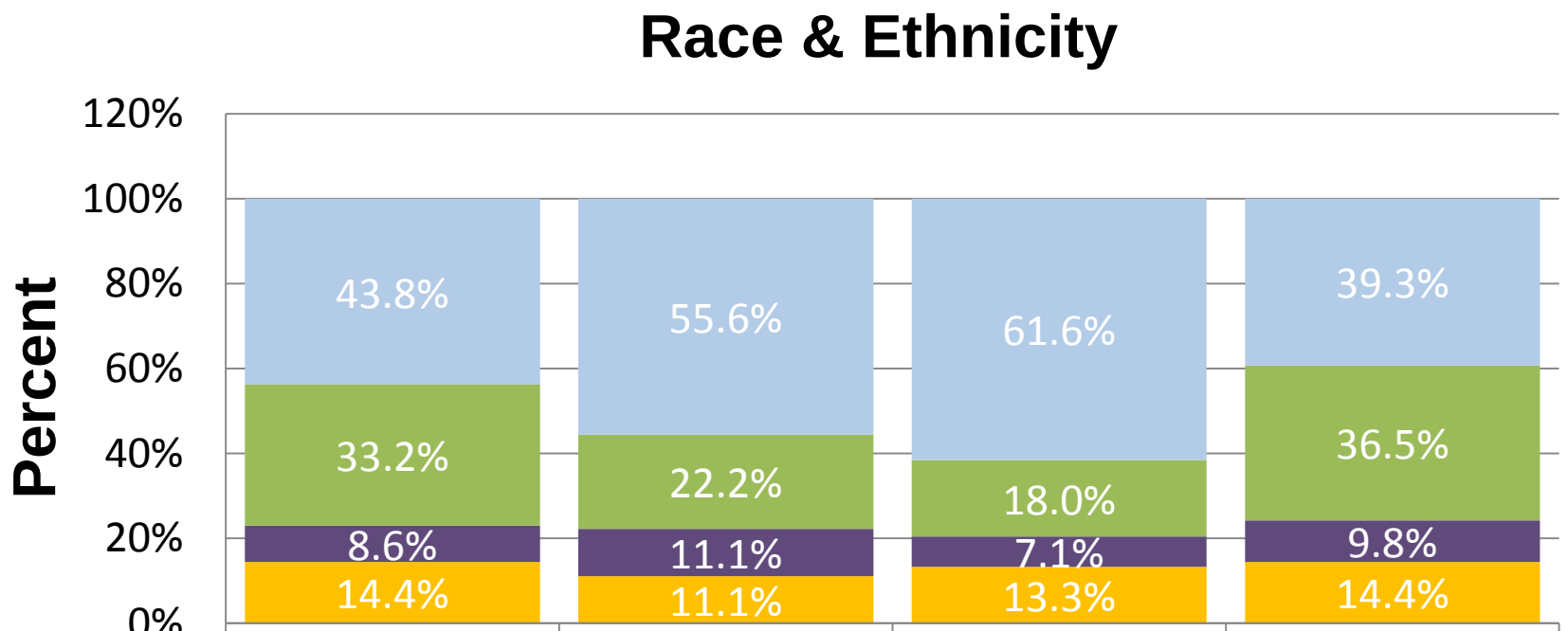
	Children (n = 1211)	BLL ≥ 10µg/dL (n =18)	Asthmatic (n = 211)	HHI≥53 (n =400)
Age 0-4	28.2%	22.2%	18.0%	24.7%
Age 5-9	36.6%	33.3%	39.8%	38.6%
Age ≥ 10	35.3%	44.4%	42.2%	36.6%

Prevalence Rates



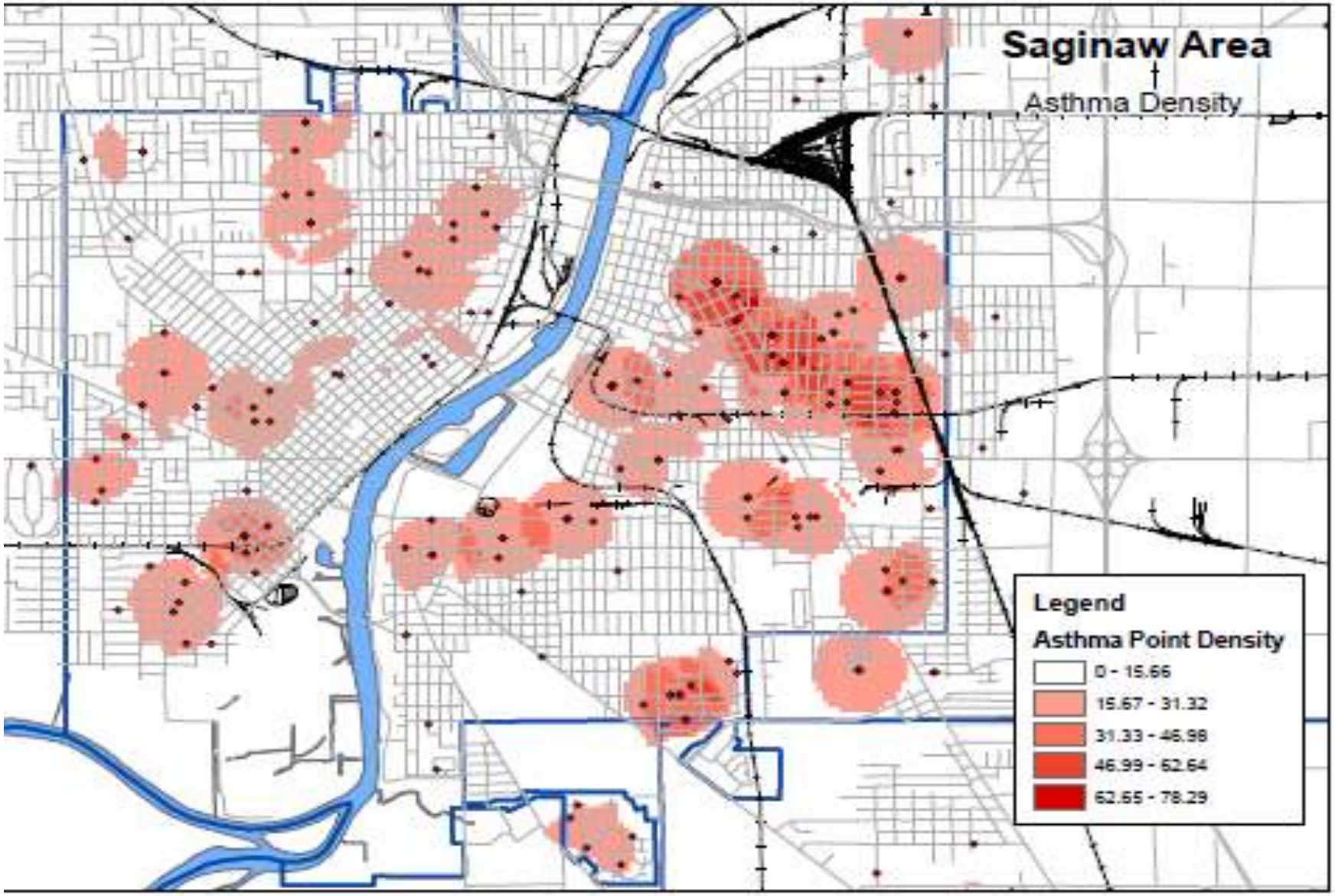
	Children	BLL ≥ 10µg/dL	Asthma	HHI≥53
Less than $19,999	0.433	0.706	0.549	0.524
$20,000-$34,999	0.218	0.118	0.256	0.242
$35,000-$49,999	0.111	0.059	0.072	0.095
$50,000 or more	0.1888	0.118	0.123	0.139

Prevalence Rates

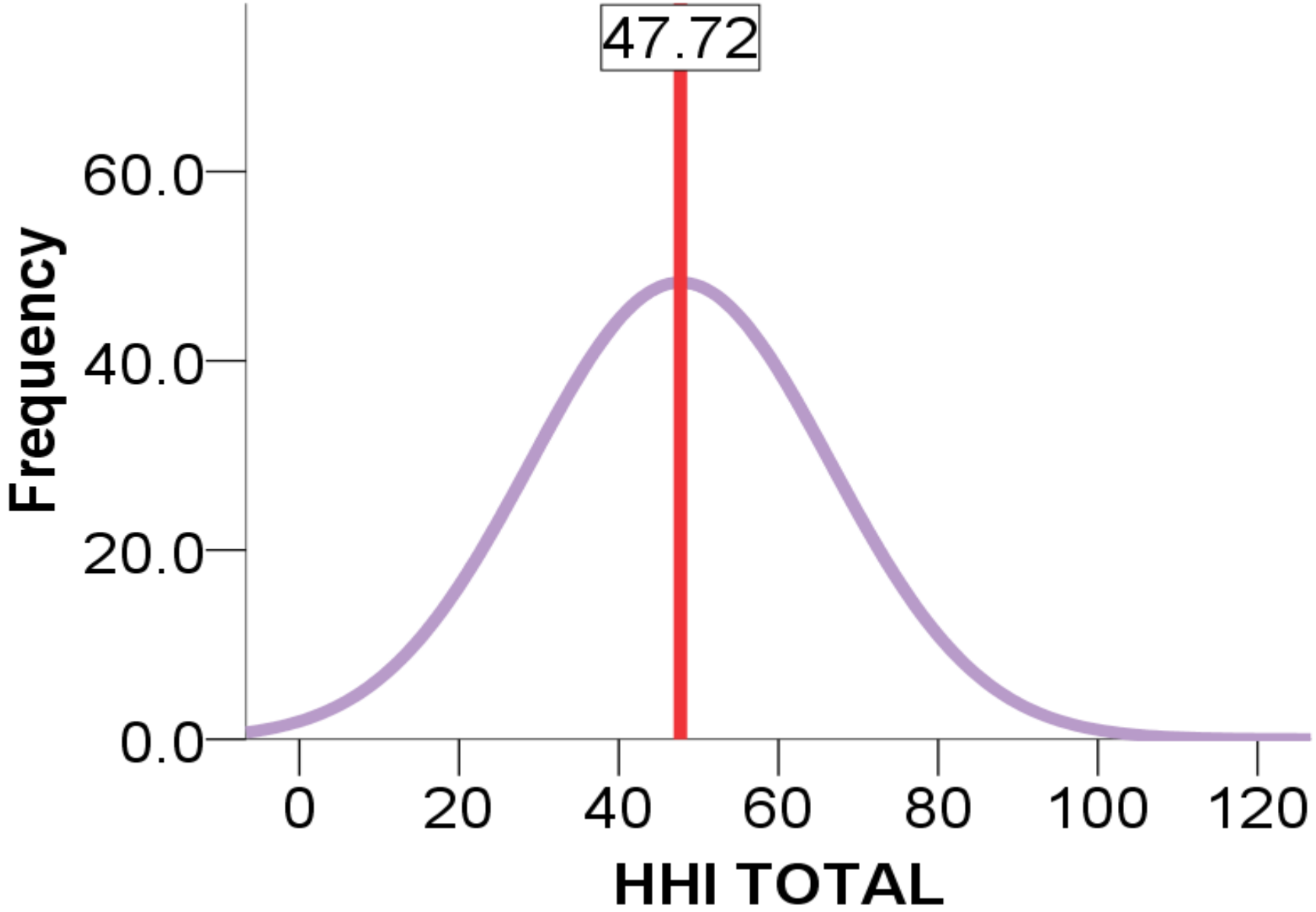


	Children (n = 1211)	BLL ≥ 10µg/dL (n =18)	Asthmatic (n = 211)	HNI≥53 (n =400)
African Amer.	0.438	0.556	0.616	0.393
White	0.332	0.222	0.18	0.365
Hispanic/Latino	0.086	0.111	0.071	0.098
Other	0.144	0.111	0.133	0.144

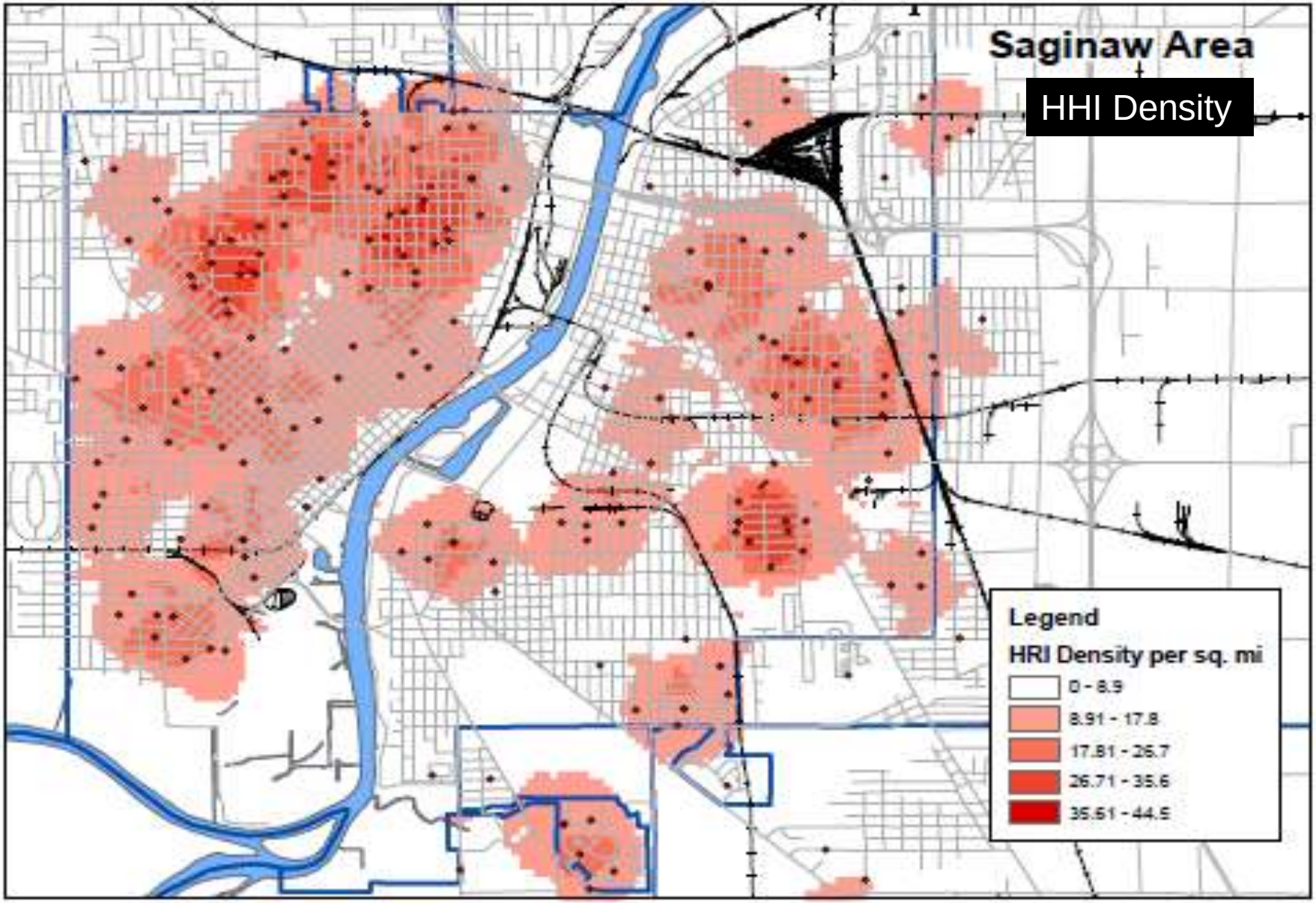
Findings – Asthma Density



Distribution - HHI



Findings – HHI ≥ 53 Density



Crude Odds Ratios - HHI ≥ 53

	(p-value)	Odds Ratio	95.0% CI for OR	
			Lower	Upper
Neighborhood Satisfaction	.000	1.054	1.024	1.084
Perception of Neighborhood Condition	.000	1.125	1.076	1.176
Respiratory/Lung/ Breathing Problems	.001	1.797	1.257	2.568
Asthma	.003	1.763	1.214	2.562
Household Disease Burden	.000	1.130	1.105	1.155

Questions

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