R Project Milestone 6

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Problem Statement

Rural hospitals are struggling to stay open throughout the country and the state of California ranks #4 in rural hospital closures (citation). When rural hospitals close, there is a subsequent rise in mortality (citation). This is why the California Department of Public Health, Office of Health Equity is excited that a new policy has just been created to fund a public-private partnership for healthcare facility improvement in 5 of California's rural counties that have received minimal funding from the Department of Health Care Access and Information (HCAI) over the past 5 years. Here we have analyzed 5 variables in order to determine which 5 counties are the best targets for the development fund proposals.

Methods

Data Sources

To make recommendations on target counties, we used variables from three open-access, State of California data sources which are described below.

California demographics by County Includes data on population characteristics by county including average population density, counts by race/ethnicity, sex, median age, and housing data.

Years and/or dates of data

Data was collected in 2012.

Description of cleaning and creating new variables

To prepare the data, we:

1. Data cleaning

- make "County" the first (left-most) column in the data set for merging

2. Data filtering

- subset data to only include needed data

3. Data summarizing

- *NEW VARIABLE*: categorize Median Age into "High Priority" (counties with Median Age above the third quantile), "Medium Priority" (counties with Median Age between the first and third quantiles), and "Low Priority" (counties with Median Age below the first quantile)
- *NEW VARIABLE*: categorize Population per Square Mile (hereafter Population Density) into "High Priority" (counties with Population Density above the third quantile), "Medium Priority" (counties with Population Density between the first and third quantiles), and "Low Priority" (counties with Population Density below the first quantile)
- *NEW VARIABLE*: create ratio of renting households as a fraction of total households.

- *NEW VARIABLE*: categorize Percent of Household that were Renters (hereafter Percent Renters) into "High Priority" (counties with Percent Renters above the third quantile), "Medium Priority" (counties with Percent Renters between the first and third quantiles), and "Low Priority" (counties with Percent Renters below the first quantile)

California Department of Public Health Care: Death Profiles by County Includes data on mortality events stratified by age, sex, race, hospital department, and residence status of the deceases relative to the hospital where the mortality event occurred.

Years and/or dates of data

The data set contains data from 2014 through 2020.

Description of cleaning and creating new variables

To prepare the data, we:

1. Data cleaning

- made all column names lowercase
- replaced NAs with zeros, as instructed

2. Data filtering

- filtered data in "strata_name" to only include data about the Total Population (removed age, sex, race and other stratifiers)
- filtered out non-chronic diseases (all cause, assault, accidents, influenza and self-harm)
- removed data from 2014

3. Data summarizing

- *NEW VARIABLE*: sum all chronic disease mortality events by county (both occurrence and residence data)
- *NEW VARIABLE*: [after merging data sets] divide summed chronic disease mortality by average population size (from the demographic data set) to create a rate of chronic disease mortality per person for each county
- *NEW VARIABLE*: categorize Chronic Disease Mortality Rates (hereafter Mortality) into "High Priority" (counties with Mortality above the third quantile), "Medium Priority" (counties with Mortality between the first and third quantiles), and "Low Priority" (counties with Mortality below the first quantile)

Department of Health Care Access and Information: Total Construction Cost of Healthcare Projects Includes number of projects and total spending on hospital projects funded by Department of Health Care Access and Information (HCAI) by county, date, and project status ("in review", "pending construction", "in construction" and "in closure.")

Years and/or dates of data

The original data set contains data from 10-14-2013 through 08-11-2022.

Description of cleaning and creating new variables

To prepare the data, we:

1. Data cleaning

- made all column names lowercase
- replaced spaces with underscores
- removed the numbers in front of the County names
- removed dollar signs from Total Costs
- changed date format

2. Data filtering

- removed projects listed as "in review" because we wanted to prioritize locations with the fewest projects that were at any stage of completion
- removed data from 2013 and 2014 to match other available data

3. Data summarizing

- average Total Costs in each category for each county to reduce over-counting
- *NEW VARIABLE*: sum the Total Costs over the 4 categories ('in closure', 'in construction', or 'pending construction') for each county
- *NEW VARIABLE*: categorize Total Costs into "High Priority" (counties with Total Costs below the first quantile), "Medium Priority" (counties with Total Costs between the first and third quantiles), and "Low Priority" (counties with Total Costs above the third quantile)

Analytic methods

We decided to approach the ranking of counties with two techniques to examine the robustness of our final recommendations. Our first approach was to use two scatterplots that build off each other. Plot 1 has just the 3 demographic variables of interest: fraction of renters, median age of the residents, and population density. For Plot 2, we collapsed the demographic data into a single *NEW VARIABLE* by coding giving 2 points for values identified as "high priority," 1 point for values identified as "medium priority" and 0 points for "low priority" values for each county. For example, Amador County is a high priority in regards to the median age and population density of its residents (2 points for each variable), but a low priority based on fraction of renters (0 points), for a total demographic ranking score of 4 points. This new variable was used to color code the dots in Plot 2 where we graph Previous Funding and Chronic Disease Mortality Rate. Plot 2 highlights the counties that we would consider recommending for future funding because it includes all 5 variables of interest.

Our second approach was to use a table with a *NEW VARIABLE* to rank the counties on all 5 variables of interest simultaneously. The ranking variable uses a similar method as above except that the point values were not universal. We decided that the Chronic Disease Mortality Rate, Population Density and Median Age were more valuable than the Renter Ratios and Previous Investments because (1) Renter Ratio is inversely correlated with Median Age (the older a person gets, the more likely they are to own a home) and (2) because we believe it is more equitable to fund hospitals that appear to be in need of funding regardless of prior funding. For the 3 "more valuable" variables, we gave 4 points for "high priority" values, 2 point "medium priority" values, and 0 points for "low priority" values. For the 2 less important variables, we gave 2 points to values identified as "high priority," 1 point for values identified as "medium priority" and 0 points for "low priority" values for each county. For example, Siskiyou County is a high priority based on median age (4 points), population density (4 more points) and chronic disease mortality rates (4 points). It was a medium priority based on total previous investment (1 point) and a low priority based on fraction of renters (0 points) for a total ranking score of 13 points. Counties were then ranked on their total ranking score.

Results

Figure 1: High priority counties based on demographic data only

Priority is given to counties with: (1) renter ratios above the median of all counties (median = 39%), (2) median population age above the median for all counties (median = 37 years old), and (3) population densities below the third quantile for all counties (High priority is below the 1st quantile = 26 people per square mile; Low priority is above the 3rd quantile = 333 people per square mile). Each dot represents a county in California. Counties that are named on the figure are those meeting all of the high priority demographic criteria.

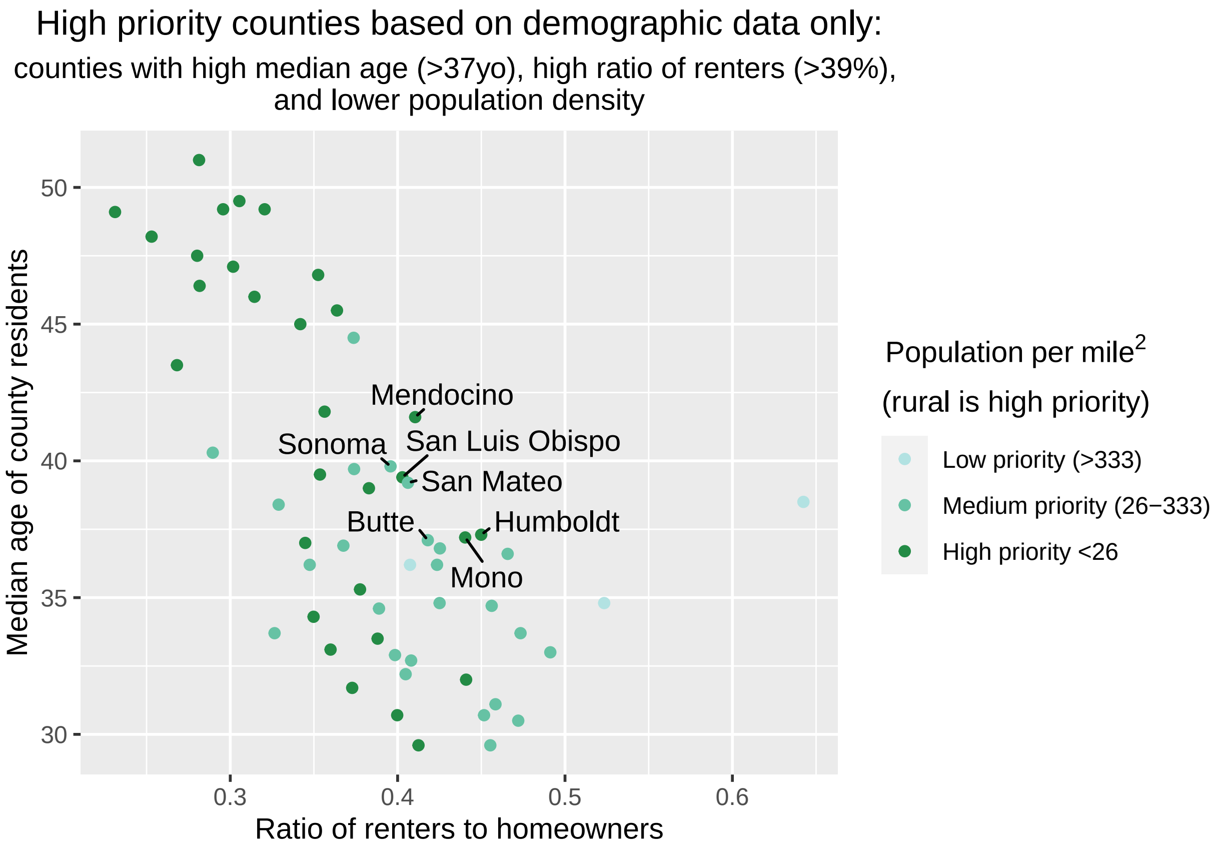
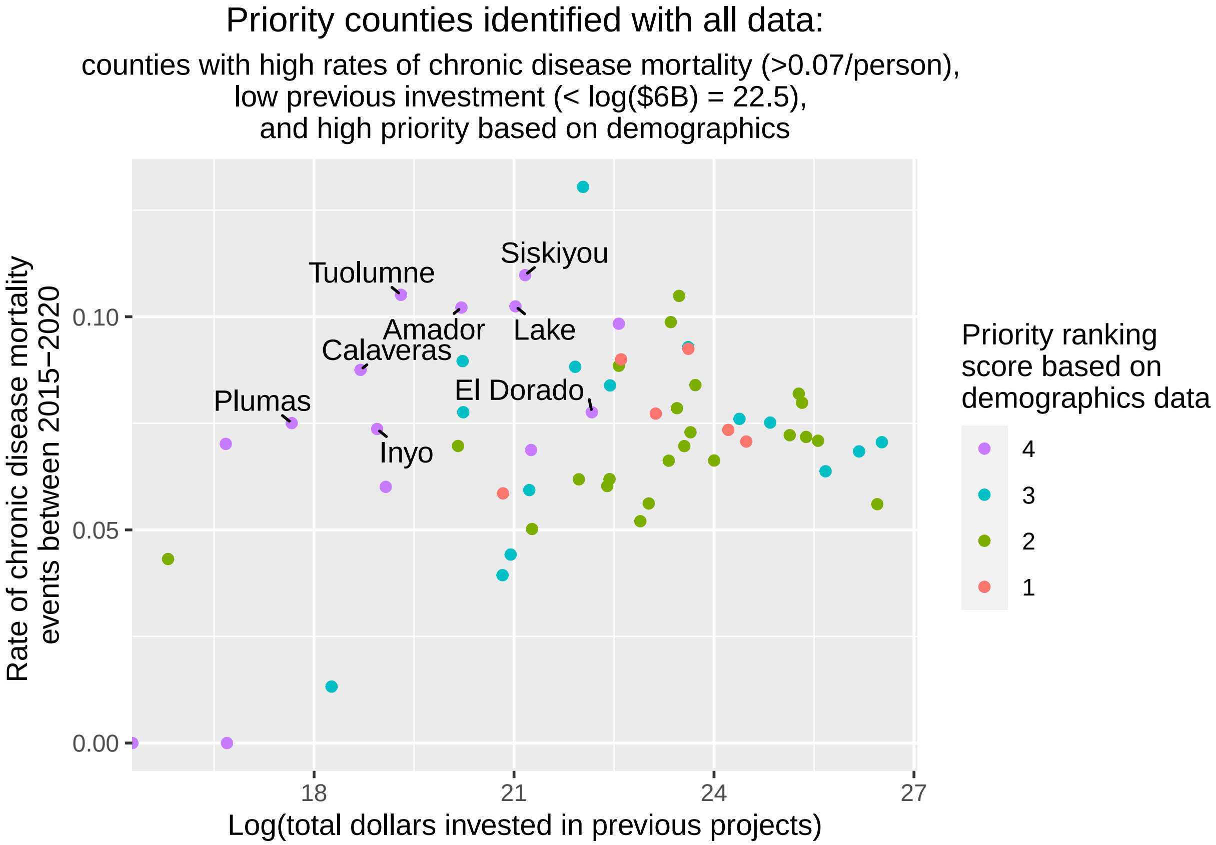

High priority counties based on demographic data only:
counties with high median age (>37yo), high ratio of renters (>39%),
and lower population density
Median age of county residents
50
45
40
35
30
0.3
0.4
0.5
0.6
Ratio of renters to homeowners
Mendocino
Sonoma
San Luis Obispo
San Mateo
Butte
Humboldt
Mono
Population per mile^2
(rural is high priority)
Low priority (>333)
Medium priority (26−333)
High priority <26

Figure 2: **High priority counties using all variables of interest.**

Color coding is based on the demographic data presented in Plot 1. A County with higher priority demographic values received a higher score (score of 4 has the highest priority). Also in the Plot is the total dollars previously invested in prior projects with higher priority for counties below the median previous investment (log($5,961,782,208) = 22.50864) on the x-axis, and, on the y-axis, rate of chronic disease mortality events between 2015-2020, with higher priority counties having higher than the median rates of chronic disease mortality (median = 0.07 cases of mortality per person).



To chose the top 5 Counties out of the 8 the graph identifies is subjective and depends on whether one wants to prioritize rate of chronic disease mortality or previous spending. As mentioned in the Analytic Methods section, our group believes rate of chronic disease mortality is more valuable so, using this graphical method, we would recommend: Tuolumne, Amador, Calaveras, Siskiyou, and Lake Counties for future funding.(If previous spending was more valuable, Tuolumne, Amador, Calaveras, Plumas, and Inyo would be prioritized).

Table 1: Top 16 Counties ranked by need for oshpd projects.

County	Chronic disease mortality burden		Median age of population		Population desnity		Previous spending on projects		% of population that are renters		County Rank
Amador	**0.1021536**	**High priority**	**48.2**	**High priority**	**63.288340**	**High priority**	**598970736**	**High priority**	**25.30**	**Low priority**	**14**
Calaveras	**0.0875314**	**High priority**	**49.1**	**High priority**	**44.582939**	**High priority**	**131848234**	**High priority**	**23.12**	**Low priority**	**14**
Tuolumne	**0.1051309**	**High priority**	**47.1**	**High priority**	**24.304973**	**High priority**	**242129946**	**High priority**	**30.17**	**Low priority**	**14**
Lake	**0.1024321**	**High priority**	**45.0**	**High priority**	**49.082334**	**High priority**	**1347450993**	**Medium priority**	**34.19**	**Low priority**	**13**
Nevada	**0.0983582**	**High priority**	**47.5**	**High priority**	**102.564339**	**High priority**	**6352716267**	**Medium priority**	**28.02**	**Low priority**	**13**
Siskiyou	**0.1097566**	**High priority**	**46.8**	**High priority**	**7.120891**	**High priority**	**1558949981**	**Medium priority**	**35.25**	**Low priority**	**13**
Inyo	0.0736661	Medium priority	45.5	High priority	1.819773	High priority	169160700	High priority	36.38	Low priority	12
Mariposa	0.0701707	Medium priority	49.2	High priority	12.613887	High priority	17474756	High priority	32.06	Low priority	12
Plumas	0.0750500	Medium priority	49.5	High priority	7.653217	High priority	46955168	High priority	30.54	Low priority	12
Tehama	0.0895902	High priority	39.5	Medium priority	21.523312	High priority	610226591	High priority	35.36	Low priority	12
El Dorado	0.0775971	Medium priority	43.5	High priority	102.156840	High priority	4239088028	Medium priority	26.82	Low priority	11
Humboldt	0.0928689	High priority	37.3	Medium priority	38.062105	High priority	17981394511	Medium priority	44.99	Low priority	11
Modoc	0.0687366	Medium priority	46.0	High priority	2.329272	High priority	1703663257	Medium priority	31.45	Low priority	11
San Luis Obispo	0.0882523	High priority	39.4	Medium priority	81.815416	High priority	3302001201	Medium priority	40.28	Low priority	11
Shasta	0.1304416	High priority	41.8	Medium priority	46.480517	High priority	3715362195	Medium priority	35.64	Low priority	11

***Table:* Top 16 counties ranked by need for OSHPD projects**

Overview of the top 16 counties based on their ranking priorities for OSHPD project need for each variable. Priority categories ‘Low’, ‘Medium’, and ‘High’ are assigned based on quantile position for each county. The six counties highlighted in yellow are the counties with the highest priority need accounting for each variable. Rankings were determined by assessing priority categories per county where more ‘high priority’ designations increases overall county ranking.

The ranking variable described in the Analytic Methods identifies 3 Counties as top priorities - Amador, Calaveras, and Tuolumne - and 3 more Counties as second-rank priorities - Lake, Nevada, and Siskiyou.

Discussion

CC’s suggestions on what could go in this section - clarify that Plot 1 doesn’t identify top priority populations, it’s just a first step - talk about how Nevada is identified as top priority in the table but not the graphical method - Otherwise, our two methods are consistent