

# Assessing Measles Vaccination Coverage and Income in Orange County, California

## Background

Measles is a highly contagious respiratory disease that can be prevented with the MMR (measles, mumps, and rubella) vaccine. Although health officials declared that measles had been eliminated in the U.S. since 2000, an outbreak that started in Orange County, California in December 2014 brought attention to state policy that allows unvaccinated students to enroll in schools.

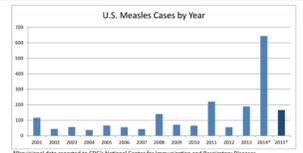


Figure 1. The CDC report shows a peak number of measles cases in 2014.

Students are required to complete both doses of the MMR vaccine, but parents can choose to submit a personal belief exemption or medical exemption in order to avoid vaccination. During the 2013-2014 school year, there were 1,000 medical exemptions and 17,000 personal belief exemptions filed in California. While private health care covers the cost of the MMR vaccine, families with public health care may experience more barriers to the vaccine which include the time and cost associated with completing both doses. In order to assess what drives MMR vaccination coverage, household income is analyzed as a potential variable causing the disparity in immunization levels among kindergarten students.

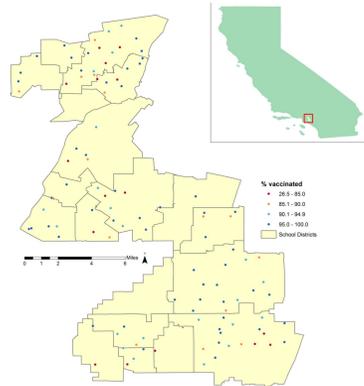
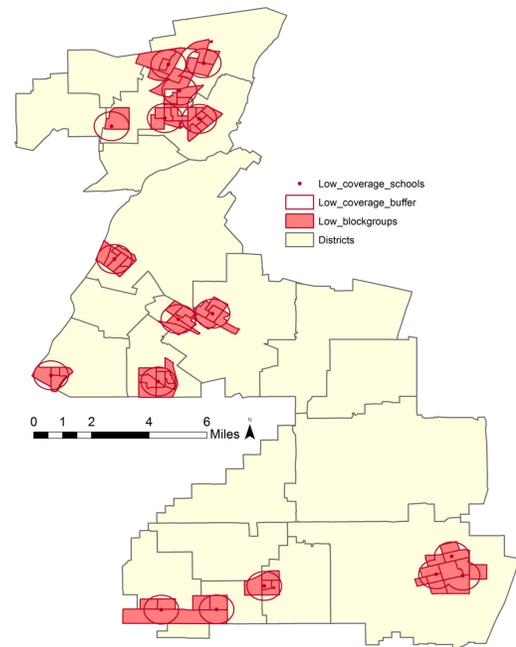
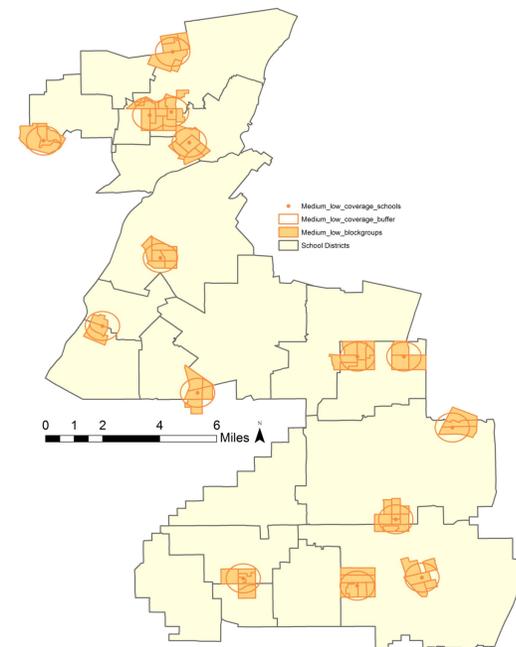


Figure 2. 108 schools are separated into 4 categories based on the percent of MMR vaccinated kindergarten students.

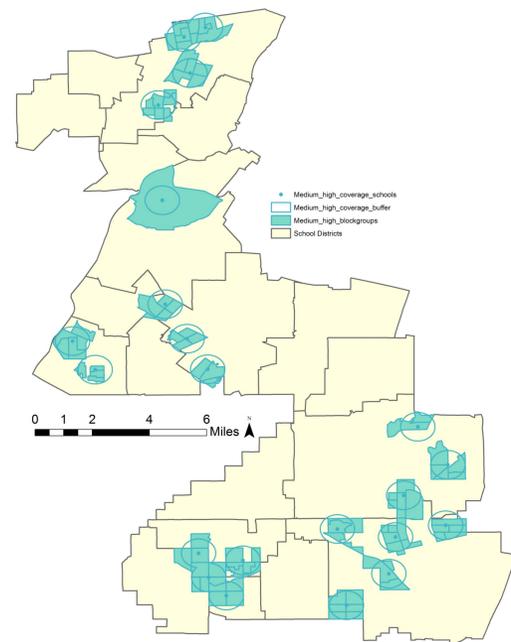
## Low Coverage Schools



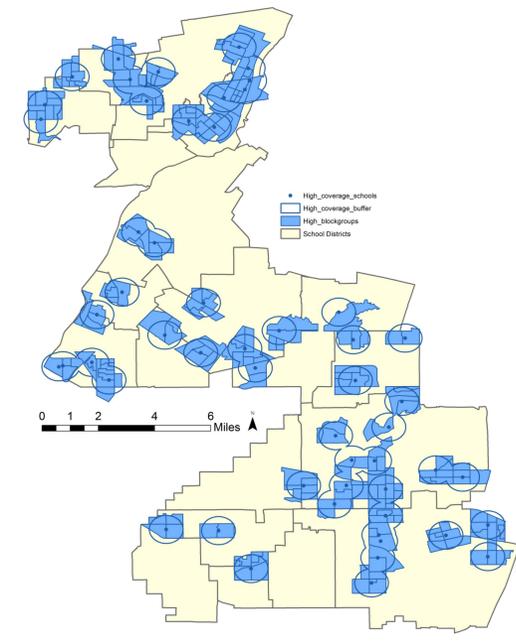
## Medium Low Coverage Schools



## Medium High Coverage Schools



## High Coverage Schools



## Discussion and Limitations

Across the four MMR coverage groups, there does not appear to be a significant difference between the percentages of households in the High, Medium, and Low Income groups (Figure 3). 50% of elementary schools in this model fell in the high coverage category and are considered to be protected from a measles outbreak.

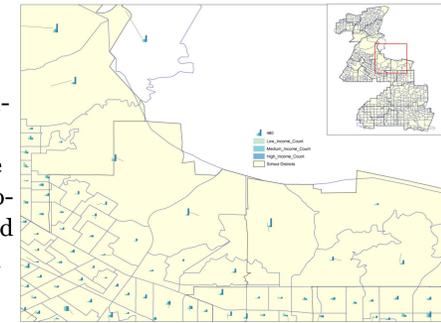


Figure 4. The number of households in the high income, medium income, and low income group are depicted per block group.

Limitations to the Data: Only 108 elementary schools were captured in this model despite other elementary schools being present within the 19 school districts. Schools were omitted because their names from the PBS&J data did not match school names from the California Department of Public Health or because they did not report MMR vaccination rates. If schools are failing to report their vaccination data in order to avoid being identified as an unsafe school, this model underestimates the number of schools with less than 95% coverage. In order to improve the model, a larger data set that includes more schools and more school districts across the state of California should be tested.

Limitations to the Model: This model assumes that a 0.5 mile buffer around schools will capture all of its students and their households in order to determine their income. The block groups selected must have their center within the buffer which excludes some larger block groups that surround the school. In order to capture more information within a buffer, the model could use census block data.

## Conclusion

Based on the results of this model, household income does not explain the large variation in MMR vaccination rates among kindergarten students in 108 elementary schools in 19 California school districts. Other factors such as health care coverage could be further explored in order to determine why kindergarten students are unvaccinated. These results could be a significant help in designing public health interventions that aim to increase vaccination coverage in elementary schools and reduce the number of students vulnerable to the next measles outbreak.

Cartographer: Linda Jiang  
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Fundamentals of GIS  
Instructor: Paul Cote



### Sources

- Elementary Schools: PBS&J, Atlanta GA, National Institute of Building Sciences, 2000. <<http://library.mit.edu/item/001550134>>
- MMR Vaccination Rates: California Department of Public Health, 2015-2015 CA Kindergarten Data. <<http://www.cdph.ca.gov/programs/immunize/pages/immunizationlevels.aspx>>
- Family Income: 2009-2013 Block Group Census Data from TIGER/Line Shapefiles with Selected Demographics and Economic Data <<https://www.census.gov/geo/maps-data/data/tiger-data.html>>
- California School Districts: U.S. Census Bureau, 2010. <<http://hgl.harvard.edu:8080/HGL/hgl.jsp?command=VColl&VCollName=TGI0USSHCOLELEM>>

## Methodology

MMR vaccination rates of kindergarten students in elementary schools were divided into the following four categories:

- High Coverage (> 95% vaccinated)
- Medium High Coverage (90 – 94.9% vaccinated)
- Medium Low Coverage (85 – 89.9% vaccinated)
- Low Coverage (26.5 – 84.9% vaccinated)

Family income in the past 12 months was divided into the following three categories:

- Low Income Household (Less than \$10,000 – \$34,999)
- Medium Income Household (\$35,000 – \$74,999)
- High Income Household (\$75,000 – \$200,000 or more)

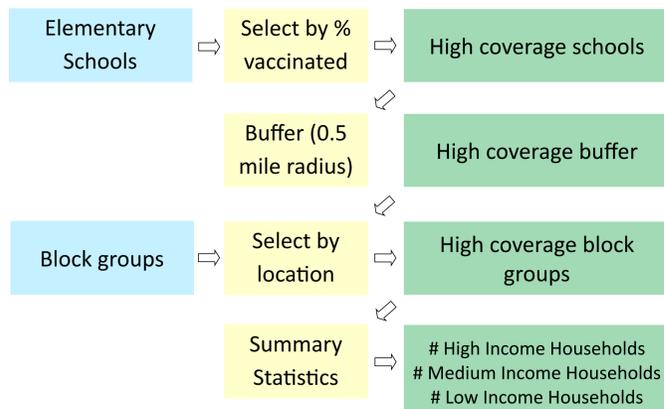


Figure 3. Model used to analyze schools with high vaccination coverage and their corresponding block groups. The steps were repeated for all coverage groups.

## Results

Coverage Group	# of Schools	# of Block Groups	# of Low Income Households	# of Medium Income Households	# of High Income Households	Total # of Households	% Low Income	% Medium Income	% High Income
> 95%	54	236	32,848	33,187	37,719	103,754	31.7	32.0	36.4
90-94.9%	22	93	13,757	14,798	16,683	45,238	30.4	32.7	36.9
85-89.9%	15	77	11,477	12,116	13,140	36,733	31.2	33.0	35.8
26.5-84.9	17	78	10,006	10,474	11,667	32,147	31.1	32.6	36.3

Table 1. Summary of the results of the model. From the block groups located within each buffer category, the percentage of households that fall in the Low Income, Medium Income, and High Income groups were calculated in order to compare across the different MMR vaccine coverage groups.