The Synergistic Effects of Social Determinants of Health and Race-Ethnicity on 30-Day Readmission Disparities in an Inpatient Population

S03: Social Determinants and Health Assessment

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Disclosure

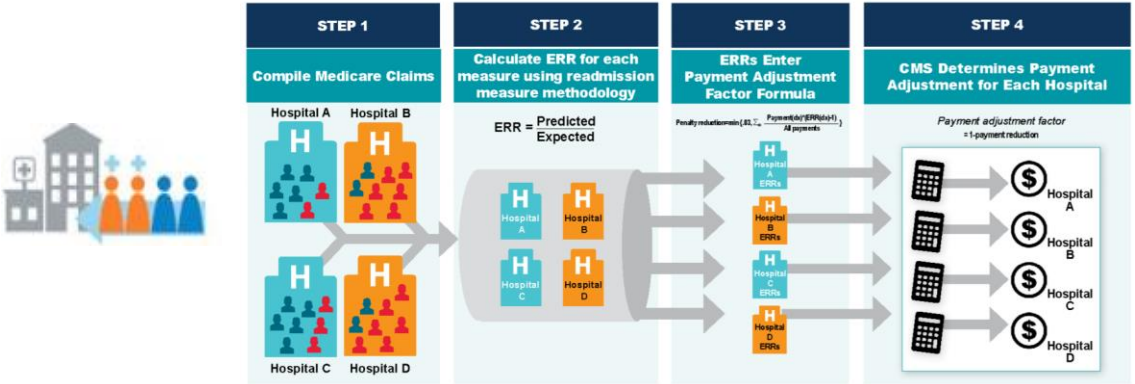
I and my co-authors have no relevant financial relationships with commercial interests to disclose

Learning Objectives

After participating in this session, the learner should be better able to learn:

- how the combination of social determinants of health (SDOH) and race-ethnicity impact disparities in 30-day readmission using multiple multivariate analytic methods
- how such a mixed methods approach can reveal different groups of patients at the highest risk of readmission
  - Health care organizations can deploy limited resources to reduce readmissions

Introduction



CMS Hospital Readmissions Reduction Program & Financial Penalties

Sources: CMS (2017) HRRP User Guide; Edward Hunt (2016), Ponce Research Institute

- Hospital readmission rates have been used as a public reporting of quality metrics for hospital reimbursements or penalties with excess risk-standardized readmissions
- Reduction in hospital readmission rates has been a priority for improvement of healthcare quality and patient clinical outcomes
  - Identifying risk factors of readmission is critical for early interventions

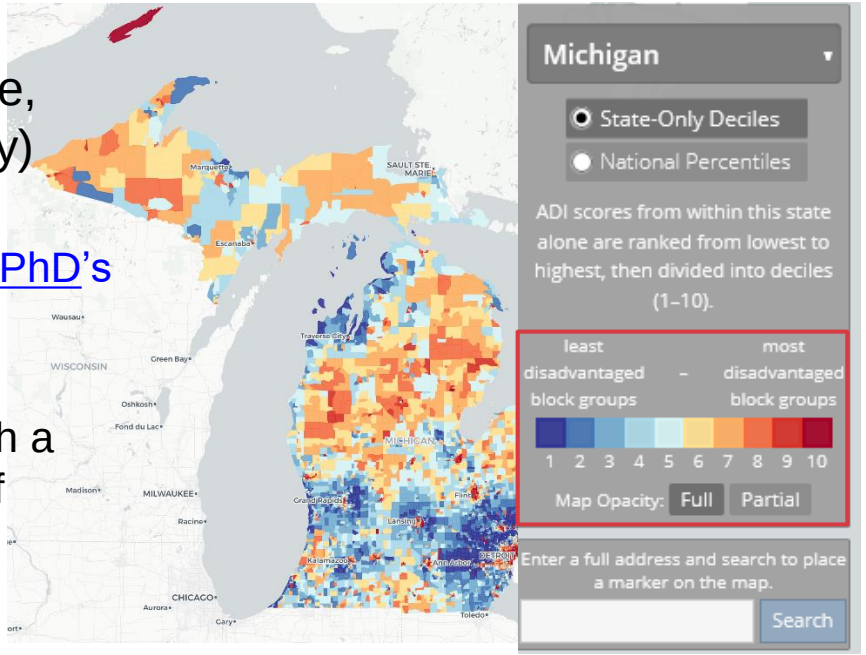
Motivation

- In additional to the clinical characteristics, previous studies showed that race-ethnicity and the nonclinical conditions, SDOH,—including Area Deprivation Index (ADI)—were important factors that influence the likelihood of readmission
  - SDOH: Centers for Disease Control and Prevention defined as “The conditions in which people live, learn, work, and play affect a wide range of health risks and outcomes”

Sources: https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health

Area Deprivation Index (ADI)

- A ranking measure of neighborhoods by socioeconomic status disadvantage (income, education, employment, and housing quality)
  - Created by the Health Resources & Services Administration and refined by Amy Kind, MD, PhD's research team at the University of Wisconsin-Madison
  - A Census Block Group/neighborhood level with a ranking of 10/100 indicates the highest level of "disadvantage" within the state/nation
  - Higher ADI (worse): more deprived area



Source: https://www.neighborhoodatlas.medicine.wisc.edu/

Research Gap & Objectives

- There is a lack of research studying
  - the impact of SDOH and race-ethnicity on readmission risk in the broader population setting
  - how the effects of SDOH on readmission may depend upon race-ethnicity

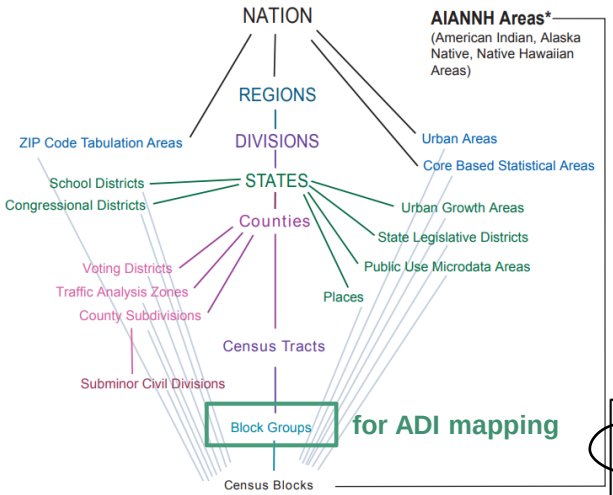
- Objectives:
  - Examine the effects of SDOH and race-ethnicity on readmission separately for all inpatient populations across a large health care system
  - Investigate the racial-ethnicity specific effects of SDOH on readmission
  - Identify groups of patients with differing readmission risk based on SDOH, race-ethnicity, and other key confounding features.

Data Sources: HFHS Inpatient Registry

Data structure & key data elements (Encounter-level)

Time: 11/2015 - 12/2018 (256,077 Patient Encounters)

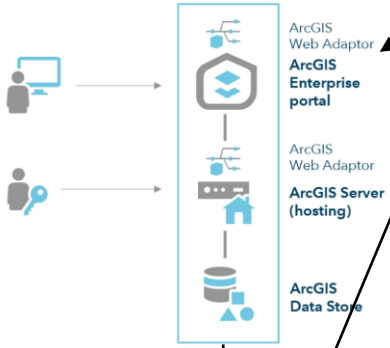
Hierarchy of Census Geographic Entities



for ADI mapping

Source: United States Census Bureau; The Esri Community

ArcGIS Geocoding Software



- **Encounter ID**
- **Zip code+4 (Block Groups)**

ADI

- **Zip code+4**
- **Encounter ID**
- ADI Ranking Score

Readmission

- **Encounter ID**
- Patient ID
- Demographics
  - Age
  - Gender
  - Race-Ethnicity[1]
- Primary Insurance Type
- Dual Eligible Coverage
- Primary Diagnosis Code (map to CCSR[2])
- 30-day Readmission(Y/N)

Red: Outcome
Purple: Race-Ethnicity
Green: SDOH
Black: Other Variables

Other Social Factors (Flowsheet)

- **Encounter ID**
- Patient ID
- Drug Use
- Lives Alone
- Depression

Charlson Comorbidities Index

- **Encounter ID**
- Patient ID
- Charlson Comorbidities
- Chronic Diseases (Y/N)

[1] Black, White, Hispanic & Latino, Others
[2] CCSR: AHRQ Clinical Classifications Software Refined Categories

Analytical Workflow

Encounter-level Dataset

- Race-Ethnicity
- Six SDOH
- Age
- Gender
- Charlson Comorbidities Index & 17 Chronic Diseases (Y/N)
- Top15 CCSR Diagnosis Categories & Others
- 30-day Readmission (Y/N)

Descriptive Analysis & Basic Univariate Analysis

- Chi-squared test for categorical variables
- t-test for continuous variables

Latent Class Analysis[1]

- Data-driven analytic approach (similar as cluster analysis)
- This data exploratory tool can be used to identify district, unknow patterns in subpopulations based on a set of observed indicators from multiple layers of data

Multivariate Logistic Regression Models

- Model A: **Test SDOH and race-ethnicity separately on readmission**

Race-Ethnicity + SDOH + confounding factors (Age, Gender, CCI, Chronic Diseases, and CCSR)

- Model B: **Test the synergistic effects (SDOH and race-ethnicity)**

Variables in Model A + multiplicative interaction terms

- Model C: **Compare each SDOH effect in different race-ethnicity groups**

Three stratified models for three race-ethnicity groups
(Variables in Model A, except Race-Ethnicity)

[1]: Muthén B, Muthén LK. Integrating person-centered and variable-centered analyses: Growth mixture modeling with latent trajectory classes. Alcohol Clin Exp Res. 2000;24(6):882–891.

Latent Class Analysis (LCA) Diagram

Observed Variables

Drug Use | Lives Alone | Depression | Insurance Type | Dual Eligible Coverage | ADI (4 groups) | Race-Ethnicity (4 groups) | Age (4 groups) | Gender | Charlson Comorbidities Index

Latent Class Model

$posterior\ p_1$ $posterior\ p_2$ $posterior\ pN$

Latent Class 1 | Latent Class 2 | ..... | Latent Class N

Selection criteria for number of latent classes:

(1) adjusted Bayesian information criteria (BIC)
(2) number of participants assigned to each class
(3) mean posterior probabilities in each class

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The univariate results showed that Race-Ethnicity and all SDOH were significantly associated with readmission

Readmission rate: 13.6%

	Overall (n = 256074)	Readmission Status: Yes (n = 34901)	Readmission Status: No (n = 221173)	Unadjusted p-value[a]
Demographics				
Age, mean (SD)	59.69 (19.71)	64.54 (16.91)	58.92 (20.01)	<0.001
Sex, n (%)				<0.001
Female	147837 (57.7)	18189 (52.1)	129648 (58.6)	
Male	108237 (42.3)	16712 (47.9)	91525 (41.4)	
Race-Ethnicity, n (%)				<0.001
White	161304 (63.0)	21534 (61.7)	139770 (63.2)	
African American	69025 (27.0)	10635 (30.5)	58390 (26.4)	
Hispanic	8073 (3.2)	821 (2.4)	7252 (3.3)	
Other/Unknown	17672 (6.9)	1911 (5.5)	15761 (7.1)	
Social Determinants of Health				
ADI National Rank, mean (SD)	65.43 (26.20)	67.68 (25.80)	65.08 (26.25)	<0.001
ADI Quartiles, n (%)				<0.001
Q1 (1-45)	63015 (25.6)	7596 (22.5)	55419 (26.1)	
Q2 (46-69)	60387 (24.5)	8209 (24.3)	52178 (24.6)	
Q3 (70-90)	63145 (25.7)	8782 (26.0)	54363 (25.6)	
Q4 (91-100)	59445 (24.2)	9139 (27.1)	50306 (23.7)	
Drug Use, n (%)	14632 (5.7)	2487 (7.1)	12145 (5.5)	<0.001
Lives Alone, n (%)	46128 (18.0)	7813 (22.4)	38315 (17.3)	<0.001
Depression, n (%)	32977 (12.9)	5684 (16.3)	27293 (12.3)	<0.001
Dual Eligible, n (%)	31229 (12.2)	6258 (17.9)	24971 (11.3)	<0.001
Insurance, n (%)				<0.001
Medicare	138734 (54.2)	23696 (67.9)	115038 (52.0)	
Commercial	65105 (25.4)	5529 (15.8)	59576 (26.9)	
Medicaid	49175 (19.2)	5497 (15.8)	43678 (19.7)	
Other/Unknown	3060 (1.2)	179 (0.5)	2881 (1.3)	

ReadmissionY/N ~ Race-Ethnicity

ReadmissionY/N ~ each SDOH

[a] Chi-squared test for categorical variables; t-test for continuous variables

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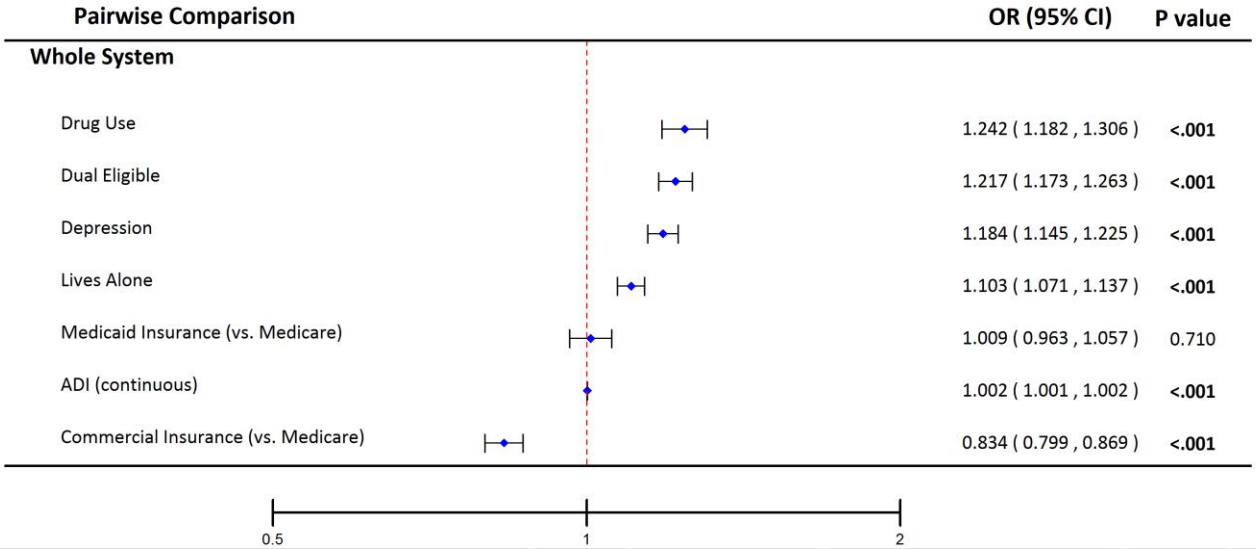
According to the multivariate results, all SDOH were associated with readmission, except Medicaid insurance (vs. Medicare)

- The patients with at least one SDOH had higher risk of 30-day readmission

Model: **ReadmissionY/N** ~ **each SDOH** + Race-Ethnicity +
Age + Gender + AHRQ CCSR Diagnosis Category + Charslon CCI Score + Chronic Diseases



The patients living in more deprived areas were more likely to be readmitted in 30 days

Logistic Regression Model: **Readmission Y/N** ~ **ADI (continuous/categorical)** + Race-Ethnicity + Age + Gender + AHRQ CCSR Diagnosis Category + Charslon CCI Score + Chronic Diseases

	Odds Ratio	95% CI	*P*-value
ADI (continuous)	1.002	1.000-1.002	$P < 0.001$
ADI (categorical)	Reference: ADI percentile Q1 (1-45)		
ADI Q2 (46-69)	1.068	1.032-1.106	$P < 0.001$
ADI Q3 (70-90)	1.066	1.029-1.104	$P < 0.001$
ADI Q4 (91-100)	1.127	1.084-1.173	$P < 0.001$

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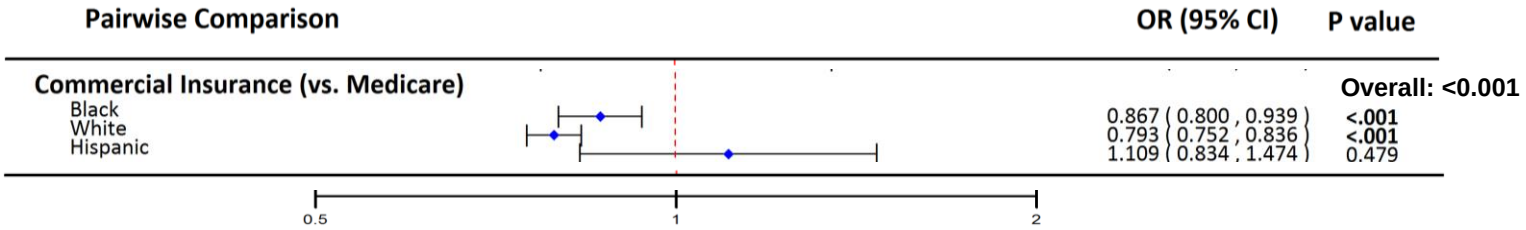
The effect of insurance type on readmission was dependent upon race-ethnicity

- The patients who were covered by commercial (private) insurance compared with those covered by Medicare had lower risk of readmission, especially for the White patients

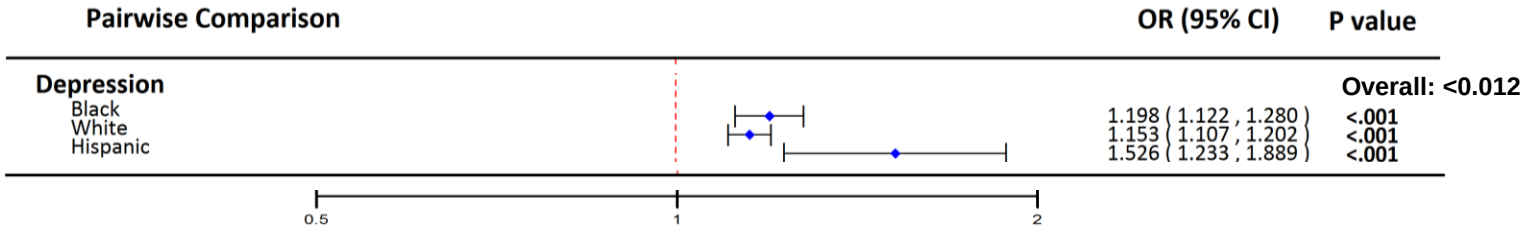
Overall Model: **ReadmissionY/N** ~ **Insurance Type** + **Race-Ethnicity** + **Insurance Type x Race-Ethnicity** + Age + Gender + AHRQ CCSR Diagnosis Category + Charslon CCI Score + Chronic Diseases



The effect of depression on readmission was dependent upon race-ethnicity

- The patients who had depression history were more likely to be readmitted in 30 days, especially for the Hispanic patients

Overall Model: **ReadmissionY/N** ~ **Depression** + **Race-Ethnicity** + **Depression x Race-Ethnicity** + Age + Gender + AHRQ CCSR Diagnosis Category + Charslon CCI Score + Chronic Diseases



Analytical Workflow

Encounter-level

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- Gender
- Charlson Comorbidities Index

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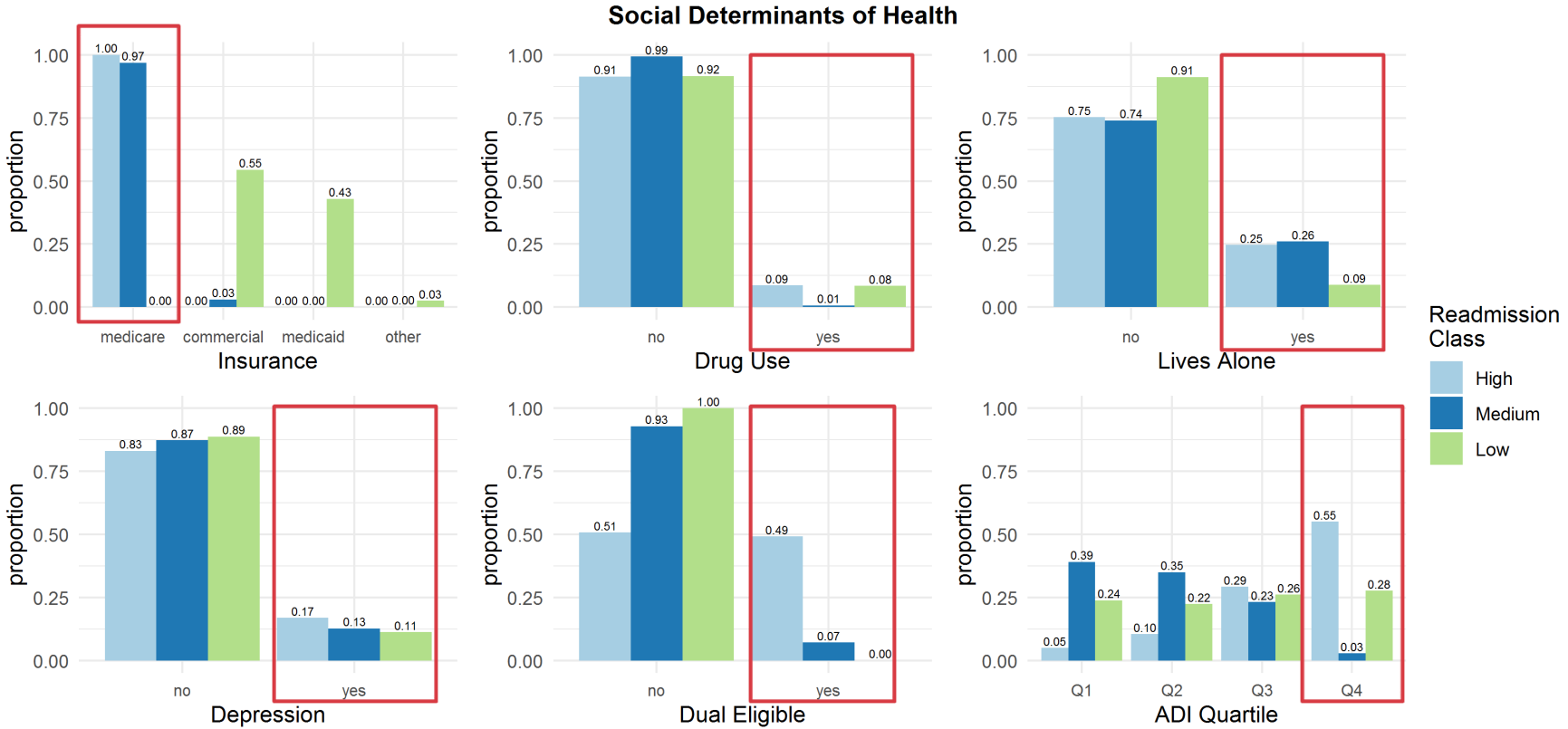
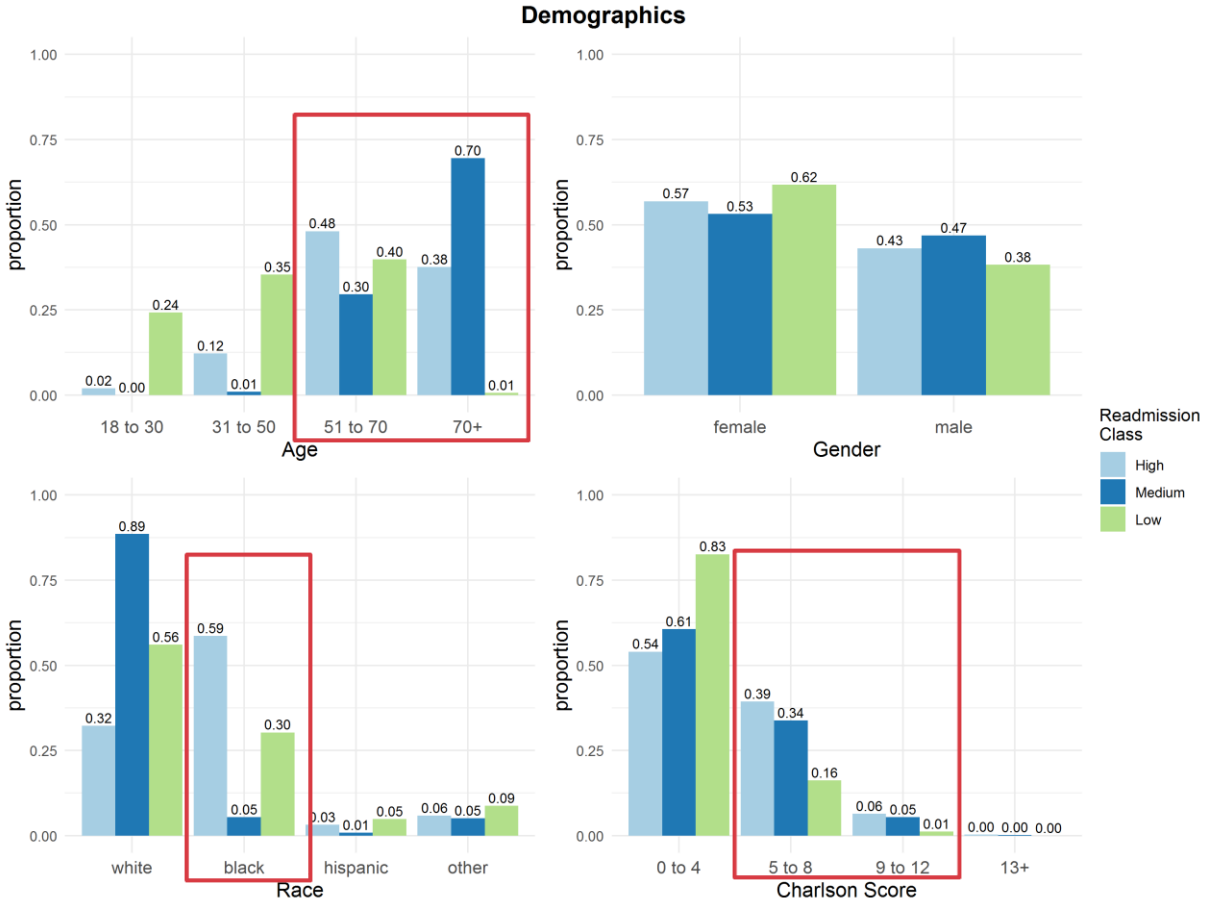
Latent Class Analysis – Six SDOH



Latent Class Analysis – Age, Gender, Race, and Charlson CCI



Latent Class Analysis – Overall Summary

Total: 256,077 Patient Encounters (PE)

20% of PE
Group 1: High Readmission (19.5%)

High proportions of
- African American
- High ADI
- Drug use
- Living alone
- Depression
- Dual Eligibility
- Medicare insurance

35% of PE
Group 2: Medium Readmission (15.7%)

High proportions of
- White patients
- Older patients
- Living alone
- Low ADI

45% of PE
Group 3: Low Readmission (9.5%)

High proportions of
- White patients
- Females
- Low comorbidity scores

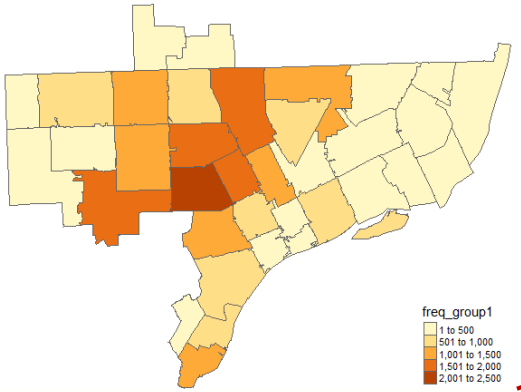
Low proportions of
- All SDOH

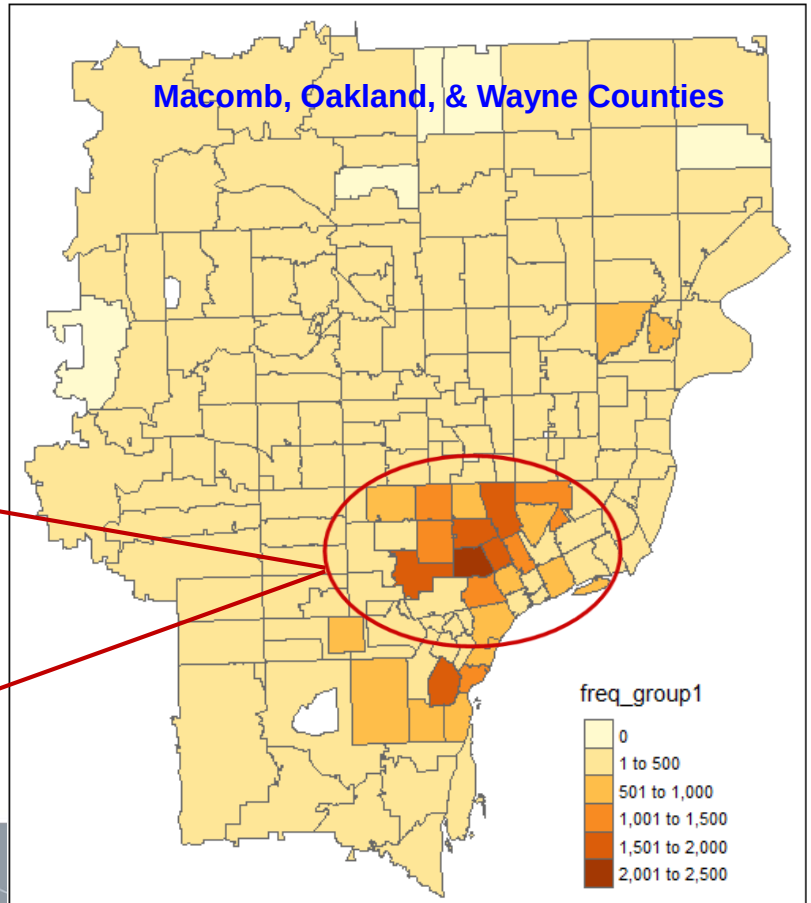
Patient Encounter Frequency for High-risk Readmission Group from LCA (Detroit Metropolitan Tri-County Area)

20% of PE

Group 1: High Readmission (19.5%)

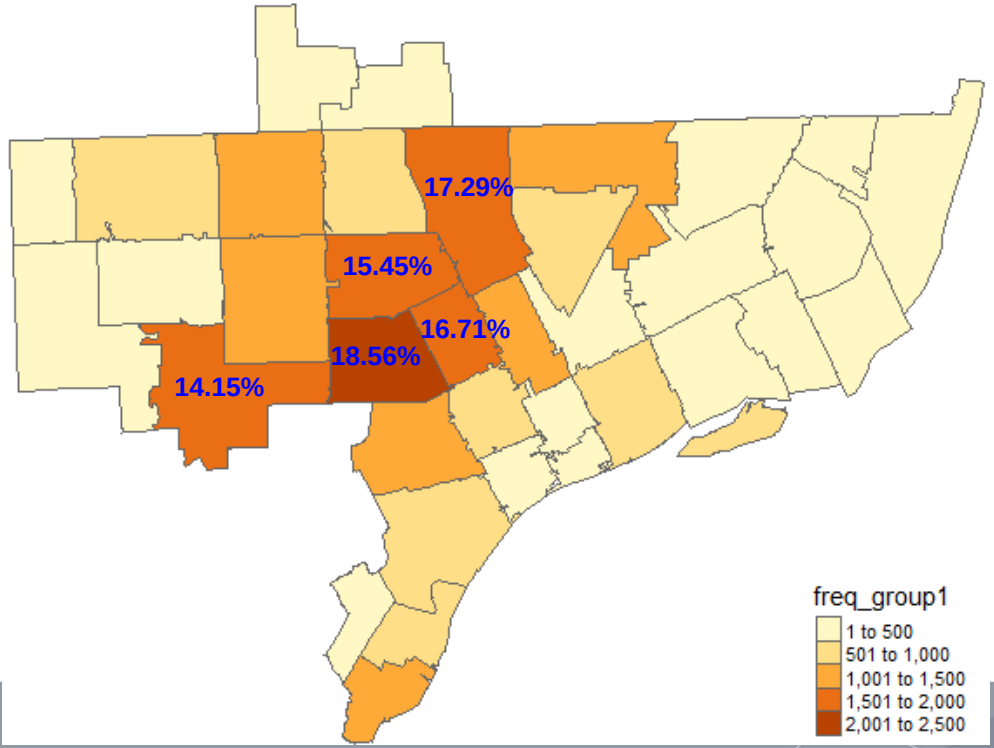
High proportions of
- Minorities
- High ADI
- Drug use
- Living alone
- Depression
- Dual Eligibility
- Medicare insurance





Patient Encounter Frequency for High-risk Readmission Group (Detroit Cities)

- Five hot-spots and the readmission rates (overall readmission rate: 13.6%)



Limitations

- This study is a retrospective observational study, and the data source is limited to one health system
  - A high proportion of patients who are African American and of lower socioeconomic status (living in more deprived areas)–which may not be representative of patient populations elsewhere
- The readmission data comes primarily from our Epic EMR databases and is supplemented with other external datasets, but without a complete match
  - It is supplemented with Admission data from our connection with the *Michigan Health Information Network* (*MiHIN*) and P*ost Acute Referral information*
  - Do not get a complete match from the *MiHIN* data to our patients,
    - We are only allowed to see information on patients that are under the care of a Henry Ford Medical Group doctor or the populations covered by some specific insurance types

Conclusion

- Findings from this study demonstrate the complex interplay between SDH and race-ethnicity influencing 30-day readmission
- Based on the identification of susceptible groups of patients, these results will be used to establish priorities for limited resources to reduce readmission
- Future work will leverage insight obtained for this study combined with additional clinical and discharge features to develop comprehensive predictive models for 30-day readmission

Practical Application of this Session

- The study help address the patients who were minority with SDOH issues had higher risk of readmission
  - Health care organizations can keep tracking and enhance education for these patients after they discharge, and support appropriate resource deploy to reduce disparities of readmission for improving healthcare quality

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Dr. Indra Adrianto
(Scientist)

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(Chief Quality Officer,
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Jessica Haeusler
(Sr. Performance
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Thank you!

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