

Relationship Between Kindergarten Vaccination Rate and Mean Household Income in California

Introduction

In 2014, California was the state with the third highest median household income. It also had one of the lowest kindergarten vaccination rates by state, at just 90.4 percent. While the tendency for lower income families to have less access to proper medical care is certainly true, the recent anti-vaccination movement is stereotypically followed by young affluent families who have the means and resources to take advantage of personal belief exemption policies. This abnormality, the opposite of what typically happens in the public health sector, can create concentrated pockets of children who are under-vaccinated. The risk then extends to infants and children who are not able to be vaccinated for medical reasons, children who would have normally been protected by herd immunity. Herd immunity is the process by which a disease is phased out of a population over time due to the immunity of a high percentage of the population. This means that people who would have been susceptible to the disease are instead safe from it because it is not able to circulate throughout the general population. Since herd immunity became weakened due to the anti-vaccination movement, vaccine-preventable diseases like measles and mumps have made a staggering comeback. In 2010, a pertussis outbreak in California caused 10 deaths and nearly 10,000 illnesses. Its origin was traced back to a voluntarily under-vaccinated community. This project aims to establish the relationship between household income and childhood vaccination by comparing mean household income and kindergarten immunization records of elementary school districts in California. It also looks at different cities in California to examine the trend by region. With a link established, appropriate behavior change initiatives can then be focused on the families who need them.

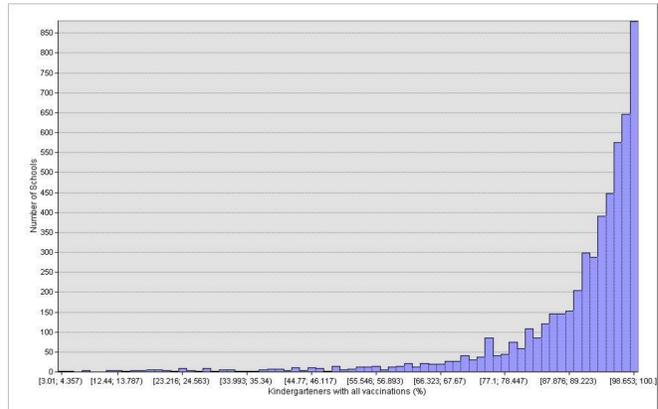


Figure 1: Frequency Distribution of Schools and Kindergarten Vaccination Rates

Methodology

The primary tools used in this project were joins, queries, and statistical analyses. The census and education statistics data were found in excel format needing to be georeferenced. The income census data was "joined by attribute from a table" to the school district polygons in ArcMap using a distinct GeoID assigned to each district. In California, there are elementary school districts as well as unified school districts (inclusive of kindergarten through twelfth grade), so all analyses were performed on the two separate layers. The unified school districts are presented as elementary school districts in the maps, however, because only the elementary schools within them are considered. The mean household incomes assessed are only the relevant households within each district, that being families with school-aged children. The kindergarten vaccination rate data was joined to the California

schools point file using school name as the common attribute. The vaccination rate was given as the percentage of kindergarteners within the school who had all of their vaccinations up-to-date. However, as can be seen in **Figure 1**, there are many more schools with high vaccination percentages than low. When making quantiles of the data, the larger dots representing higher percentages overwhelmed the map. To account for this, the quantile point sizes were flipped so that so that a bigger dot size represented a lower vaccination rate. To keep to the customary symbolism of "bigger means bigger", the legend was then

altered to show the percent of kids lacking complete vaccinations, subtracting the original percent from 100. The result was a map of California that highlighted schools lacking full kindergarten vaccination, overlaid onto a polygon layer of school districts made into quantiles by mean household income. This complete map of California was then clipped to four separate county shape files: Sacramento County, San Diego County, Los Angeles County, and San Francisco/Marin County. San Francisco County and Marin County were combined due to San Francisco County's small size. With all of the maps completed, a statistical summary analysis was run on the map of California. The goal was to sum the number of less than 50% vaccinated schools that lie within the highest quantile of income versus the lowest quantile of income. This was also done for greater than 90% vaccinated schools. To do this, both layers had to be queried (by income or by vaccination rate) and joined to each other. Then, the number of school points that lied within those polygons were counted. This was iterated for both elementary school districts and unified school districts, whose results were added to give numbers for school districts in general. The results of this statistical analysis can be found in **Table 1**.

Entire-California Statistics		Percent of kindergarteners with complete and updated vaccinations (number of schools)			
		less than 50%	Average number of <50% schools within each district	more than 90%	Average number of >90% schools within each district
Mean Income	less than 60,000 dollars (202 districts total)	7	0.035	811	4.01
	more than 120,000 dollars (107 districts total)	7	0.065	403	3.76

Table 1: Overlap of the Low and High Quantiles of Mean Income and Kindergarten Vaccination Percentage

The data and maps show that a relationship between income and childhood vaccination rates exists, and that the trend is for high-income families to choose to delay or forgo vaccinations for their children. Even though lower-income families may have less access to proper healthcare, children in low socioeconomic areas might receive aid or vaccinations in a way that minimizes parental involvement. Upper and middle income families, even if they are well-educated, are more likely to question the authority of a doctor and the veracity of medical claims. These results indicate that low childhood vaccination is a serious problem, especially among well-off families and communities. Cities need to take more initiatives to correct misunderstandings about vaccines. If I were to expand this project, I would include private and charter schools in the dataset. I would also relate the locations of under-vaccinated schools to the locations of recent outbreaks of vaccine-preventable diseases.

Conclusions

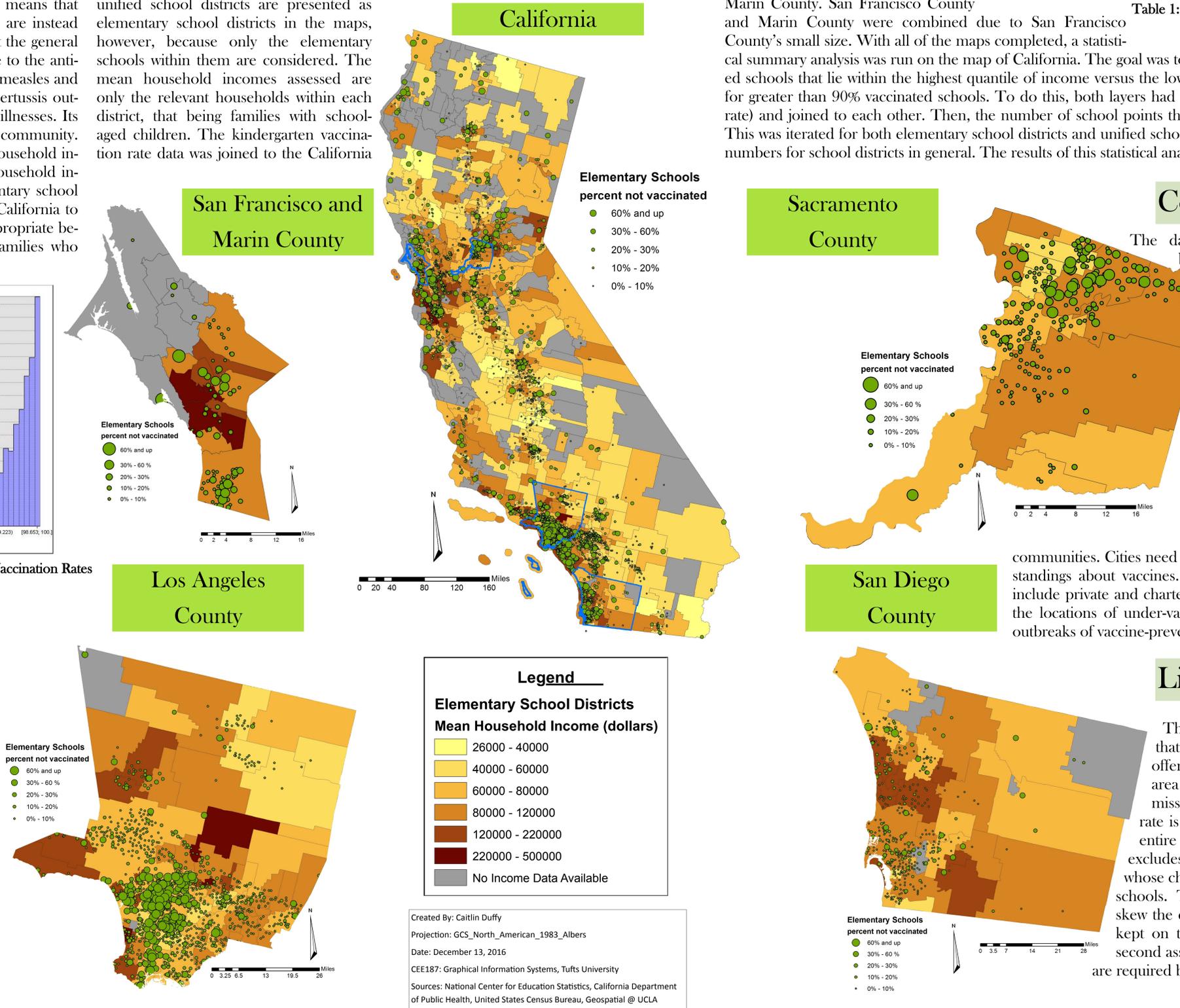
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Limitations

The data analysis makes several assumptions that idealize the true situation: 1. Public schools offer an adequate-enough representation of the area so private and charter schools can be dismissed, and 2. The kindergarten vaccination rate is representative of the vaccination rate of an entire school's population. The first assumption excludes extremely high and low income families, whose children might attend private or charter schools. This ignores outliers and could therefore skew the data; however, it also allows the focus to be kept on the general trend of average families. The second assumption is valid because many vaccinations are required before the start of kindergarten.

Discussion

The map of California as a whole makes it clear that there are definitive clusters of unvaccinated populations, and those clusters are more likely to occur in and around cities. Higher income school districts also occur more widely in cities. Los Angeles County, which has an overall higher mean income than Sacramento, also has more schools with low kindergarten vaccination rates. San Diego had the least amount of under-vaccinated schools, and Los Angeles the most. Sacramento's low vaccination schools showed up in abundance in the northeastern corner of the county, near each other in upper-middle income districts. San Francisco and Marin County seemed to have more under-vaccinated schools in middle income districts than very high income districts. **Table 1** shows that there is a tendency for upper-income districts to contain more under-vaccinated schools and fewer properly-vaccinated schools than low-income districts.



Legend

Elementary School Districts Mean Household Income (dollars)

- 26000 - 40000
- 40000 - 60000
- 60000 - 80000
- 80000 - 120000
- 120000 - 220000
- 220000 - 500000
- No Income Data Available

Created By: Caitlin Duffy
 Projection: GCS_North_American_1983_Albers
 Date: December 13, 2016
 CEE187: Graphical Information Systems, Tufts University
 Sources: National Center for Education Statistics, California Department of Public Health, United States Census Bureau, Geospatial @ UCLA