



# Residential Segregation and Prostate Cancer Post-Diagnosis Treatment Decisions

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# Objectives

1. To discuss prostate cancer incidence and geographic and racial disparities in prostate cancer incidence in the United States
2. To define the term “residential segregation” and to discuss methods to calculate the level of segregation experienced in an area
3. To detail the application of GIS to the study of racial differences in prostate cancer treatment decisions among metropolitan areas in the United States

# U.S. Prostate Cancer Incidence and Mortality

- Most commonly diagnosed cancer among men (excluding basal and squamous skin cell cancers)
- One in six men will be diagnosed with prostate cancer during lifetime
- Estimated 192,280 new prostate cancer cases will be diagnosed during 2009
- Second leading cause of cancer related mortality in men
- Approximately 2.1 million men are currently living with prostate cancer

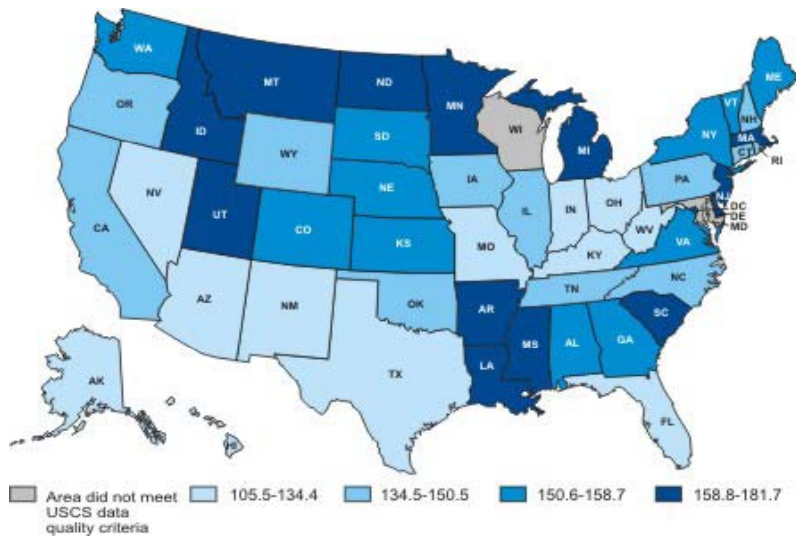
# Prostate Cancer Risk Factors

- Well-defined risk factors
  - Age
    - Approximately 65% of diagnoses are in men age 65 and older
    - Probability of being diagnosed increases with age
  - Race
    - Incidence rate in Black men is approximately 60% higher than in white men
    - Black men more likely than white men to be diagnosed with advanced stage prostate cancer
    - Black men have the highest death rate from prostate cancer of any race in the U.S. and worldwide
    - Death rate for Black men 2.4 times higher than for white men
  - Family History
    - Men with a family history are 2 to 3 times more likely to develop prostate cancer than men without a family history
- Hypothesized risk factors
  - Lifestyle factors
  - Demographics

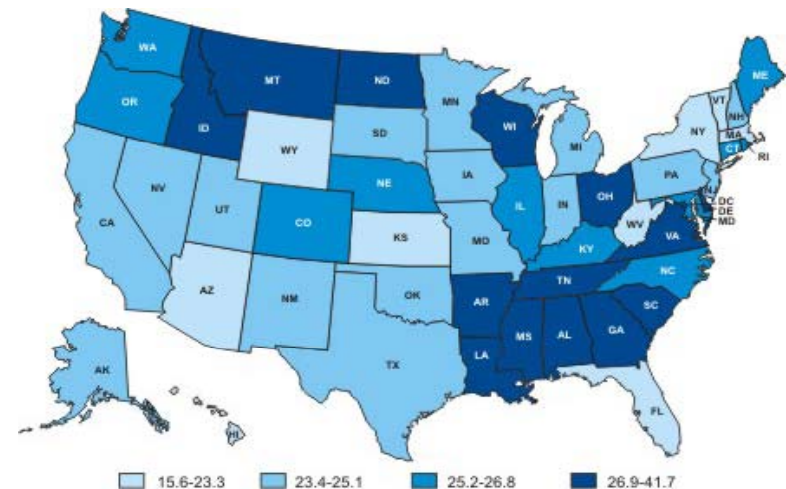
# The Geography of Prostate Cancer in the United States

- Prostate cancer exhibits a striking degree of geographic variation in both incidence and mortality

Prostate Cancer Incidence, 2005



Prostate Cancer Mortality, 2005



Source: U.S. Cancer Statistics Working Group. *United States Cancer Statistics: 1999–2005 Incidence and Mortality Web-based Report*. Atlanta (GA): Department of Health and Human Services, Centers for Disease Control and Prevention, and National Cancer Institute; 2009. Available at: <http://www.cdc.gov/uscs>.

# Proposed Mechanisms Underlying Disparities in Prostate Cancer

- Prostate cancer incidence and mortality
  - Access to screening for early detection of prostate cancer
  - Treatment after prostate cancer diagnosis
    - Access
    - Regimen prescribed by physician
- Need to focus on identifying factors that disproportionately affect either white or Black men

# What is Residential Segregation?

- “The degree to which two or more groups live separately from one another, in different parts of the urban environment.” (Denton and Massey, 1988)
- The term segregation is an adjective describing a characteristic of a region
- Segregation does not necessarily apply to individual neighborhoods, but to larger regions of neighborhoods

# Why Does Segregation Matter?

- Segregation can affect:
  - Access to resources, including hospitals, health clinics, and economic opportunities
  - Social networks
  - Proximity to environmental hazards
  - Intergroup/ intragroup contact
- From a social inequality perspective, the distribution of racial groups throughout the space might not matter for health outcomes if all groups have equal access to health-related resources



# How is Residential Segregation Measured?

- **Dissimilarity**- the percentage of a group's population that would have to change residence for each neighborhood to have the same percentage of that group as the overall geographic area overall
- **Isolation**- the extent to which members of the minority population are exposed to other members of the same minority population
- **Concentration**- the amount of physical space occupied by a minority group relative to the space occupied by the majority group in the same geographical area
- **Centralization**- the relative share of the minority population that would have to change their area of residence to match the centralization around the population centroid of the majority population
- **Clustering**- the comparison of the distance that a minority member would have to travel to come in contact with another member of that population to the distance that a member of the majority population would have to travel to come in contact with another member of the majority population

# Purpose and Specific Aims

- The purpose of this study is to examine the independent effect of residential racial segregation on prostate cancer incidence and treatment type while controlling for patient- and area- level characteristics
- Specific Aims:
  - To map prostate cancer incidence and compare incidence between white and Black men
  - To calculate the Black isolation index for metropolitan areas located in SEER registry states
  - To develop a series of multilevel logistic regression models to assess the independent effect of residential racial segregation on post-diagnosis prostate cancer treatment

# Data Sources

- Incident prostate cancer cases reported in the SEER-Medicare database between 1995 and 2002 were utilized in this study
- The SEER component of the data file provided information on the cancer site, histology, and tumor behavior; patient demographics, including census tract and county of residence; and cancer-directed treatment
- The Medicare component of the data file provided information on treatment type and secondary diagnoses
- Geographic boundary files were obtained from the U.S. Census Bureau

# MSA Level Isolation Index Calculation

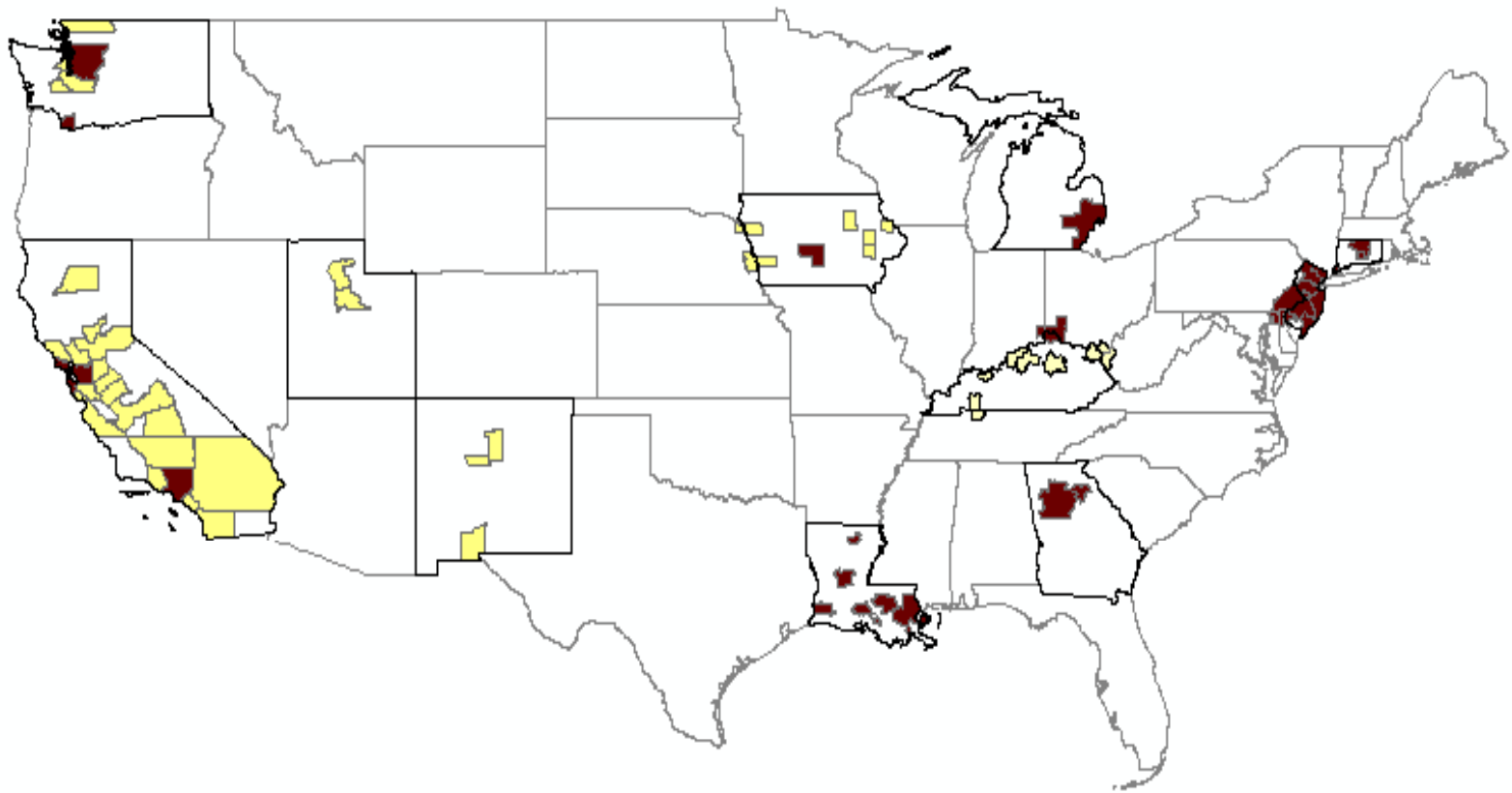
- Utilizing GIS, cases located in one of the 46 metropolitan areas within the SEER states were identified
- The Black isolation index for each of the metropolitan areas was calculated using the following equation:

$$\sum_{i=1}^n \left[ \left( \frac{x_i}{X} \right) \left( \frac{x_i}{t_i} \right) \right]$$

where:  $n$  = number of census tracts in the metropolitan area  
 $x_i$  = number of blacks in a tract  
 $X$  = total population of blacks in the metro area  
 $t_i$  = total population in the metropolitan area

- Metropolitan areas were classified as low or high isolation
  - Based on the 75<sup>th</sup> percentile for the study sample

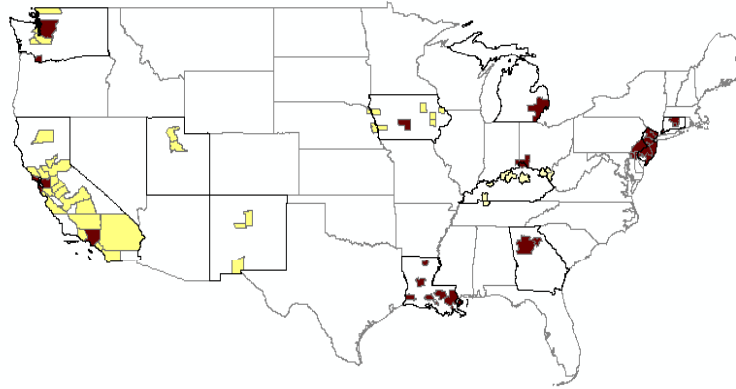
# Metropolitan Area Residential Segregation



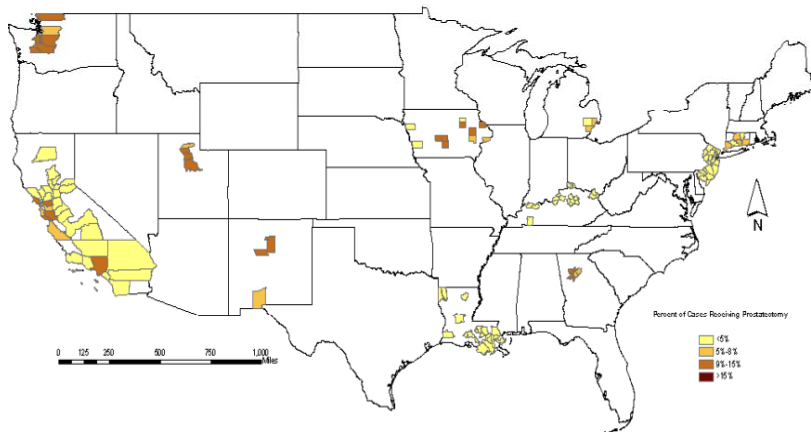
# Treatment Type Classification

Treatment Type	Data File	Variables	Data File Categories Included
Radiation Therapy	PEDSF	Rad1	1: Beam radiation 2: Radioactive implants 3: Radioisotopes 4: Combination of 1 with 2 or 3 5: Radiation, source not specified 6: Other radiation
Radical Prostatectomy	PEDSF	Ssurg1	50: Radical/ total prostatectomy without dissection of lymph nodes 60: Radical/ total prostatectomy with dissection of lymph nodes
Hormone Therapy	Medicare inpatient, outpatient, and physician services claims	HCPCS J codes	J9202, J1950, J9217, J9218, J9219
Active Surveillance	No surgery, radiation, or hormone treatment within the first 7 months of diagnosis		

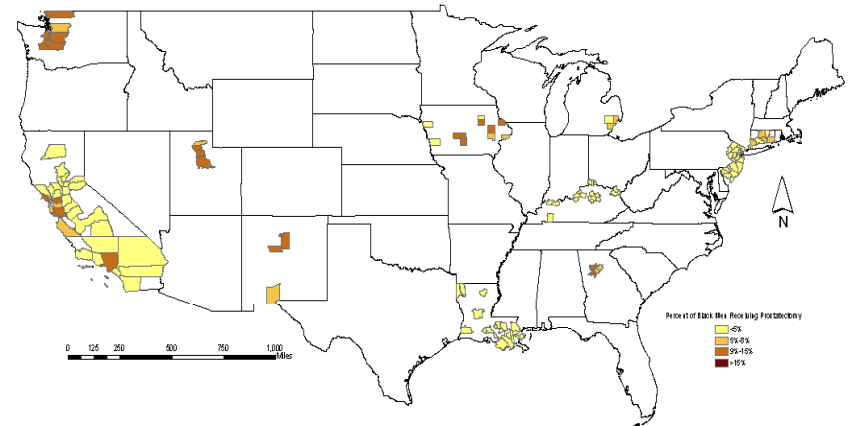
# Radical Prostatectomy



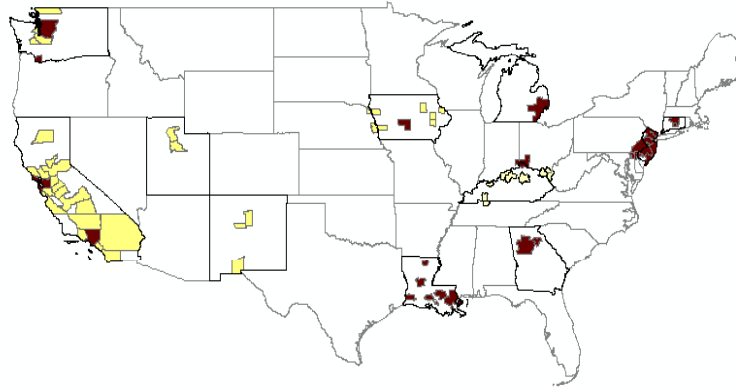
White Males



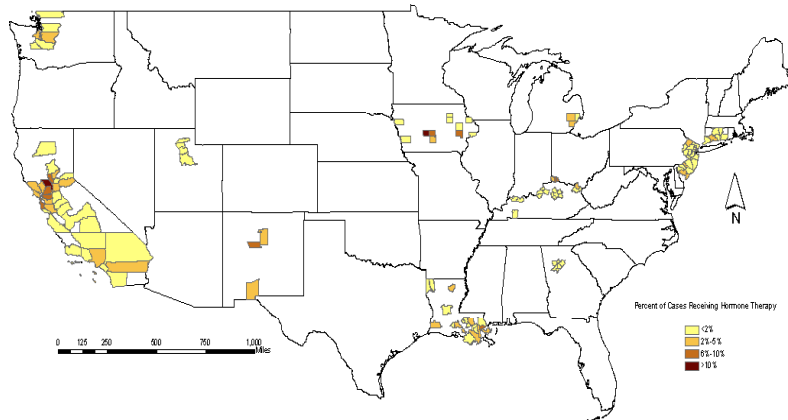
Black Males



# Hormone Therapy



**White Males**

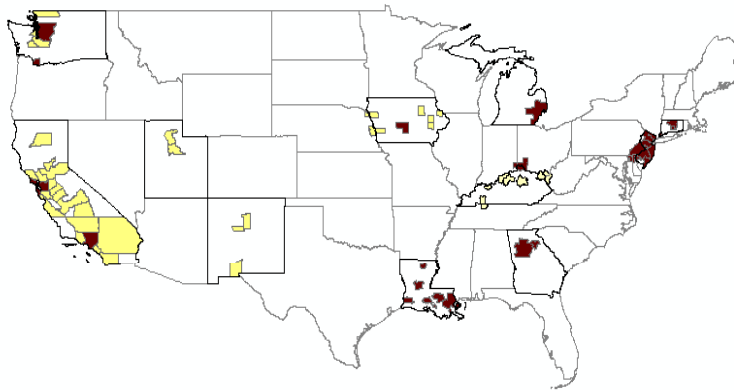


**Black Males**

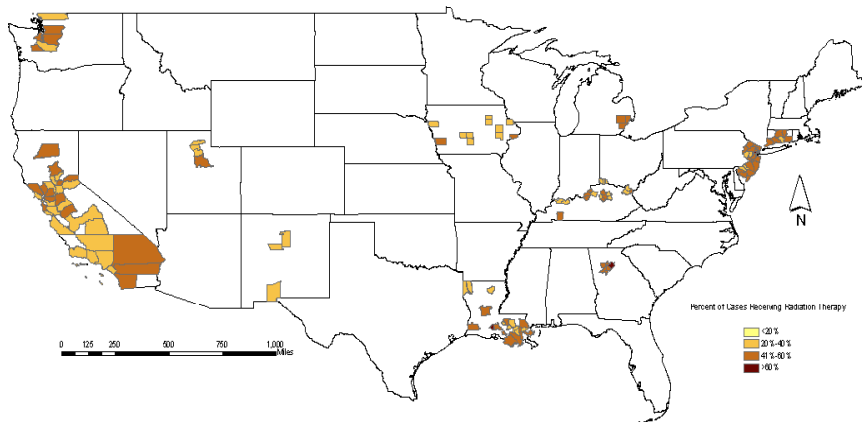




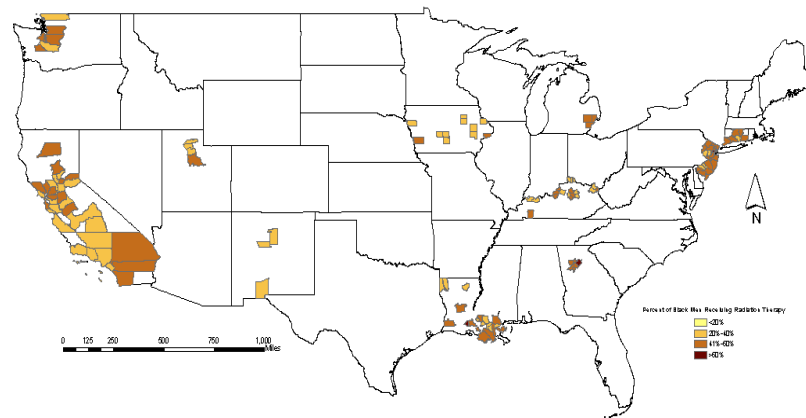
# Radiation Therapy



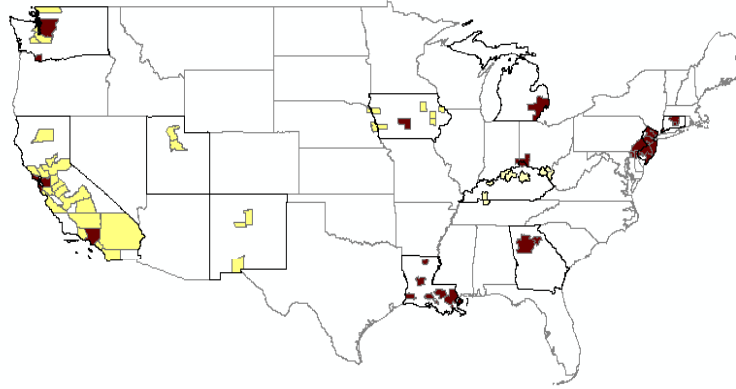
**White Males**



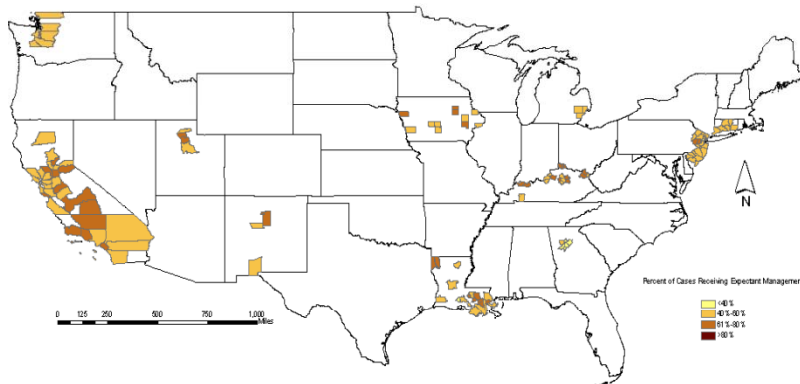
**Black Males**



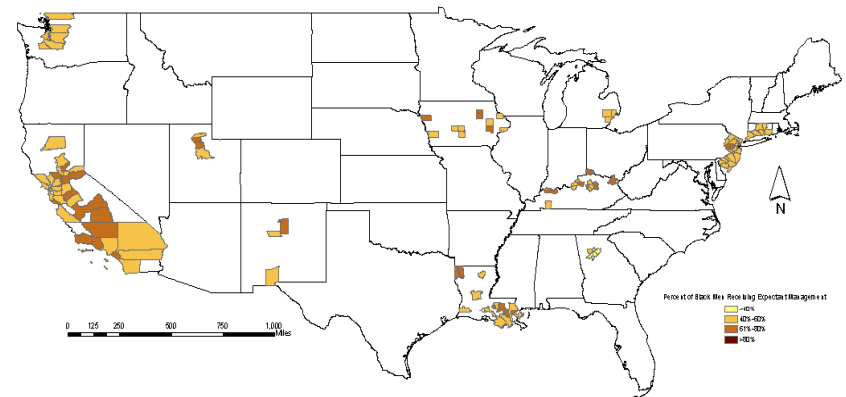
# Expectant Management



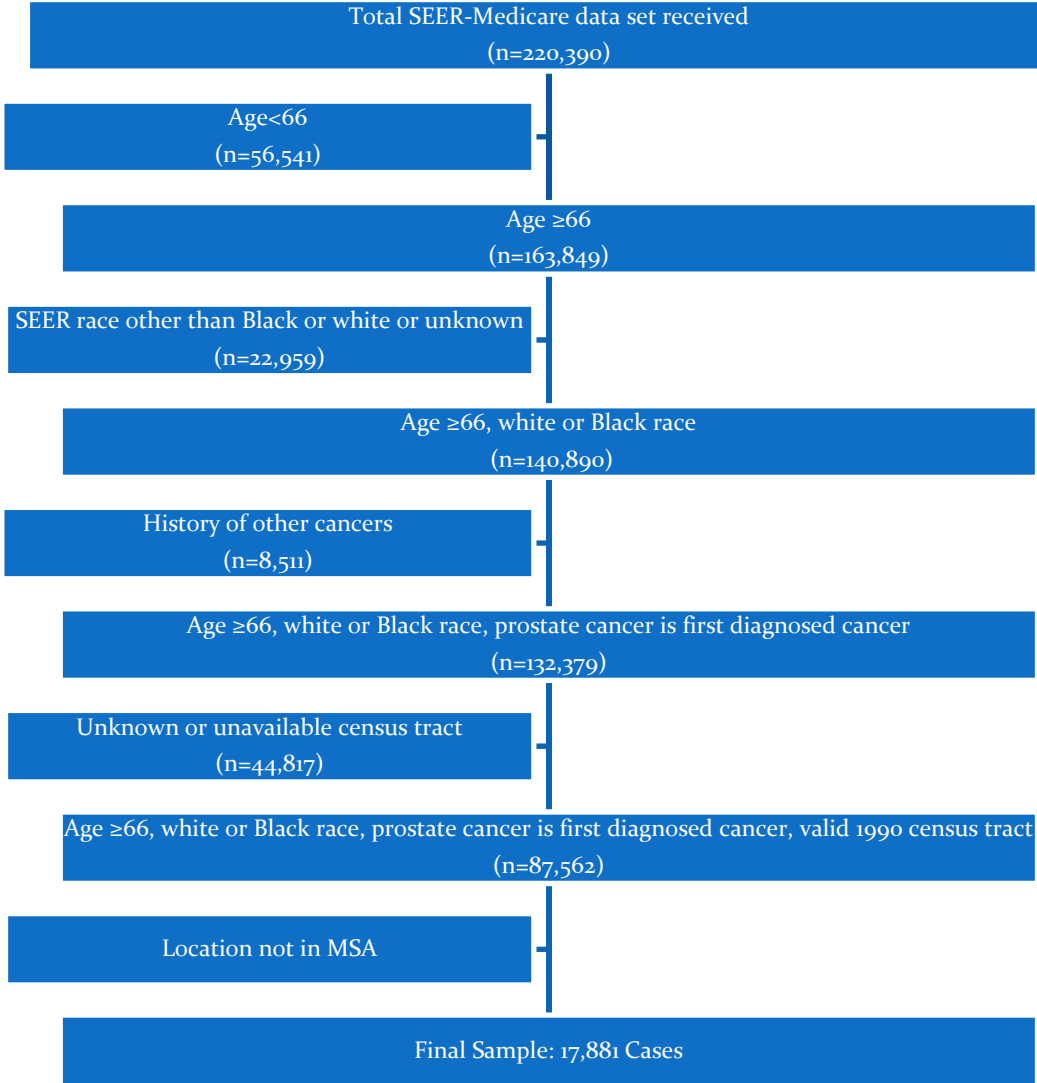
White Males



Black Males



# Data Set



# Statistical Methods

- Multilevel logistical regression modeling
  - Outcome: probability of receiving each treatment type (radiation therapy, hormone therapy, radical prostatectomy, expectant management)
  - Level 1 characteristics: age, race, tumor stage and grade, marital status, and comorbidities (Elixhauser)
  - Level 2 characteristic: MSA

# Study Sample Characteristics by Segregation Level

	Low Isolation MSAs N (%)	High Isolation MSAs N (%)	<i>p</i> -value
<b>Age</b>			
65-69	1734 (26.1)	3060 (27.2)	.081
70-74	2099 (31.6)	3662 (32.6)	
75-79	1579 (23.8)	2605 (23.2)	
80-84	782 (11.8)	1216 (10.8)	
85+	442 (6.7)	702 (6.2)	
<b>Marital Status</b>			
Single	4904 (81.6)	7935 (75.7)	.000
Married	316 (5.3)	738 (7.0)	
Separated/Divorced	228 (3.8)	538 (5.1)	
Widowed	560 (9.3)	1267 (12.1)	
<b>Race</b>			
White	6534 (98.5)	9791 (87.1)	.000
Black	102 (1.5)	1454 (12.69)	
<b>Stage</b>			
0	64 (1.0)	59 (0.5)	.000
1	1916 (28.9)	3980 (35.4)	
2	750 (11.3)	1032 (9.2)	
3	622 (9.4)	766 (6.8)	
4	493 (7.4)	834 (7.4)	
<b>Grade</b>			
1	736 (11.1)	739 (6.6)	.000
2	3985 (60.1)	7208 (64.1)	
3	1404 (21.2)	2272 (20.2)	
4	59 (0.9)	42 (0.4)	
<b>Comorbidities</b>			
Mean (SD)	2.444 (2.57)	2.816 (2.86)	.000

# Receipt of Hormone Therapy

	Unadjusted Analysis OR(95% CI)	Fixed Parameter Model OR (95% CI)	2 Level Model: Black Isolation OR (95% CI)
<b>Fixed Parameters</b>			
Age*	1.645 (1.587, 1.705)	1.541 (1.474, 1.611)	1.537 (1.469, 1.608)
Marital Status			
Married	1.0	1.0	1.0
Single	1.328 (1.109, 1.590)	1.254 (1.034, 1.522)	1.222 (1.004, 1.487)
Separated/Divorced	1.169 (.940, 1.454)	1.240 (.979, 1.569)	1.281 (1.009, 1.627)
Widowed	1.635 (1.431, 1.868)	1.027 (.886, 1.191)	1.025 (.882, 1.191)
Race			
White	1.0	1.0	1.0
Black	1.022 (.877, 1.191)	.660 (.306, 1.421)	.579 (.258, 1.299)
Stage			
0	1.0	1.0	1.0
1	.159 (.051, .502)	2.623 (.806, 8.541)	2.684 (.822, 8.765)
2	.801 (.721, .889)	2.727 (.823, 8.943)	2.832 (.861, 9.313)
3	.761 (.645, .897)	1.606 (.483, 5.335)	1.645 (.494, 5.480)
4	.426 (.340, .535)	7.402 (2.263, 24.206)	7.655 (2.334, 9.103)
Grade			
1	1.0	1.0	1.0
2	1.475 (1.203, 1.810)	1.870 (1.0470, 2.380)	1.896 (1.484, 2.421)
3	3.792 (3.075, 4.677)	3.137 (2.445, 4.026)	3.205 (2.490, 4.126)
4	6.360 (4.029, 10.039)	5.416 (3.234, 9.070)	.824 (.611, 1.111)
<b>Black Isolation Index</b>			
Low	1.0	1.0	1.0
High	.990 (.905, 1.083)	.993 (.891, 1.106)	1.112 (1.090, 1.295)
<b>Isolation/Race Interaction</b>			
Low Isolation/White	1.0	1.0	1.0
High Isolation/Black	1.678 (.828, 3.401)	1.473 (.669, 3.239)	2.079 (.906, 4.773)

# Receipt of Radiation Therapy

	Unadjusted Analysis OR(95% CI)	Fixed Parameter Model OR (95% CI)	2 Level Model: Black Isolation OR (95% CI)
<b>Fixed Parameters</b>			
Age*	.741 (.719, .764)	.770 (.743, .799)	.777 (.749, .807)
Marital Status			
Married	1.0	1.0	1.0
Single	.786 (.678, .912)	.757 (.648, .885)	.789 (.673, .936)
Separated/Divorced	.946 (.802, 1.116)	.872 (.732, 1.039)	.851 (.711, 1.017)
Widowed	.660 (.584, .744)	.838 (.736, .954)	.828 (.726, .944)
Race			
White	1.0	1.0	1.0
Black	1.020 (.906, 1.148)	1.305 (.817, 2.083)	1.143 (.704, 1.855)
Stage			
0	1.0	1.0	1.0
1	.379 (.208, .690)	4.656 (2.438, 8.893)	4.701 (2.451, 9.015)
2	2.017 (1.869, 2.178)	2.984 (1.554, 5.728)	2.281 (1.473, 5.477)
3	1.364 (1.213, 1.534)	1.009 (.519, 1.962)	.964 (.493, 1.882)
4	.483 (.407, .573)	1.197 (.612, 2.343)	1.184 (.602, 2.327)
Grade			
1	1.0	1.0	1.0
2	1.521 (1.336, 1.732)	1.021 (.879, 1.186)	.997 (.855, 1.163)
3	.873 (.753, 1.012)	.801 (.677, .947)	.787 (.663, .936)
4	.434 (.229, .822)	.433 (.218, .857)	.484 (.243, .966)
<b>Black Isolation Index</b>			
Low	1.0	1.0	1.0
High	1.319 (1.229, 1.416)	1.183 (1.093, 1.282)	.294 (.108, .805)
<b>Isolation/Race Interaction</b>			
Low Isolation/White	1.0	1.0	1.0
High Isolation/Black	.656 (.417, 1.030)	.665 (.409, 1.083)	.562 (.339, .931)

# Receipt of Radical Prostatectomy

	Unadjusted Analysis	Fixed Parameter Model	2 Level Model: Black Isolation
	OR(95% CI)	OR (95% CI)	OR (95% CI)
<b>Fixed Parameters</b>			
Age*	.332 (.306, .360)	.373 (.340, .408)	.370 (.337, .406)
<b>Marital Status</b>			
Married	1.0	1.0	1.0
Single	.616 (.471, .805)	.739 (.548, .996)	.804 (.592, 1.092)
Separated/Divorced	.637 (.468, .866)	.710 (.506, .996)	.755 (.535, 1.065)
Widowed	.293 (.220, .390)	.687 (.502, .941)	.715 (.520, .983)
<b>Race</b>			
White	1.0	1.0	1.0
Black	.618 (.487, .784)	.464 (.175, 1.227)	.483 (.179, 1.298)
<b>Stage</b>			
0	1.0	1.0	1.0
1	1.733 (.925, 3.246)	.230 (.111, .478)	.224 (.107, .471)
2	.499 (.414, .601)	1.009 (.490, 2.078)	.951 (.456, 1.984)
3	2.786 (2.353, 3.299)	2.997 (1.460, 6.154)	3.085 (1.483, 6.414)
4	9.628 (8.290, 11.183)	.212 (.093, .482)	.210 (.091, .484)
<b>Grade</b>			
1	1.0	1.0	1.0
2	1.447 (1.160, 1.805)	1.346 (1.034, 1.754)	1.515 (1.158, 1.983)
3	.985 (.767, 1.265)	.869 (.643, 1.175)	.962 (.708, 1.308)
4	.783 (.311, 1.972)	.577 (.184, 1.808)	.637 (.204, 1.986)
<b>Black Isolation Index</b>			
Low	1.0	1.0	1.0
High	.534 (.477, .597)	.583 (.510, .667)	1.041 (.981, 1.101)
<b>Isolation/Race Interaction</b>			
Low Isolation/White	1.0	1.0	1.0
High Isolation/Black	1.489 (.626, 3.542)	1.978 (.720, 5.435)	1.588 (.567, 4.450)



# Receipt of Expectant Management

	Unadjusted Analysis OR(95% CI)	Fixed Parameter Model OR (95% CI)	2 Level Model: Black Isolation OR (95% CI)
<b>Fixed Parameters</b>			
Age*	1.308 (1.275, 1.342)	1.273 (1.234, 1.313)	1.260 (1.222, 1.301)
Marital Status			
Married	1.0	1.0	1.0
Single	1.412 (1.244, 1.602)	1.389 (1.217, 1.585)	1.354 (1.184, 1.549)
Separated/Divorced	1.287 (1.110, 1.491)	1.296 (1.110, 1.514)	1.274 (1.089, 1.491)
Widowed	1.655 (1.500, 1.826)	1.253 (1.126, 1.395)	1.255 (1.127, 1.399)
Race			
White	1.0	1.0	1.0
Black	1.260 (1.135, 1.399)	1.298 (.846, 1.992)	1.313 (.850, 2.030)
Stage			
0	1.0	1.0	1.0
1	3.987 (2.595, 6.125)	.280 (.176, .446)	.263 (.0165, .420)
2	.562 (.524, .603)	.292 (.182, .468)	.276 (.172, .443)
3	.558 (.500, .622)	.294 (.183, .473)	.282 (.174, .455)
4	.488 (.432, .552)	.452 (.280, .729)	.433 (.268, .700)
Grade			
1	1.0	1.0	1.0
2	.416 (.373, .465)	.566 (.497, .644)	.572 (.502, .653)
3	.355 (.314, .402)	.444 (.385, .513)	.445 (.384, .515)
4	.399 (.262, .608)	.481 (.309, .749)	.488 (.312, .763)
<b>Black Isolation Index</b>			
Low	1.0	1.0	1.0
High	.809 (.760, .860)	.815 (.759, .875)	.361 (.143, .910)
<b>Isolation/Race Interaction</b>			
Low isolation/White	1.0	1.0	1.0
High isolation/Black	1.195 (.796, 1.797)	1.132 (.726, 1.766)	1.415 (1.098, 2.229)

# Discussion

- Geographic and racial variation in prostate cancer incidence was observed
- Black men living in metropolitan areas with high segregation were statistically significantly more likely to receive expectant management and were statistically significantly less likely to receive radiation therapy compared to white men living in areas of low segregation following a diagnosis of prostate cancer
- Black men living in metropolitan areas with high segregation were more likely to receive hormone therapy and radical prostatectomy than white men living in areas of low segregation, although these differences were not statistically significant

# Limitations

- SEER-Medicare claims data exist only for patients age 66 and older
  - Prostate cancer is more likely to occur at an earlier age in African American men
- Potential misclassification of treatment type
- Missing census tract identifiers
- Lack of data on individual level characteristics of cases

# Future Research

- Investigate the effect of segregation and race on post-treatment PSA surveillance
- Investigate the independent effect of race on the probability of recurrent prostate cancer among patients receiving definitive therapy (surgery or radiation)
- Research is currently underway to characterize the effects of segregation at varying spatial levels, and to assess the role of the modifiable areal unit problem (MAUP) on the assessment of segregation and prostate cancer treatment and outcomes.
- Focus on the roll of hypersegregation on prostate cancer diagnosis, treatment decisions, and outcomes.
- Work to identify the potential intermediary pathways between segregation and prostate cancer treatment and outcomes.



# Contact Information

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