Using Geographic Information Systems to Identify High-Risk Neighborhoods for Community-Based Interventions to Increase Cardiac Arrest Survival: A Mixed Methods Approach

ESRI Health Users Group Meeting: October 19th, 2010

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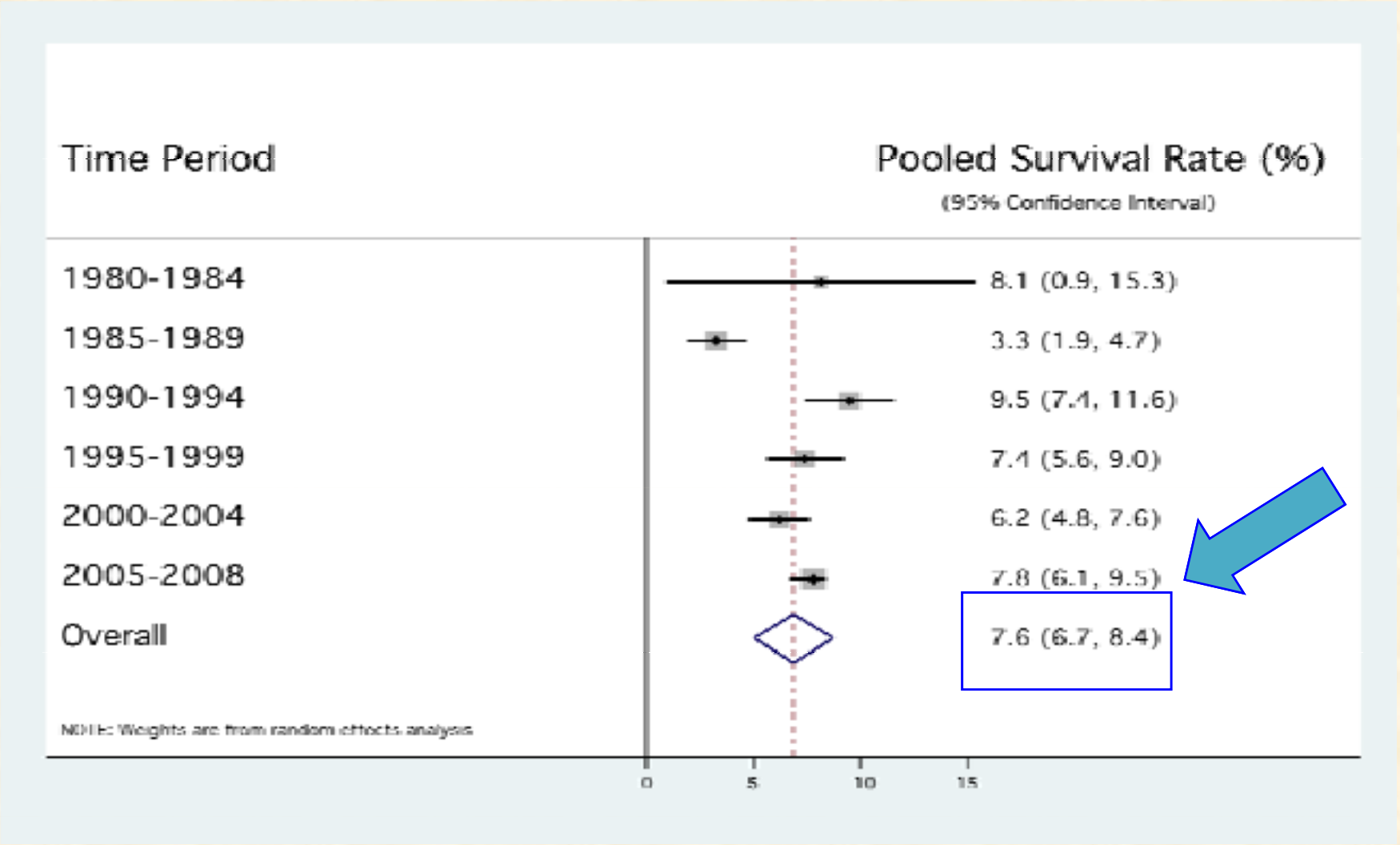
Overview

- Background on out-of-hospital cardiac arrest
  - What we know
  - What we don't know
- HANDDS Trial
  - Mixed Methods Approach to Increasing CPR Rates in High-Risk Communities

What we know:

1. No change in survival in 30 years

Temporal Trends on OHCA Survival



Sasson, C. et. al. Circulation Cardiovascular Quality and Outcomes, 2009

What we know:

1. No change in survival in 30 years
2. Huge variation in OHCA survival
   - 0.3% in Detroit[1] to 20.4% in Seattle[2]
   - Denver[3]- 8.0%

1. *Dunne et. al. Resuscitation 2007*
2. *Nichols et. al. JAMA 2008*
3. *Haukoos et. al. Annals of Emergency Medicine 2009*

What we know:

1. No change in survival in 30 years
2. Huge variation in OHCA survival by city
3. CPR matters

Number Needed to Treat to Save One Life

		Low Performing EMS Systems		High Performing EMS Systems	
	Pooled % of Patients	**Pooled Survival Rate**	**NNT**	**Pooled Survival Rate**	**NNT**
CPR	32%	3.9 (1.8-6.0)	36	16.1 (11.5-20.7)	24
No CPR	68%	1.1 (0.5-1.8)		12.0 (10.0-14.0)	

Sasson, C. et. al. Circulation Cardiovascular Quality and Outcomes, 2009

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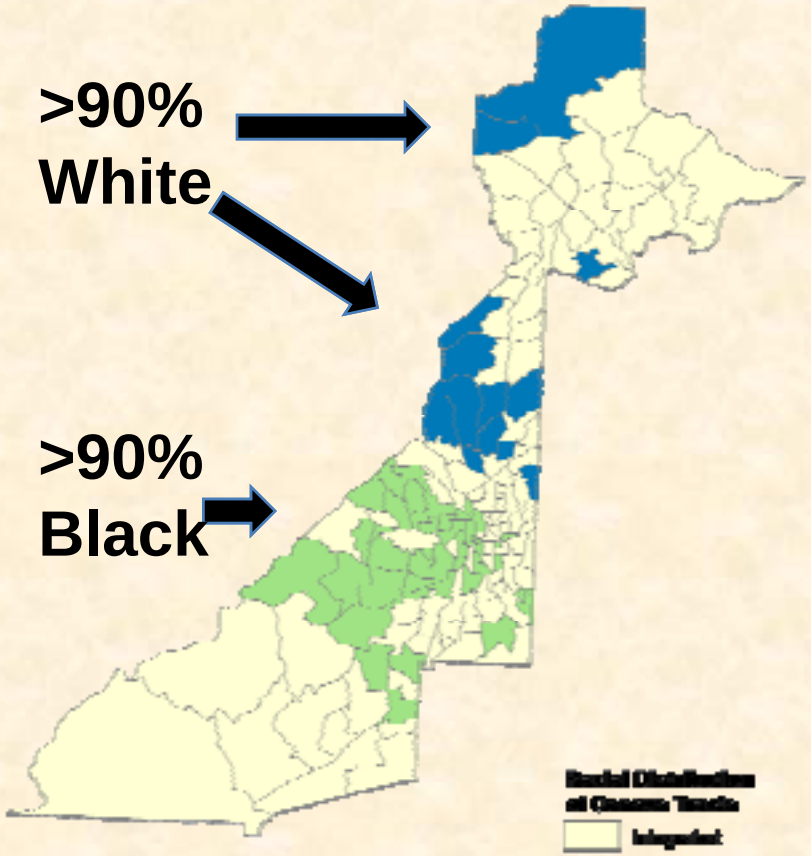
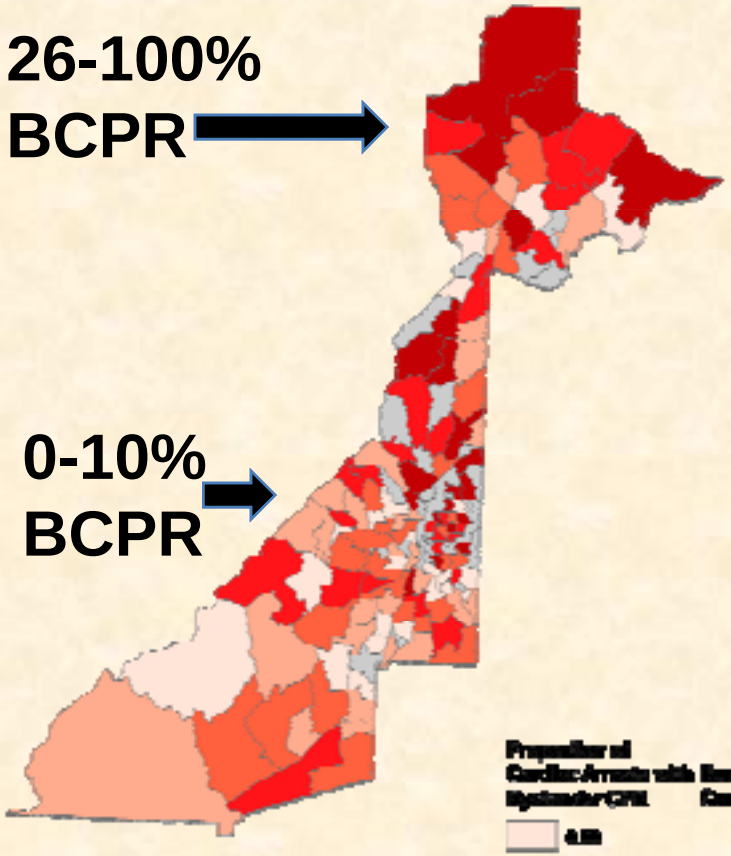
What we know:

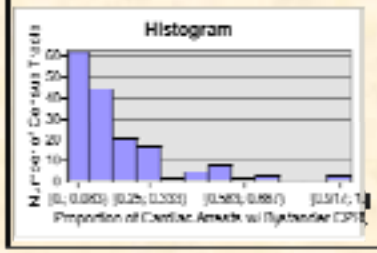
1. No change in survival in 30 years
2. Huge variation in OHCA survival by city
3. CPR matters
4. Likelihood of receiving bystander CPR is affected by the neighbor-hood one lives in

Racial Distribution
Cares Data - Fulton County, GA



Cardiac Arrests with Bystander CPR
Cares Data - Fulton County, GA





Cardiac Arrest Bystander Status by Median Household Income

	Private Unwitnessed	Private Witnessed	Public Unwitnessed	Public Witnessed
Median Income <$21,600	0.15	0.23	0.28	0.41
Median Income $21,601-$30,500	0.14	0.20	0.25	0.35
Median Income $30,501-$42,000	0.15	0.22	0.30	0.44
Median Income $42,001-$62,000	0.19	0.29	0.38	0.48
Median Income >$62,000	0.28	0.38	0.41	0.55

What we know:

1. No change in survival in 30 years
2. Huge variation in OHCA survival by city
3. CPR matters
4. Likelihood of Receiving Bystander CPR is affected by the Neighborhood one lives
5. Difficult to Translate Bench Research to Community

How can we use public health surveillance tools and GIS to understand this issue, and help communities plan the utilization of scarce healthcare resources?

Translating Science into Practice

- 2008- American Heart Association recommends “Hands only CPR”

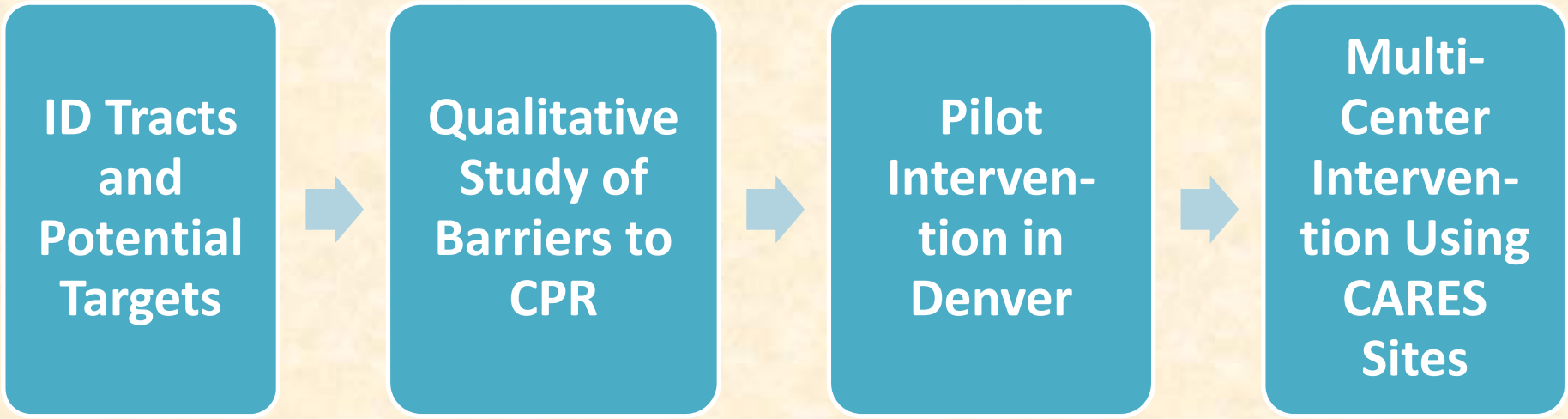
American Heart Association℠
Fighting Heart Disease and Stroke

(Sayre, M. et. al. Circulation, 2008)

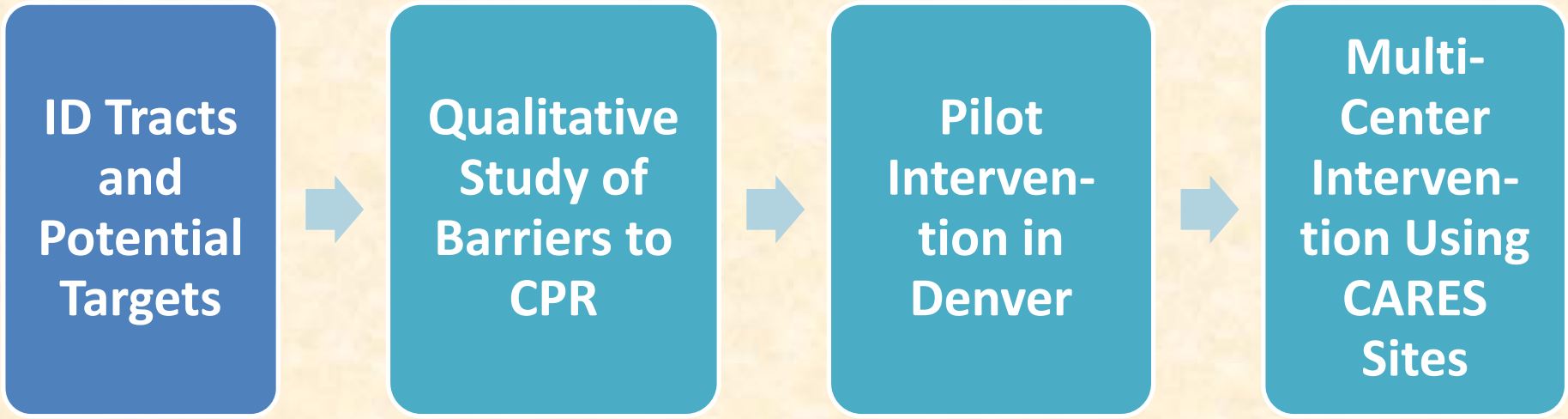
Identifying High Arrest Neighborhoods to Decrease Disparities in Survival (HANDDS) Trial

- Four Phase Study Design
- Incorporates GIS, Spatial Epidemiology, Qualitative Methods, RCT, and Community-based Participatory Research Methods

HANDDS Study Design



HANDDS Study Design



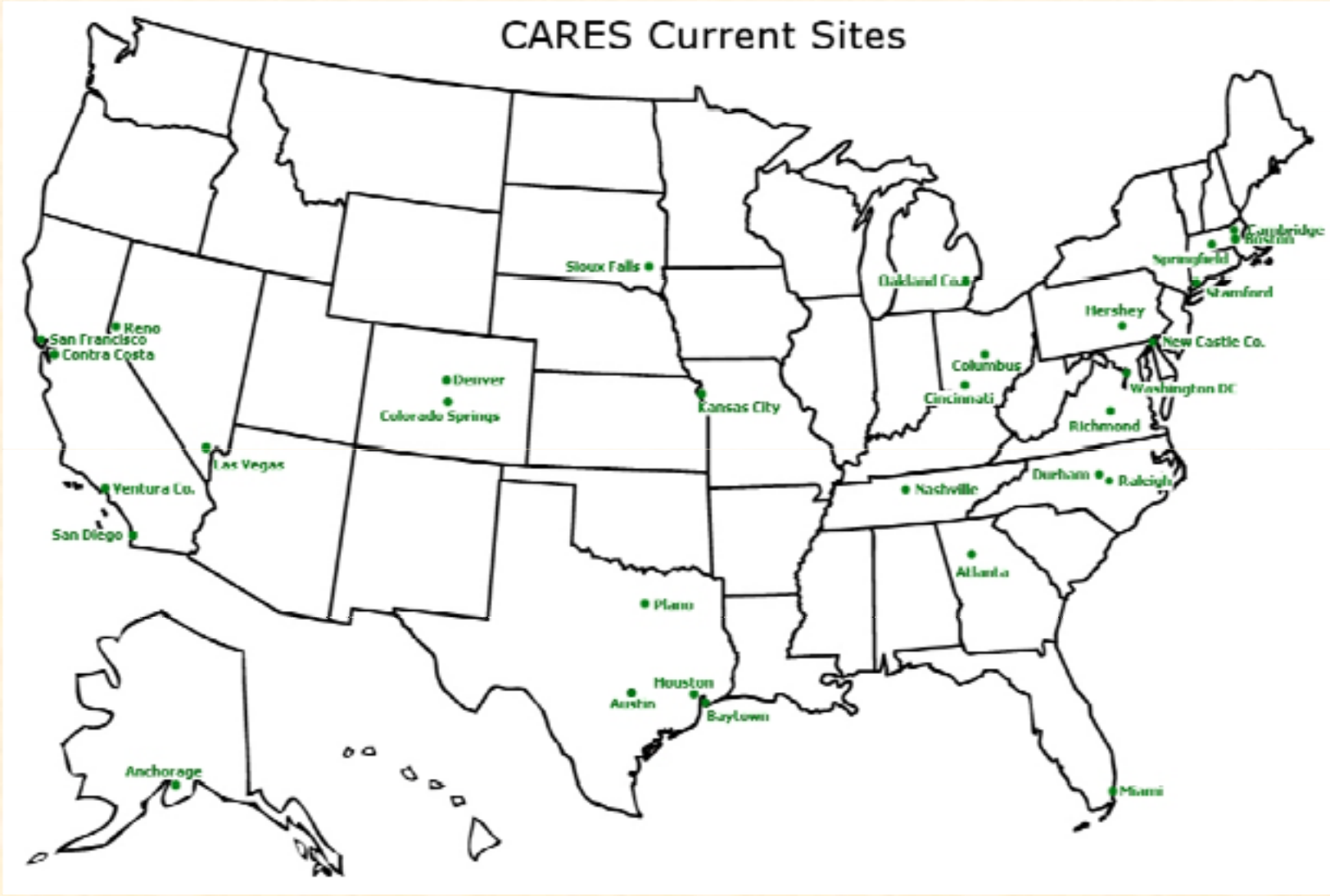
Phase One: ID Tracts/Targets

- Identify high-risk census tracts in pilot community- Denver, Colorado using GIS and Spatial Statistics
- High-Risk Census Tracts have high incidence of OHCA events and low prevalence of CPR

Cardiac Arrest Registry to Enhance Survival (CARES)

- Surveillance Registry of OHCA due to cardiac etiology
- 30 U.S. Cities Nationwide in 17 States

Distribution of CARES Cities



CARES National Dataset

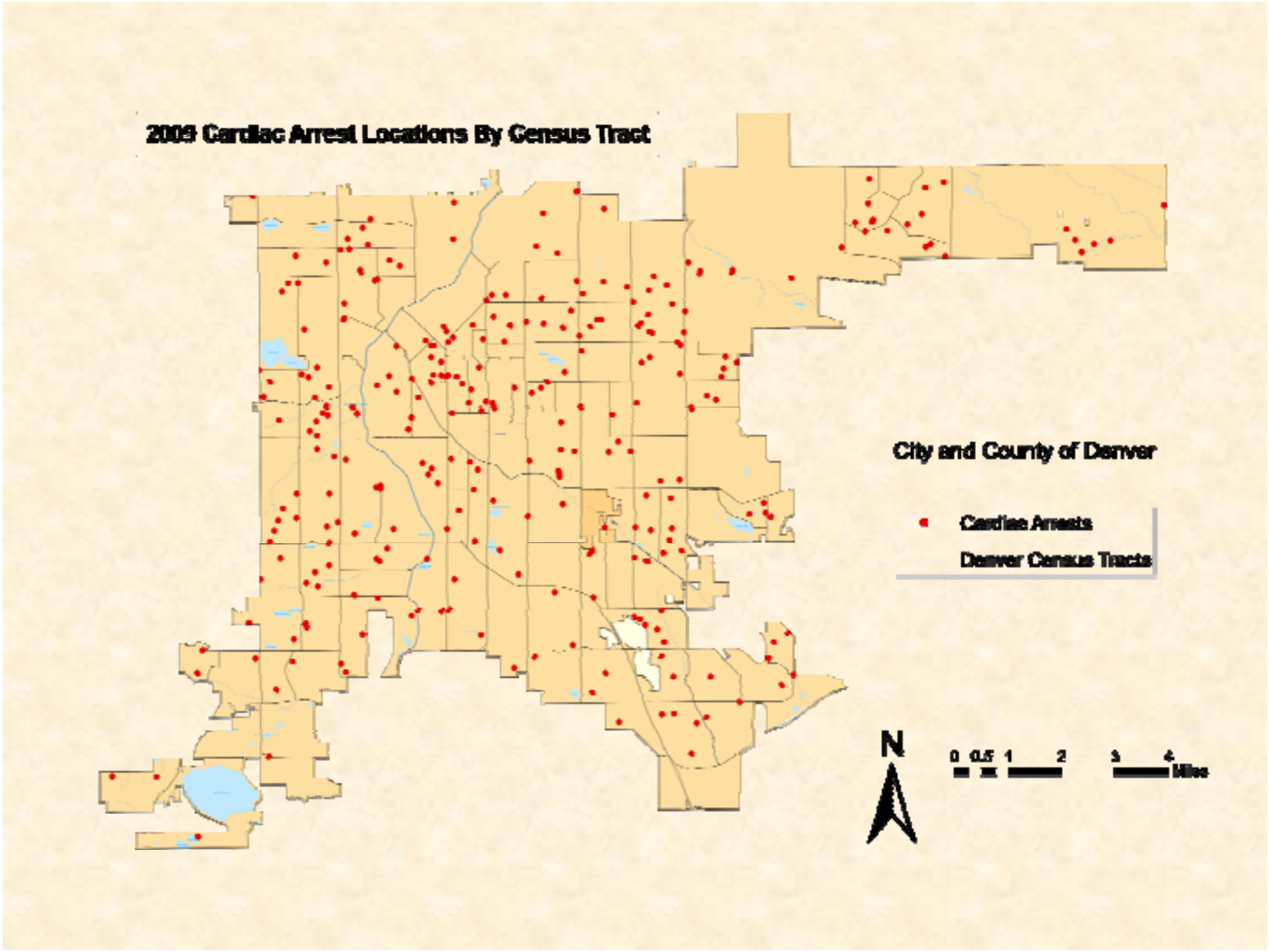
- National Dataset (Oct 2005-Dec. 2009) (n=20018)
  - Bystander CPR Rate= 24.0% (n=4298)
  - AED Used= 2.1% (n=379)
  - Survived to Hospital Discharge= 8.8% (n=1762)
- Denver Dataset (Jan. 2009-Dec. 2000 (n=356)
  - Bystander CPR Rate= 29.8% (n=106)
  - AED Used= 3.1% (n=11)
  - Survived to Hospital Discharge= 10.7% (n=38)

Denver Subset

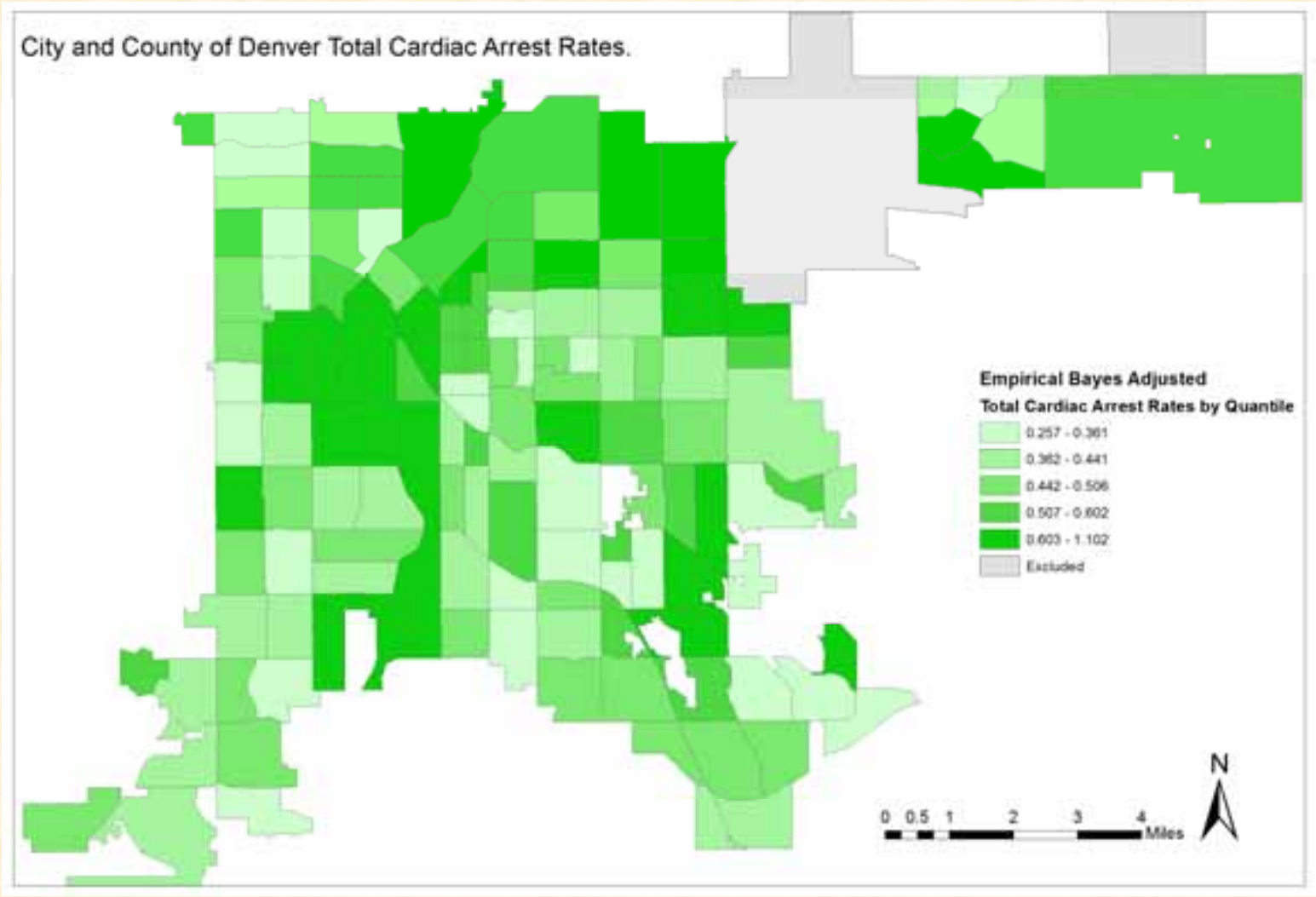
- 356 Total Arrests
  - 61 excluded for arrest occurring in airport, medical facility or nursing home
  - 1 lost to f/u
  - 2 out of county and 1 address unable to be geocoded
- 291 in Subset
  - 94 Admitted to Hospital (32.3%)
  - 30 Survived to Hospital Discharge (10.3%)
  - 105 Census Tracts
- 263 Eligible for Bystander CPR

High-Risk Census Tract Analysis

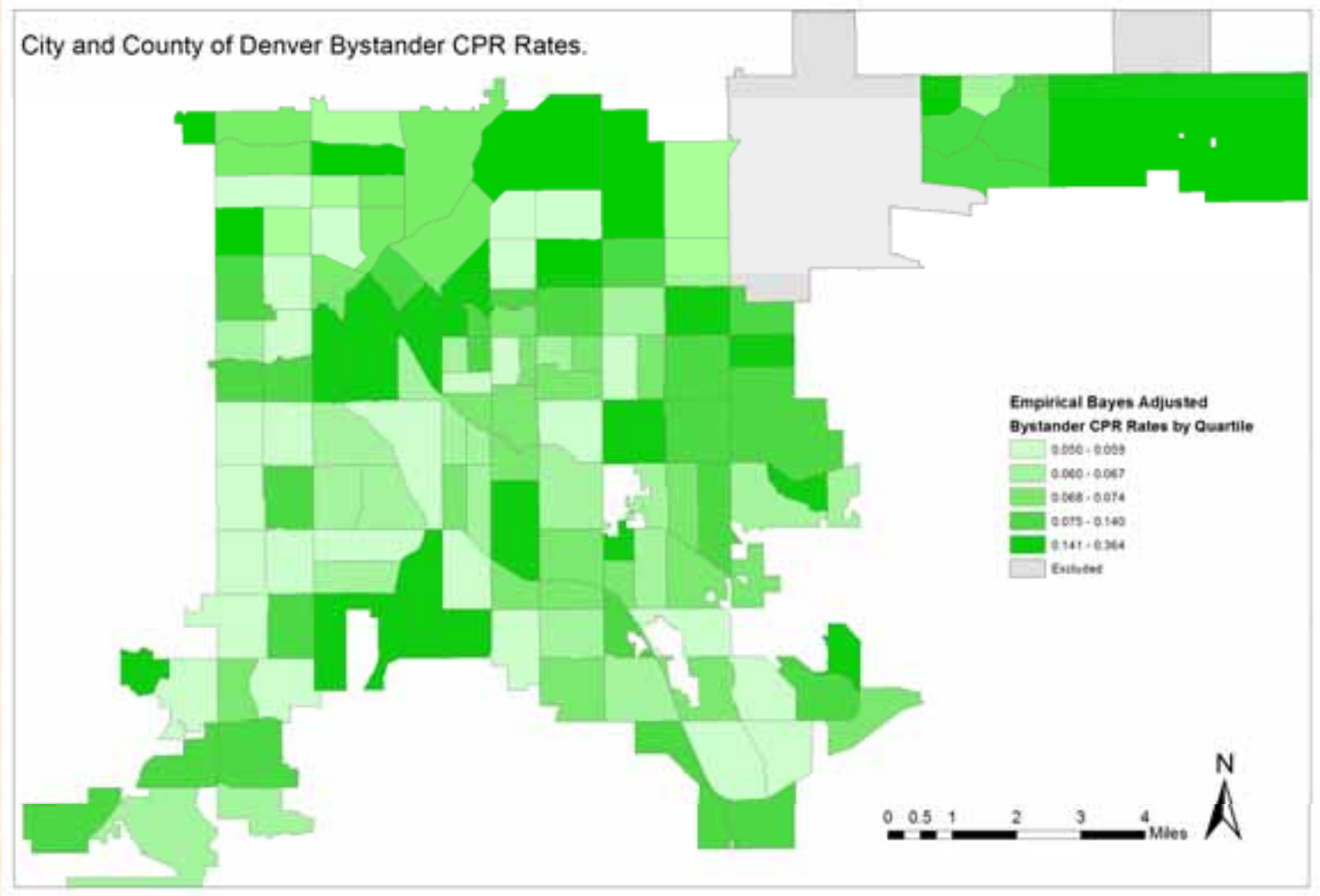
- Overlap of Census Tracts Identified based on Three Methods:
  - Multilevel Poisson Regression using Empirical Bayes Adjusted Rates to Identify Census Tracts in the Highest Quartile for OHCA Incidence and Lowest Quartile for CPR Prevalence
  - Local Moran's I to Identify Significant Areas of Clustering of OHCA Incidence and Low Prevalence of CPR
  - Gi* Statistic to Identify Significant Areas of Clustering of OHCA Incidence and Low Prevalence of CPR


2009 Cardiac Arrest Locations By Census Tract
City and County of Denver
Cardiac Arrests
Denver Census Tracts
N
0 0.5 1 2 3 4
Miles

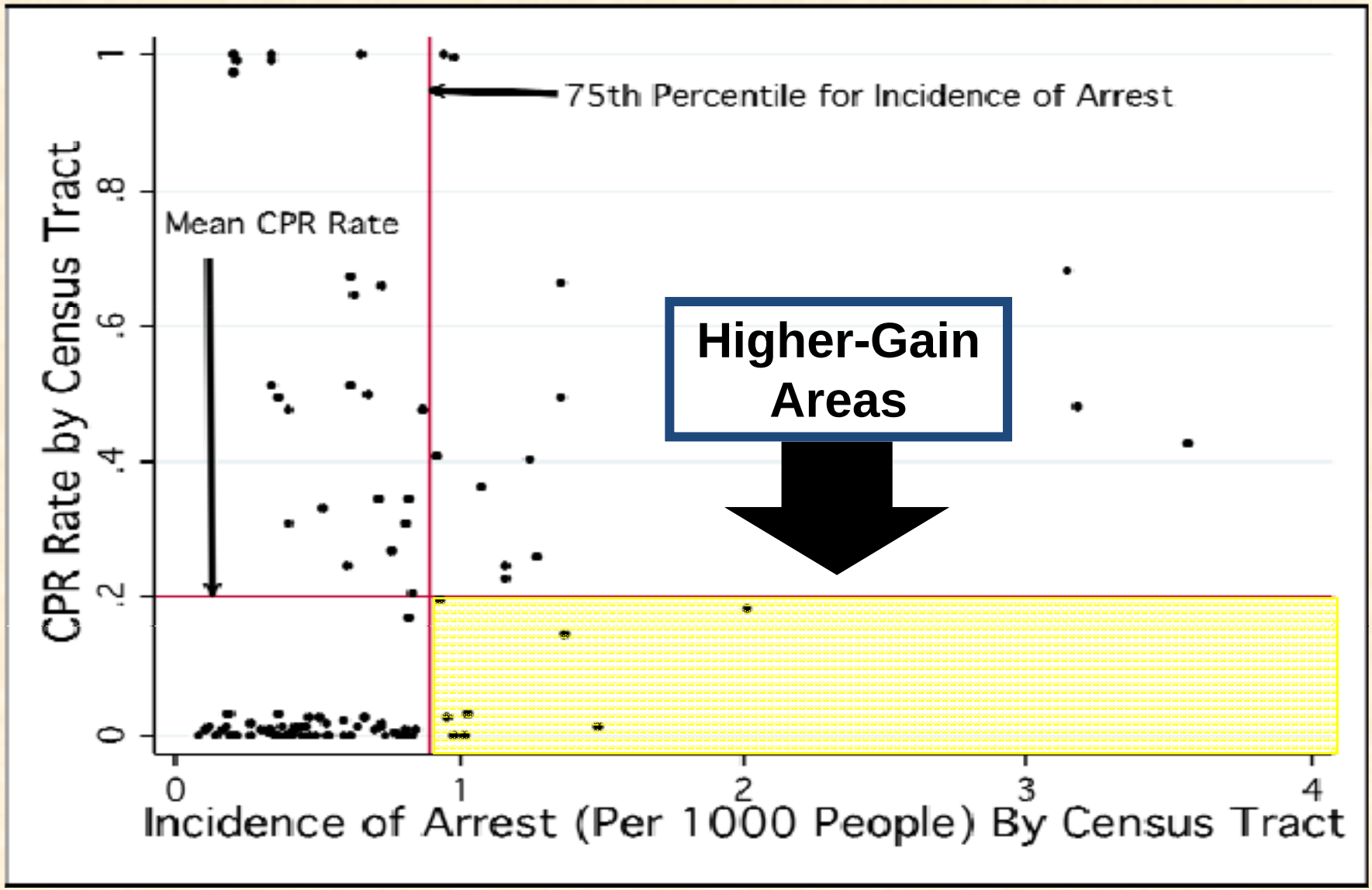
Empirical Bayes Adjusted Incidence of OHCA by Census Tract



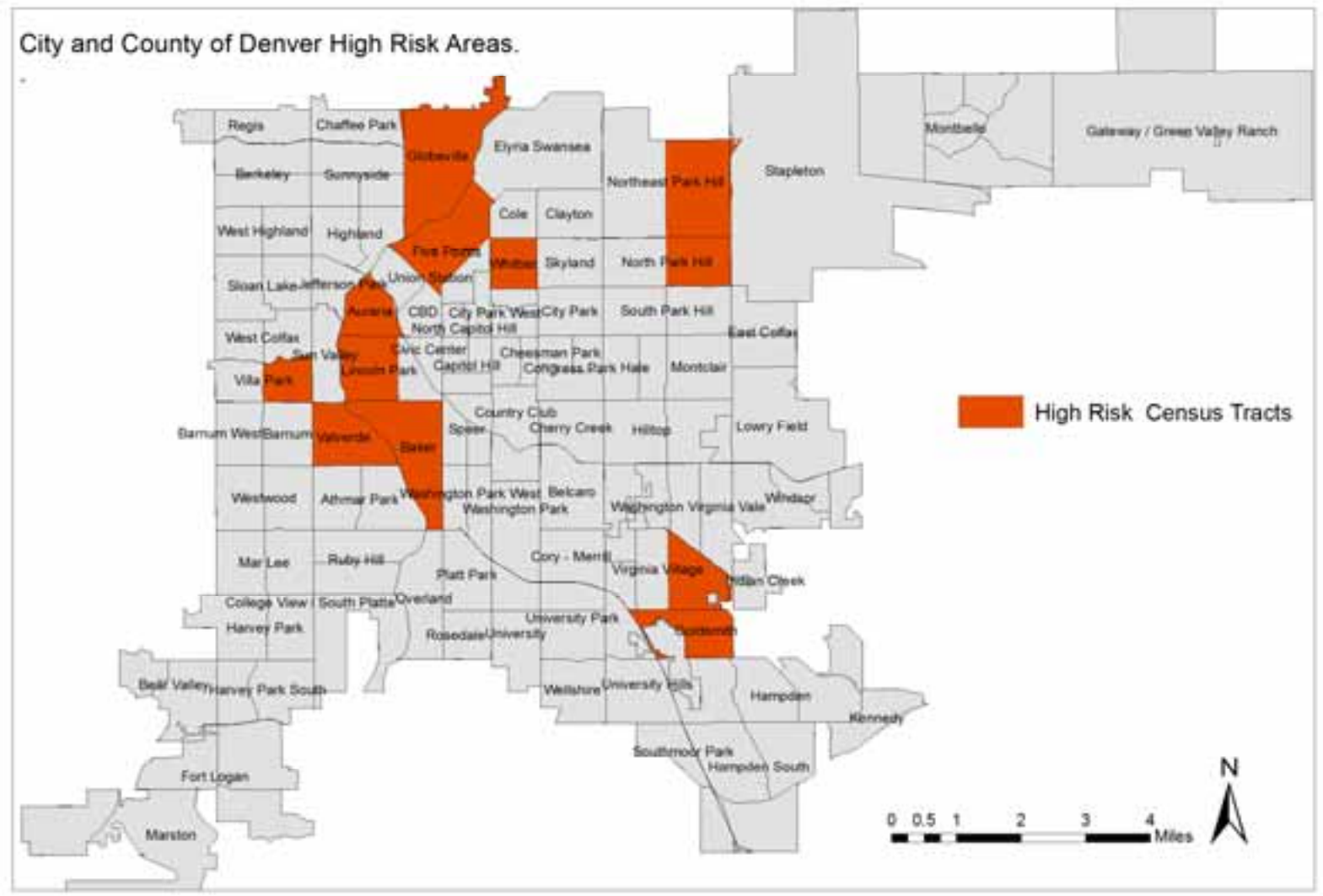
Empirical Bayes Adjusted Prevalence of CPR by Census Tract

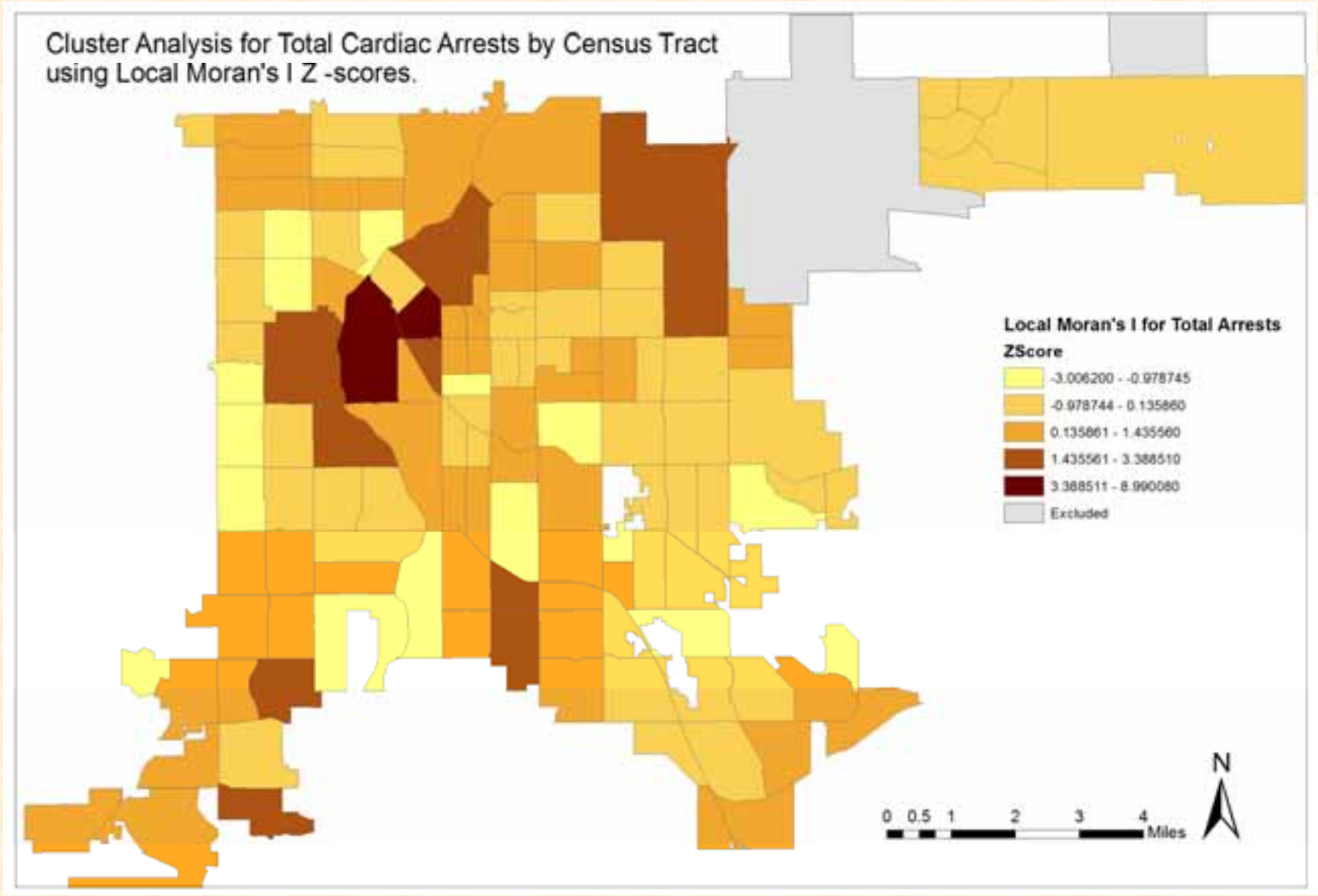


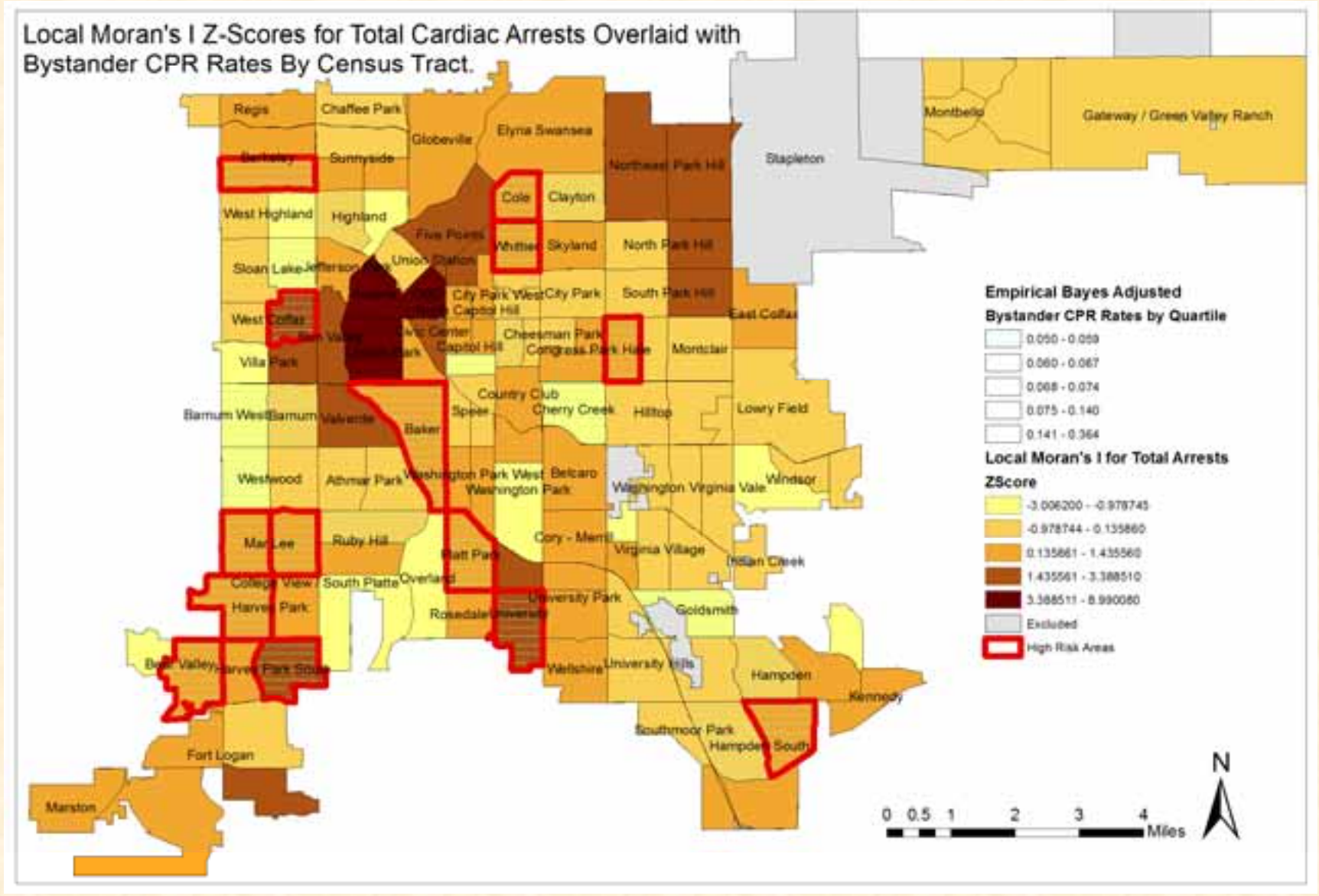
Identification of Higher-Gain Census Tracts

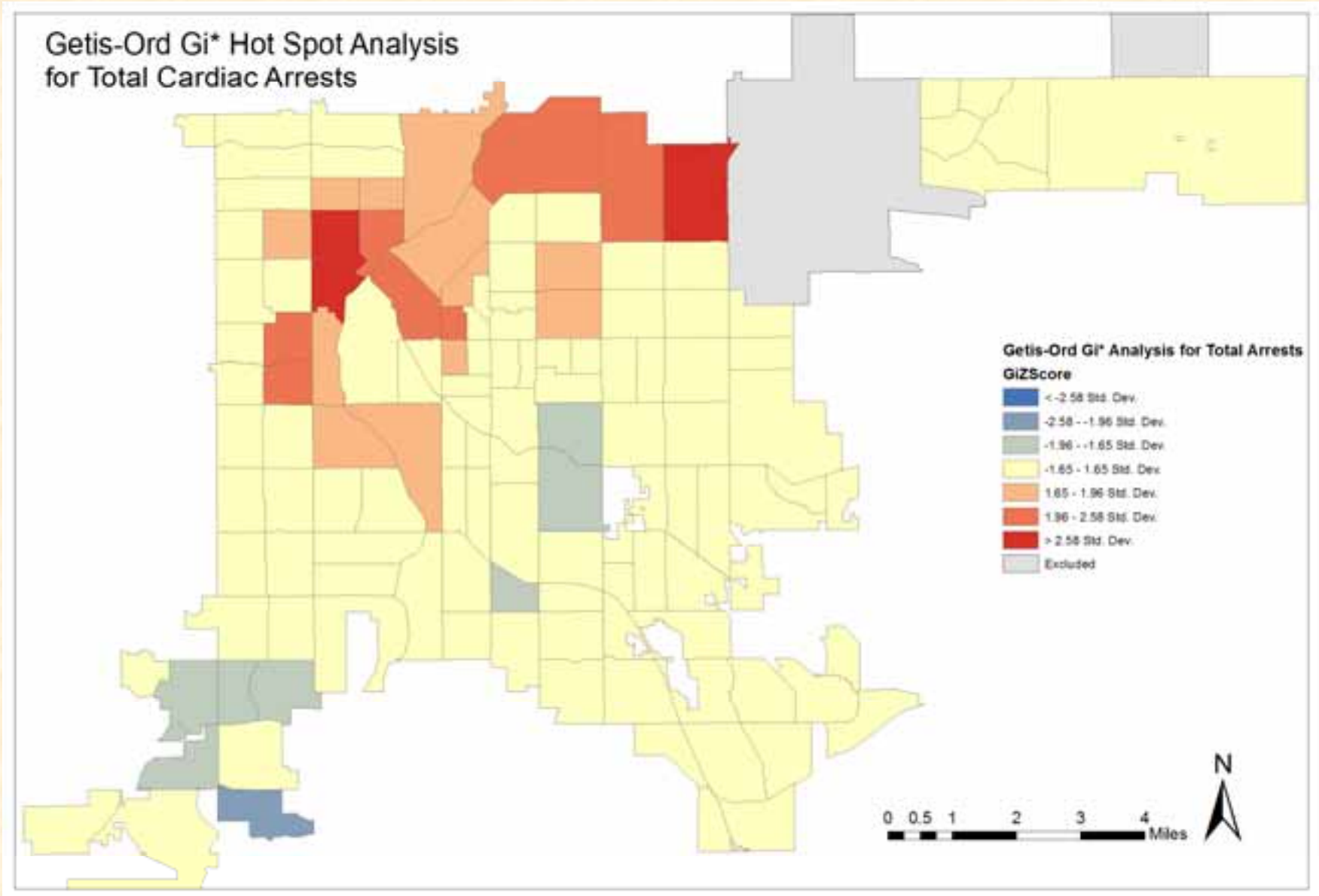


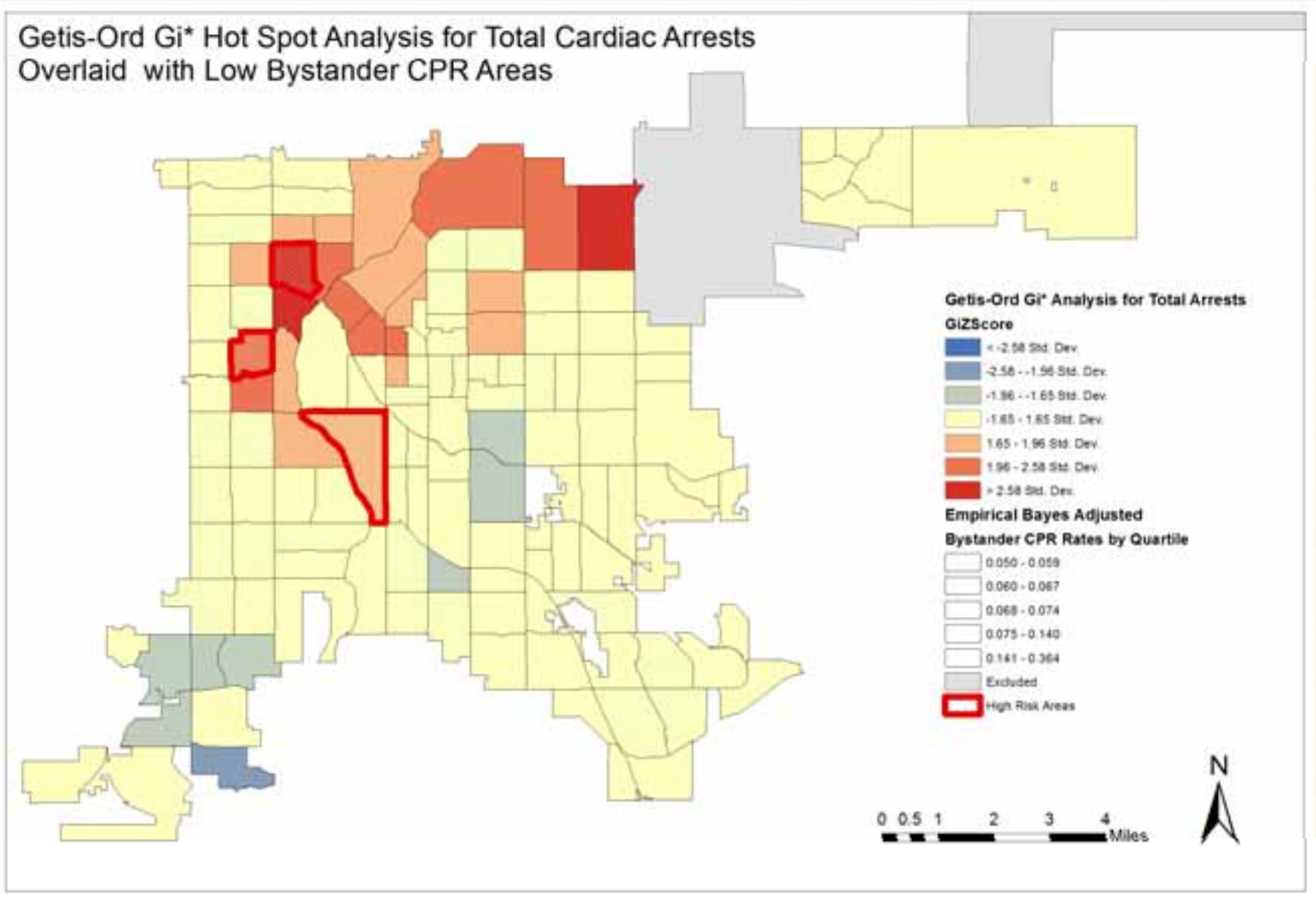
Multi-Level Poisson Regression High-Risk Census Tracts




Cluster Analysis for Total Cardiac Arrests by Census Tract
using Local Moran's I Z -scores.
Local Moran's I for Total Arrests
ZScore
-3.006200 - -0.978745
-0.978744 - 0.135860
0.135861 - 1.435560
1.435561 - 3.388510
3.388511 - 8.990080
Excluded
0 0.5 1 2 3 4
Miles
N


Local Moran's I Z-Scores for Total Cardiac Arrests Overlaid with Bystander CPR Rates By Census Tract.
Regis
Chaffee Park
Globeville
Elyria Swansea
Berkeley
Sunnyside
Northeast Park Hill
Stapleton
Montbello
Gateway / Green Valley Ranch
Cole
Clayton
West Highland
Highland
Five Points
Whittier
Skyland
North Park Hill
Sloan Lake
Jefferson
Union Station
City Park West
City Park
South Park Hill
Capitol Hill
West Colfax
East Colfax
Civic Center
Cheesman Park
Congress Park
Hale
Montclair
Villa Park
Country Club
Barnum West
Barnum
Valverde
Speer
Cherry Creek
Hilltop
Lowry Field
Baker
Westwood
Athmar Park
Washington Park West
Belcaro
Washington Park
Washington Virginia Vale
Windsor
Mar Lee
Ruby Hill
Cory - Merrill
Platt Park
Virginia Village
Hilltop
College View
South Platte
Overland
Harvey Park
University Park
Goldsmith
Harvey Park South
Wellshire
University Hills
Hampden
Kennedy
Southmoor Park
Hampden South
Fort Logan
Marston
Empirical Bayes Adjusted
Bystander CPR Rates by Quartile
0.050 - 0.059
0.060 - 0.067
0.068 - 0.074
0.075 - 0.140
0.141 - 0.364
Local Moran's I for Total Arrests
ZScore
-3.006200 - -0.978745
-0.978744 - 0.135860
0.135861 - 1.435560
1.435561 - 3.388510
3.388511 - 8.990080
Excluded
High Risk Areas
0 0.5 1 2 3 4
Miles
N


Getis-Ord Gi* Hot Spot Analysis
for Total Cardiac Arrests
Getis-Ord Gi* Analysis for Total Arrests
GiZScore
< -2.58 Std. Dev.
-2.58 - -1.96 Std. Dev.
-1.96 - -1.65 Std. Dev.
-1.65 - 1.65 Std. Dev.
1.65 - 1.96 Std. Dev.
1.96 - 2.58 Std. Dev.
> 2.58 Std. Dev.
Excluded
0 0.5 1 2 3 4
Miles
N


Getis-Ord Gi* Hot Spot Analysis for Total Cardiac Arrests
Overlaid with Low Bystander CPR Areas
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GiZScore
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-2.58 - -1.96 Std. Dev.
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Excluded
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0 0.5 1 2 3 4
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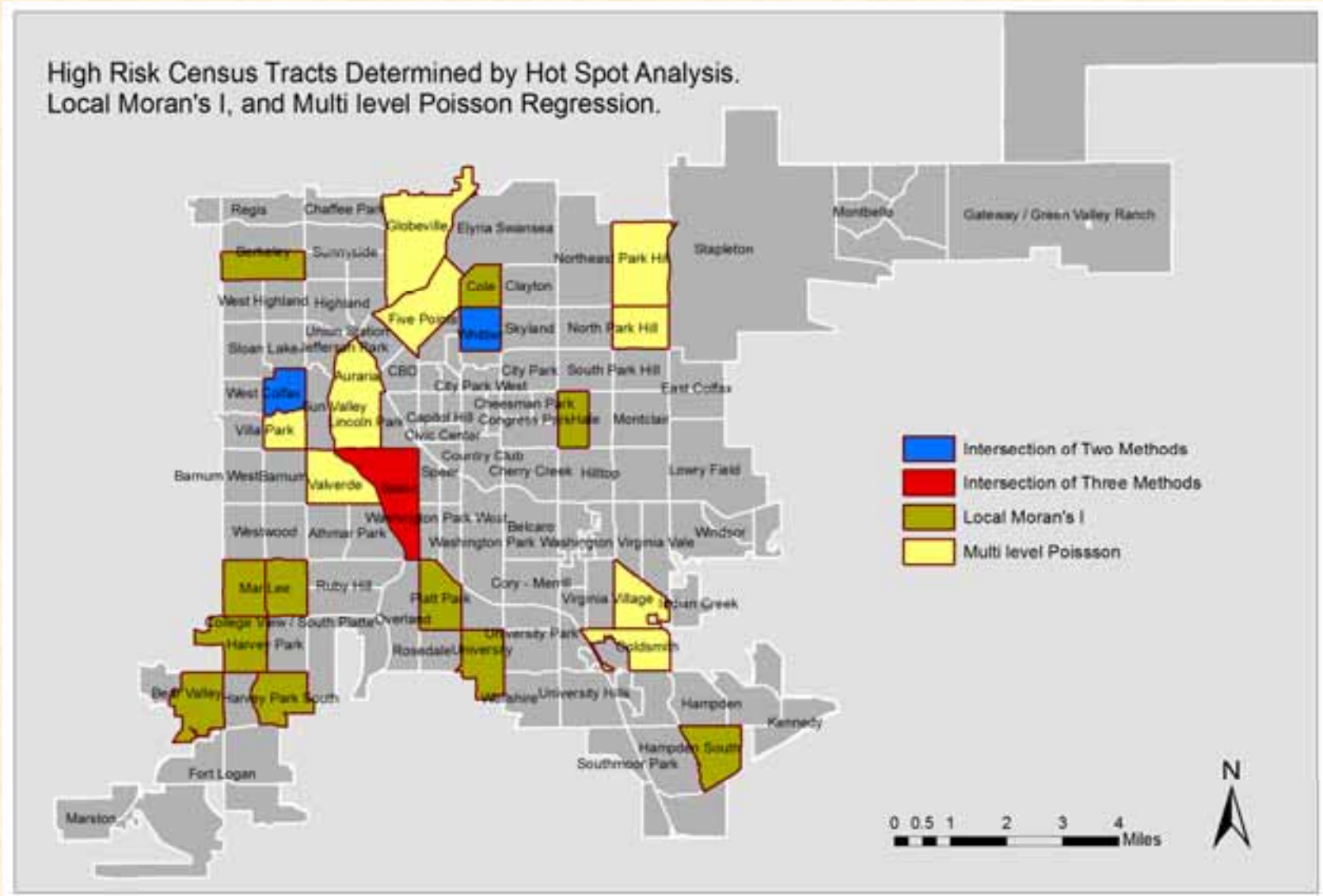
N

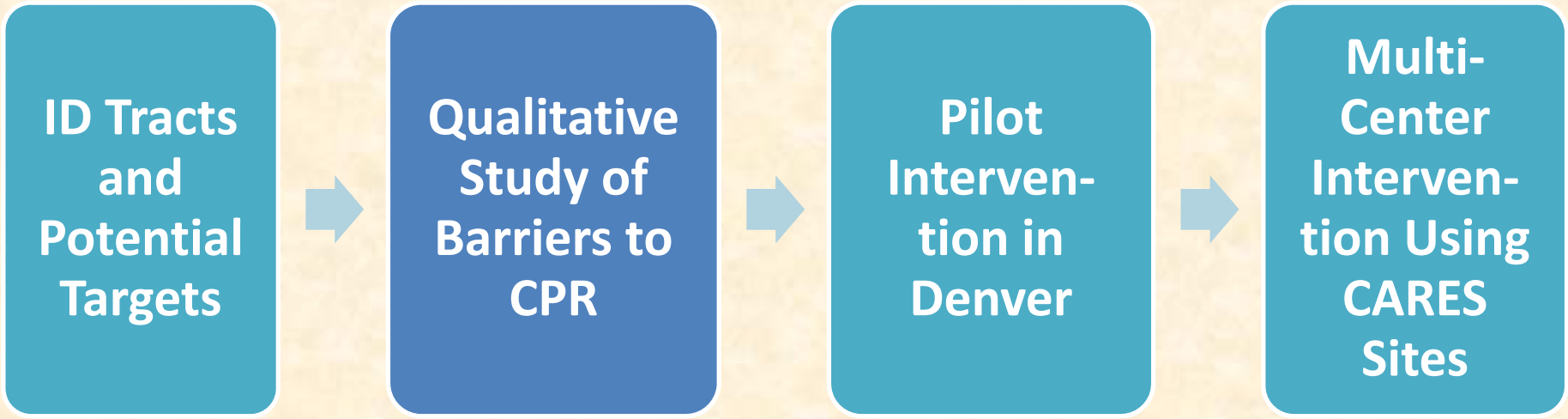
High Risk Census Tracts



Characteristics of High-Risk Census Tracts

	Tract 702 (West Colfax)	Tract 2100 (Baker)	Tract 2300 (Whittier)	Denver County Mean
White (%)	43.6	64.2	31.1	83.0
Hispanic (%)	73.6	53.6	32.6	34.3
Black (%)	4.6	3.4	44.8	10.0
High School Grads (%)	48.2	64.0	65.7	78.9
Median Household Income ($)	25,011	31,719	31,964	46,305

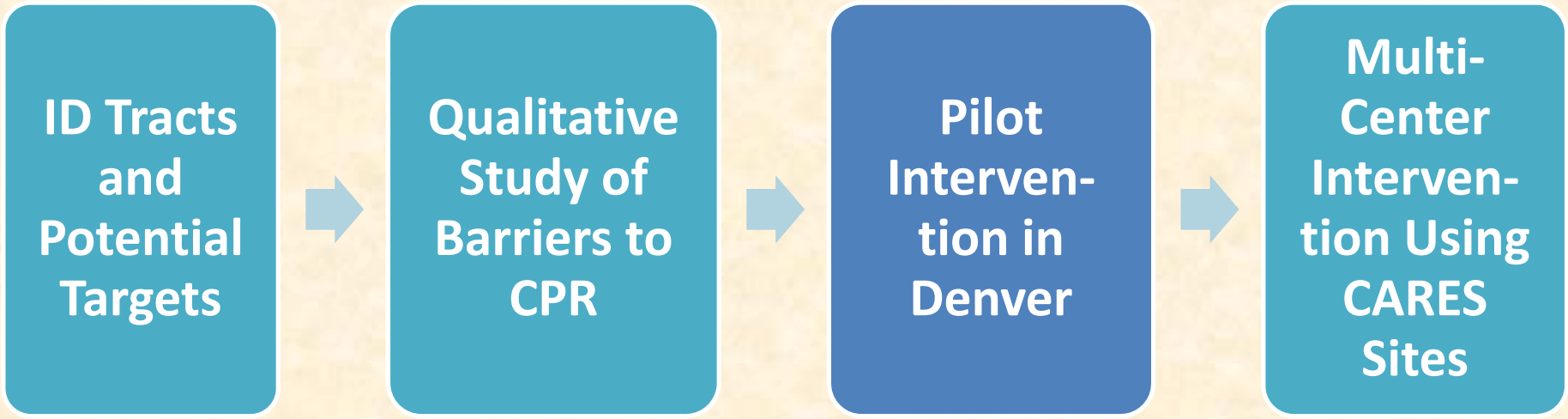
HANDDS Study Design



Phase Two: Qualitative/CBPR Study Component

- Work with community partners advisory council for LUCHAR *(Latinos Using Cardio Health Actions to Reduce Risk)*
- Use qualitative methods to conduct focus groups and semi-structured interviews with community partners to address barriers to CPR training in January 2011
- Work with the LUCHAR Community to design and develop a CPR intervention

HANDDS Study Design



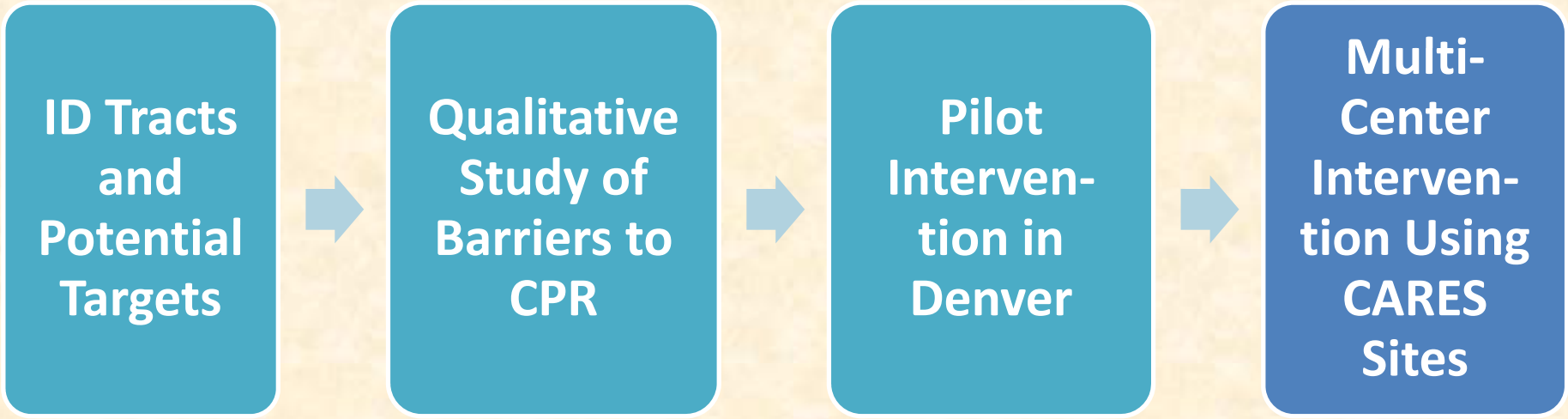
Phase Three: Pilot Study

- Quasi-experimental Design
  - Pre-post intervention with 3 control census tracts and 3 intervention census tracts
- Identify community partners/churches and schools within target census tracts

Church-Based CPR Intervention

- Control Group
  - Will receive AHA National Media Campaign
  - Pre and Post Campaign survey (at 6 months)
- Intervention Group (train the trainer model)
  - Pre, post intervention survey and then 6 month follow-up survey via mail/phone follow-up

HANDDS Study Design



Phase Four: National Implementation

- Conduct RCT, multi-centered HANNDS Trial evidence-based approach to CPR interventions
- Data Collection:
  - Examine trends in OHCA bystander CPR across cities
  - Program evaluation at 6 months

Future Directions

- Completing Cluster Analysis of Full CARES dataset
- Conducting Focus Groups in Columbus, Ohio in primarily African-American high-risk census tracts based on HANDDS Methods
- Creating Partnerships with Academic, AHA, Public Health Department, Communities, Churches, Schools in Denver
- Building National Partnerships to create building blocks for national implementation strategy

Acknowledgements

- ***Robert Wood Johnson Clinical Scholars Program and the RWJ Foundation***
- ***University of Michigan****: Rod Hayward, MD, MS; Matt Davis, MD, MPP; Michele Heisler, MD, MS; Peter Ubel, MD; Bill Barsan, MD*
- ***University of Colorado:*** *Chris Colwell, MD, Jason Haukoos, MD, MSc, Benjamin Honigman, MD, Deb Thomas, MD, Debbi Main, PhD, David Magid, MD, MPH*
- ***Centers for Disease Control****: Michelle Casper, PhD, Paula Yoon, ScD, MPH; Linda Schieb, MSPH, Greg Schwartz, MS*
- ***American Heart Association:*** *Merrilee Sweet, Patricia Mejia, Jennifer Wilkins*
- ***Emory University:*** *Arthur Kellermann, MD, MPH; Bryan McNally, MD, MPH, Eric Ossman,MD, Alex Isakov, MD, Allison Crouch, MPH*
- ***Ohio State University:*** *Michael Sayre, MD, Michael Cudnik, MD, MPH, David Keseg, MD*
- ***Oregon Health and Sciences University****: Craig Warden, MD, MS*
- ***Eastern Michigan University:*** *Hugh Semple, PhD*

Reference Slides

Baseline Demographics

	Bystander CPR (n=60) (%)	No bystander CPR (n=203) (%)
Age (SD) (n=261)	58.6(18.8)	59.6(21.4)
Sex Female (n=96)	25.0	75.0
Male (n=167)	21.6	78.4
Witnessed Arrest (n=98)	31.6	68.4
Unwitnessed Arrest (n=165)	17.6	82.4
Location of Arrest Private (n=207)	18.9	82.1
Public Location (n=56)	41.1	58.9

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	Bystander CPR (n=60) (%)	No bystander CPR ((n=203)(%)
Presenting Rhythm VF/VT/Unknown Shockable (n=62)	40.3	59.7
Unknown Unshockable (n=92)	16.3	83.7
Asystole (n=83)	15.7	84.3
PEA (n=24)	25.0	75.0
Unknown (n=2)	50.0	50.0
Who First Applied AED Bystander (n=5)	80.0	20.0
First Responder (n=120)	21.7	78.3
EMS (n=135)	21.5	78.5

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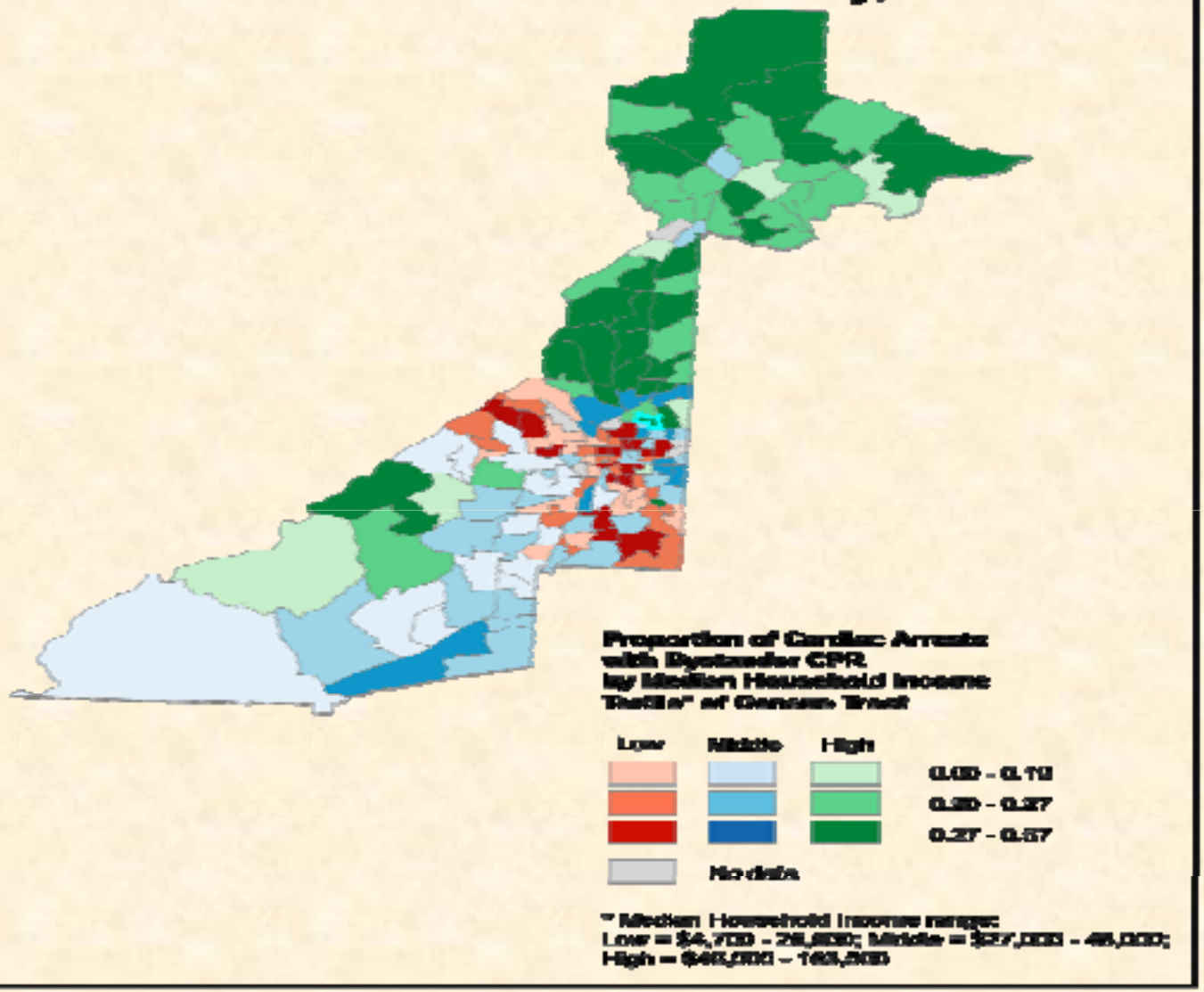
	Bystander CPR (n=60) (%)	No bystander CPR (n=203) (%)
Race **White (n=120)**	**27.5**	**72.5**
Black (n=44)	**18.2**	**81.8**
Hispanic/Latino (n=49)	**14.3**	**85.7**
Other (n=12)	**33.3**	**66.7**
Unknown (n=38)	**21.1**	**78.9**
Survival to Hospital Discharge	**10/60**	**13/203**

Cardiac Arrests with Bystander CPR by Median Household Income CARES Data - Fulton County, GA



Data: 10/1/2005 - 11/30/2006, Cardiac Arrest Registry to Enhance Survival

	Bivariate Analysis	Empty Model	INDIVIDUAL LEVEL FACTORS: Model 1	INDIVIDUAL AND CENSUS TRACT FACTORS: Model 2	INDIVIDUAL AND CENSUS TRACT FACTORS: Model 3
ICC		0.172	0.106	0.071	0.057
INDIVIDUAL LEVEL VARIABLES					
Age in Decades	0.95 (0.87-1.02)		0.95(0.87-1.04)	0.94(0.86-1.03)	0.96 (0.87-1.03)
Female	0.68 (0.51-0.86)**		0.77(0.56-1.05)	0.80(0.58-1.10)	0.81 (0.58-1.11)
Race Black	0.75 (0.55-1.80)*		0.60(0.39-0.93)*	0.78(0.49-1.23)	0.87 (0.55-1.38)
Race Other	1.05 (0.48-2.26)		0.66(0.25-1.75)	0.67(0.25-1.76)	0.70 (0.27-1.85)
Race Unknown	0.82 (0.61-1.10)		0.60(0.49-0.89)*	0.69(0.46-1.05)	0.74 (0.49-1.12)
Witnessed Arrest	1.93 (1.45-2.56)**		1.72(1.28-2.33)***	1.76(1.30-2.38)***	1.67 (1.23-2.27)***
Public Location	2.49 (1.81-3.40)**		1.96(1.38-2.78)**	1.68(1.17-2.42)*	1.65 (1.15-2.38)*
CENSUS TRACT VARIABLES					
Integrated	Ref Group			Ref Group	Ref Group
>90% White	2.58 (1.50-4.46)**			2.12(1.00-4.47)*	1.50 (0.68-3.24)
>90% Black	0.41 (0.29-0.60)**			0.55(0.35-0.87)*	0.67 (0.41-1.08)
Percent Single Householder	7.73 (2.19-27.34)**			1.01(1.00-1.03)	1.02 (1.00-1.03)*
Med Age of Census Tract	1.03(1.00-1.05)*			1.01(0.98-1.05)	1.00 (0.96-1.04)
Percent HS Education and Above	5.21 (1.21-22.44)*			1.00(0.98-1.02)	0.98 (0.96-1.01)
Percent Adults Below PS	0.25(0.03-1.90)			0.98(0.95-1.03)	0.99 (0.95-1.04)
Med Inc <$21,600	0.80 (0.51-1.24)				Ref Group
Med Inc $21,601-$38,500	0.53 (0.31-0.90)*				0.86 (0.44-1.66)
Med Inc $38,501-$42,000	0.74 (0.50-1.10)				1.27 (0.56-2.86)
Med Inc $42,001-$62,000	1.23 (0.79-1.91)				1.55 (0.68-4.00)
Med Inc >$62,001	2.30 (1.57-3.37)**				3.05 (0.92-10.09)
P value * <0.05 ** <.001					
P value * <0.05 ** <.001					
MODEL 1- (Age(Decade), Gender, Race, Witnessed, Public Location)					
MODEL 2- (Age(Decade), Gender, Race, Witnessed, Public Location, Homogeneity of Census Tract, % Single Person Household, Median Age of Census Tract, % High School Graduates or Above, % Adults Living Below Poverty Status)					
MODEL 3- (Age(Decade), Gender, Race, Witnessed, Public Location, Homogeneity of Neighborhood, % Single Person Household, Median Age of Census Tract, % High School Graduates or Above, % Adults Living Below Poverty Status, Quintile of Median Income)					