Social Determinants of Health

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Meet The Team

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and Data Science
*Milliman Spring 2022 Intern
BACKGROUND
What are Social Determinants of Health?

Social Determinants of Health

Neighborhood and Built Environment
- Crime
- Housing Quality

Economic Stability
- Employment
- Poverty

Education Access and Quality
- High School Grad.
- Language and Literacy
- Enrollment in Higher Ed.

Health Care Access and Quality
- Access to Health Services
- Access to Primary Care

Social and Community Context
- Ethnicity
- Citizenship Status
Existing SDoH Research and Literature

**Economic Stability**
- Employment Status
- Poverty Level

**Education Access and Quality**
- Underperforming Schools
- Degree Obtainment

**Health Care Access and Quality**
- Rural Areas
- Uninsured Individuals

**Social and Community Context**
- Ethnicity
- Citizenship Status

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**SOA Webinar**

“How Does Where You Live Impact Your Health?”

- Cluster analysis to divide all counties into ten groups
- Analyzed commonalities within clusters with adverse and advantageous health outcomes
Our Goal

Analyze the potential impacts that Social Determinants of Health have on people’s health outcomes.

Provide Milliman with useful information about the impacts of SDoH to help with their goal to “protect the health and financial well-being of people everywhere.”
DATA EXPLORATION
Health Statistics
Source: CMS
Data: hospitalization, ER visit, preventive services, etc.

SDoH
Source: US Census
Data: income, insurance type, race, education, etc.

COVID Data
Source: CDC
Data: COVID deaths

Merged data

65 years and older
Old age/Survivor's Insurance
jupyter
MODELING AND VISUALIZATION
Modeling

Model Selection:
- Poisson or NB for hosp/ER counts
- Logistic for high classification

Variable Selection:
- Step AIC
- Likelihood Ratio test
## Diabetes Hospitalization Model

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<th>Estimate</th>
<th>P-value</th>
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<td>Less than $25,000 household income (percent)</td>
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<td>Two or more races (percent)</td>
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<td>White alone, not Hispanic or Latino (percent)</td>
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<td>With Food Stamp/SNAP benefits (percent)</td>
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<td>With direct-purchase and Medicare coverage (percent)</td>
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<td>West (categorical)</td>
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<td>Urban (categorical)</td>
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Data Analysis and Visualization

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<th>Value</th>
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<td>Accuracy</td>
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<td>Sensitivity</td>
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<td>Specificity</td>
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<td>Positive Predictive Value (TPV)</td>
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<td>Negative Predictive Value (NPV)</td>
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High Hospitalizations Model

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<th>Model Prediction</th>
<th>Not High</th>
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<td>Actual Result</td>
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<td>33</td>
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<td>169</td>
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CONCLUSIONS
Model Results

Important Variables
- Less than 25K income, Bachelor's Degree or higher, and West were the most common variables, all predicting less hospitalizations/ER visits

Best Count Model
- Negative binomial model for all hospitalizations seemed to predict the most variance

Logistic Models
- Both ER and hospitalization logistic models had roughly equal performance
### Significant Variables

- With earnings
- With direct-purchase and Medicare coverage
- Urban
- Two or more races
- SE
- Not a U.S. citizen
- Min Medicare Enrollment
- Mean earnings (dollars)
- Less than $25,000
- Language other than English
- Hispanic or Latino origin (of any race)
- Foreign born
- Bachelor's degree or higher
- 100 to 149 percent of the poverty level
## Count Model Diagnostics

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<tr>
<th>Variable</th>
<th>Model Average Error ER</th>
<th>Model Average Error Hosp</th>
<th>ER Error Reduction</th>
<th>Hosp Error Reduction</th>
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<tr>
<td>Diabetes</td>
<td>30%</td>
<td>40%</td>
<td>12%</td>
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<tr>
<td>Asthma</td>
<td>33%</td>
<td>58%</td>
<td>18%</td>
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<td>COPD</td>
<td>32%</td>
<td>54%</td>
<td>22%</td>
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<td>Heart failure</td>
<td>22%</td>
<td>24%</td>
<td>19%</td>
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<tr>
<td>All</td>
<td>13%</td>
<td>12%</td>
<td>17%</td>
<td><strong>33%</strong></td>
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Education Impact

Education and Hospitalization by Region

Education and ER Visit by Region
Limitations

• Using census data, predictions for the future would remain essentially constant

• Many counties were missing data, only able to use about a 1/3 of counties for modeling

• Only observed a few years of data, making it difficult to know how much COVID impacted our results

• Lack of access to individual claim data
Future Analysis

Time Series Analysis to capture how SDoH impact trends over time

Changes in SDoH over time are associated with health outcomes

Reconfigure cutoff point for high hospitalizations/ER

Model only hospitalization/ER counts after a certain cutoff

Use K-means or Gaussian Mixture model to find trends of each region
POWER BI DASHBOARD
SLIDER DASHBOARD
Hospitalizations

Region
- Select all
- Midwest
- Northeast
- Southeast
- Southwest
- West

U.S. Average Hospitalizations by County
- Rural: 626
- Urban: 440

Change in Average Hospitalizations
- Rural: 337
- Urban: 337

+4.519%

Map of Selected States

Rural to Urban Ratio
- 1.423

Social Determinant Filters

Bachelor's Degree or Higher (%)
- 0.00
- 73.60

Median Income ($)
- 15
- 49845

Wellness Visit (%)
- 0
- 69

Flu Vaccine Usage (%)
- 5
- 76

Legend

All Counties Household Income

- < $25k
- $25k to $49k
- $50k to $74k
- $75k to $99k
- $100k to $124k
- $125k to $150k
- $150k to $199k

Filtered Counties Household Income

- 29.58%
- 28.26%
- 17.82%
- 10.58%

Percent of Total Counties
- 34.08%
BACHELOR’S DEGREE
# Summary

<table>
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<tr>
<th>Social Determinant of Health</th>
<th>Filter</th>
<th>Change from U.S. Average Hospitalizations</th>
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<td>Bachelor’s Degree of Higher</td>
<td>0% - 15%</td>
<td>+7.188%</td>
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<td>30% - MAX</td>
<td>-15.31%</td>
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<td>Median Income</td>
<td>$0 - $2,000</td>
<td>+2.124%</td>
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<td>$10,000 - MAX</td>
<td>-3.153%</td>
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<td>Annual Wellness Visit Usage</td>
<td>0% - 15%</td>
<td>+2.247%</td>
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<td>50% - MAX</td>
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<td>Flu Vaccine Usage</td>
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<td>50% - MAX</td>
<td>-1.159%</td>
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Acknowledgements

Danielle Rubin
Milliman Actuarial Associate

Jon Abraham
WPI Professor of Practice

Barry Posterro
WPI Associate Teaching Professor
THANK YOU!


ER Correlation Matrix

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<th>With earnings</th>
<th>With direct-purchase and Medicare coverage</th>
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<th>Urban</th>
<th>Renter-occupied: Less than 30 percent</th>
<th>Owner-occupied: Less than 30 percent</th>
<th>Less than $25,000</th>
<th>InfluenzaVirusVaccine</th>
<th>Heartfailure</th>
<th>Diabetes</th>
<th>Depression</th>
<th>COPD</th>
<th>Bachelor's degree or higher</th>
<th>Asthma</th>
<th>AnnualWellnessVisit</th>
<th>AllEmergencyDepartmentVisits</th>
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Hospitalization Correlation Matrix
Region correlation with output

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Emergency department visit rate

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Hospitalization

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Significant variables correlation with output