

B.pertussis in Colorado: Cluster & Modeling Analysis

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Department of Public
Health & Environment

IPG#1 of 2015

Complete an epidemiologic analysis examining
Pertussis rates for a 10 year period with
relevant socioeconomic factors.



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2) CASE DEFINITION

Confirmed Case

- An acute cough illness of any duration, with isolation of *B. pertussis* from a clinical specimen, OR
- A case that meets the clinical case definition and is confirmed by polymerase chain reaction (PCR), OR
- A case that meets the clinical definition and is epidemiologically linked directly to a laboratory-confirmed case (culture or PCR lab confirmed)*

Probable Case

- A case that meets the clinical case definition only.
- An **infant (less than 12 months of age)** with an acute cough illness of any duration (< 14 days) with at least one clinically-relevant pertussis symptom (paroxysms of cough, whoop, posttussive vomiting, or apnea with or without cyanosis) AND confirmation by polymerase chain reaction (PCR) or direct epidemiologic linkage to a laboratory-confirmed case.
- A case that meets the clinical case definition and has direct epidemiologic linkage with an infant < 12 months who is PCR positive for pertussis and has ≥ 1 sign or symptom and cough duration < 14 days (classified as 'probable' case).

Note: Positive direct fluorescent antibody (DFA) tests and positive serology tests do not meet the criteria for pertussis laboratory confirmation so cases diagnosed by DFA or serology are classified as PROBABLE cases if they meet the clinical case definition.

Suspect Case

- Council for State and Territorial Epidemiologists (CSTE) no longer recognizes a suspect case definition; however CEDRS still has 'suspect' as a dropdown box option under case status for those health departments that want to track these cases that do not meet a confirmed or probable case status.



Case Finding

- Extract Confirmed & Probable Cases (CASESTATUS =1 or 2) from CEDRS Using SAS
- N = 7367 cases (2006-2015)

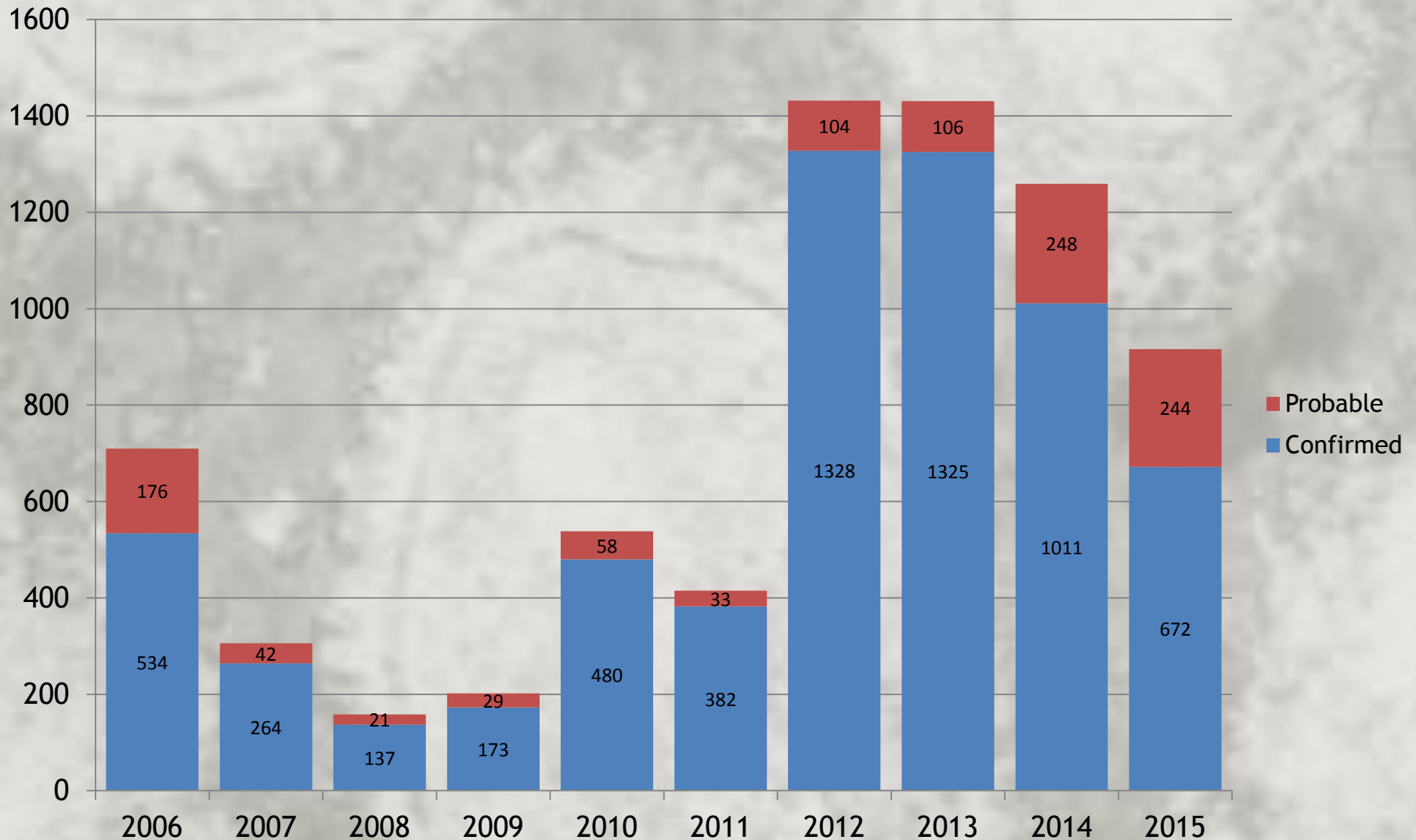
Case Status	N	%
Confirmed	6306	85.6
Probable	1061	14.4
TOTAL	7367	100

Descriptive Statistics

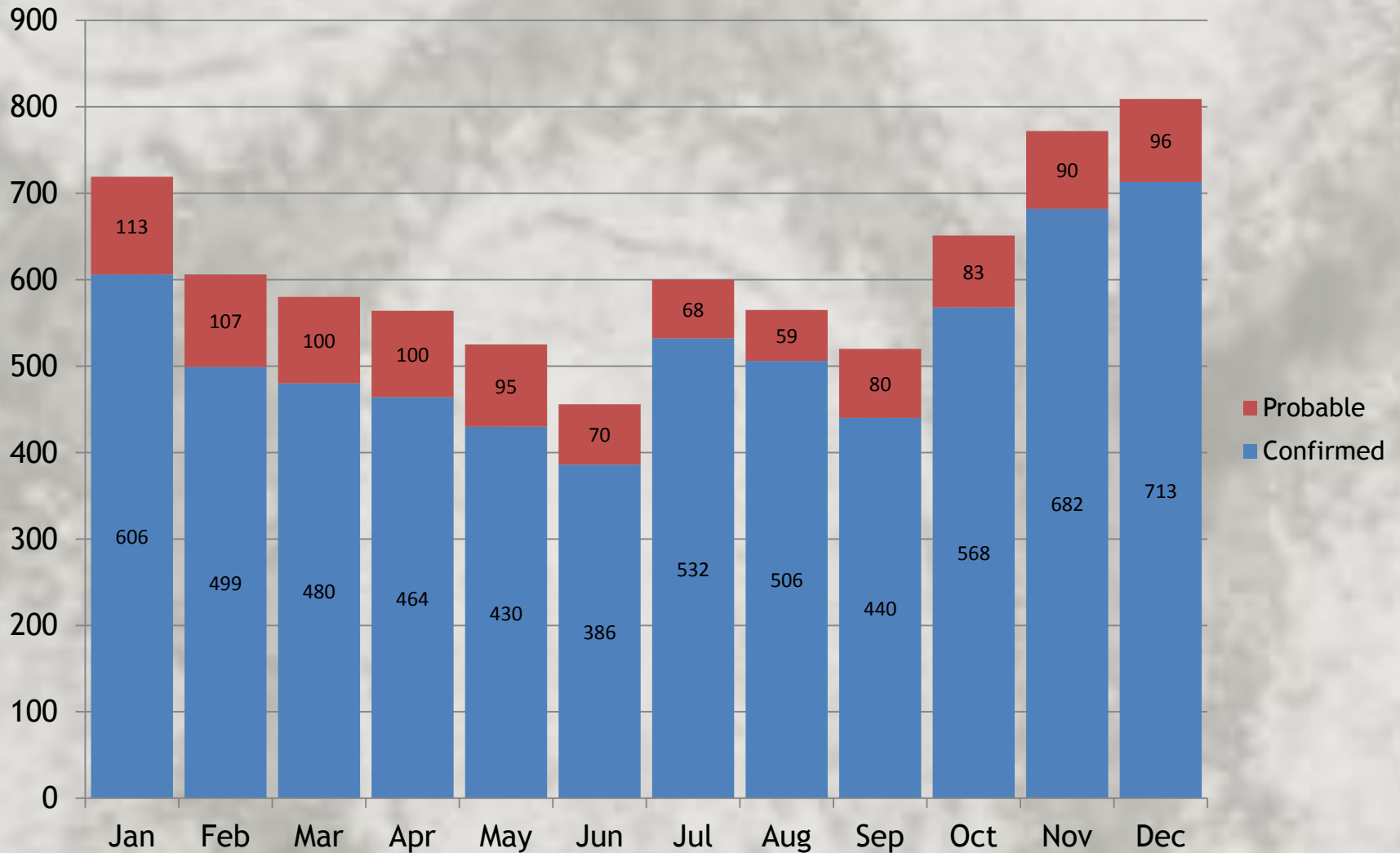


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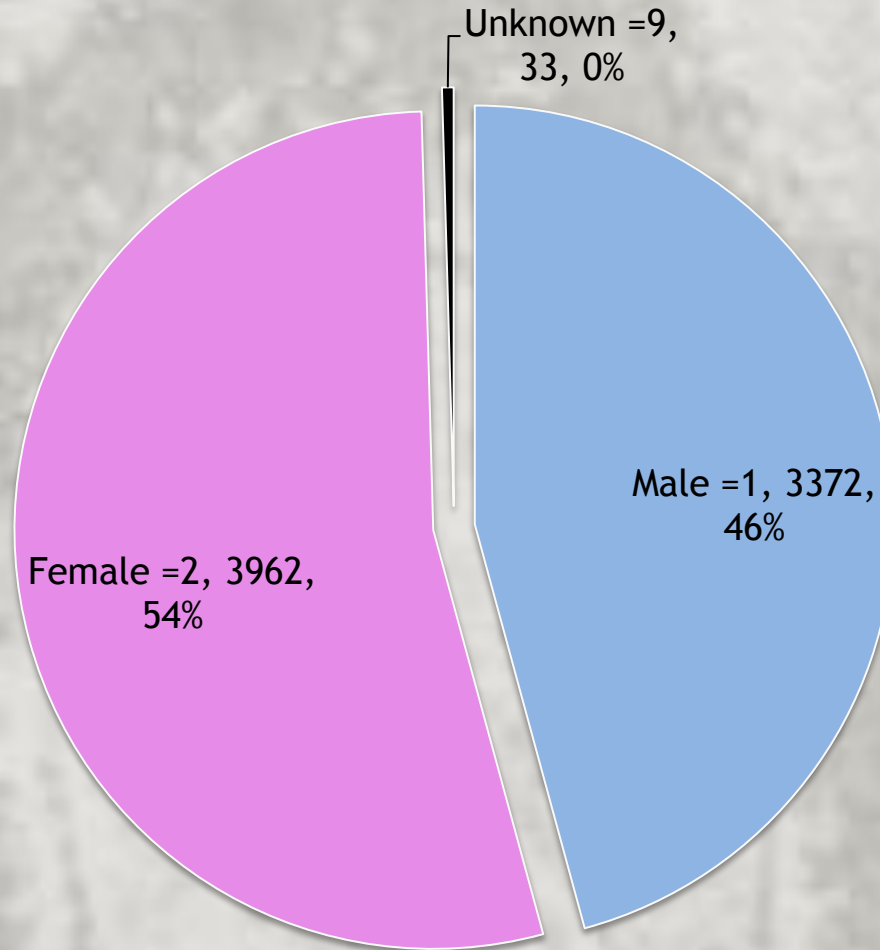
Pertussis Cases by Year, Colorado, 2006 - 2015



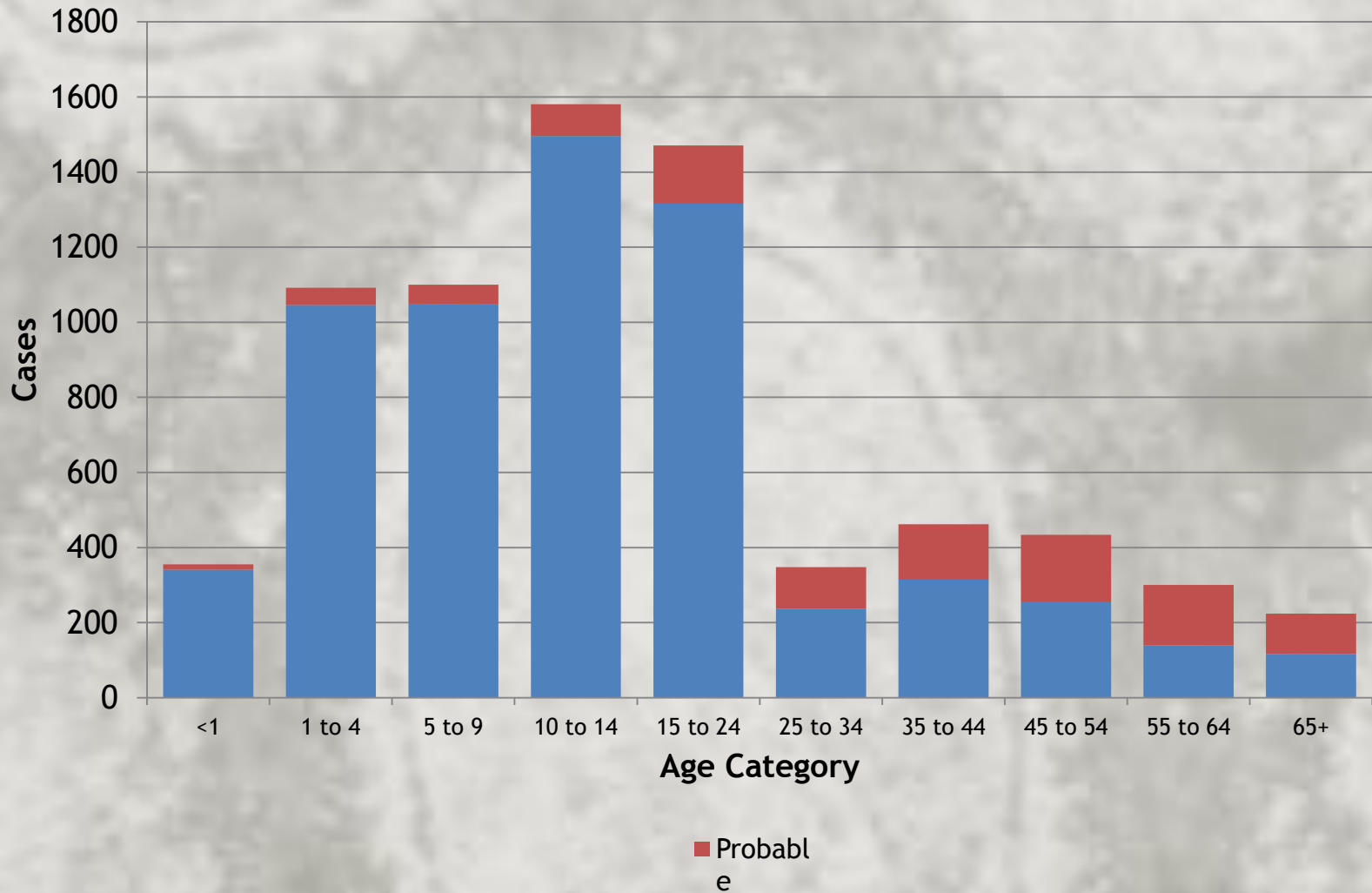
Pertussis Cases by Month, Colorado, 2006 - 2015



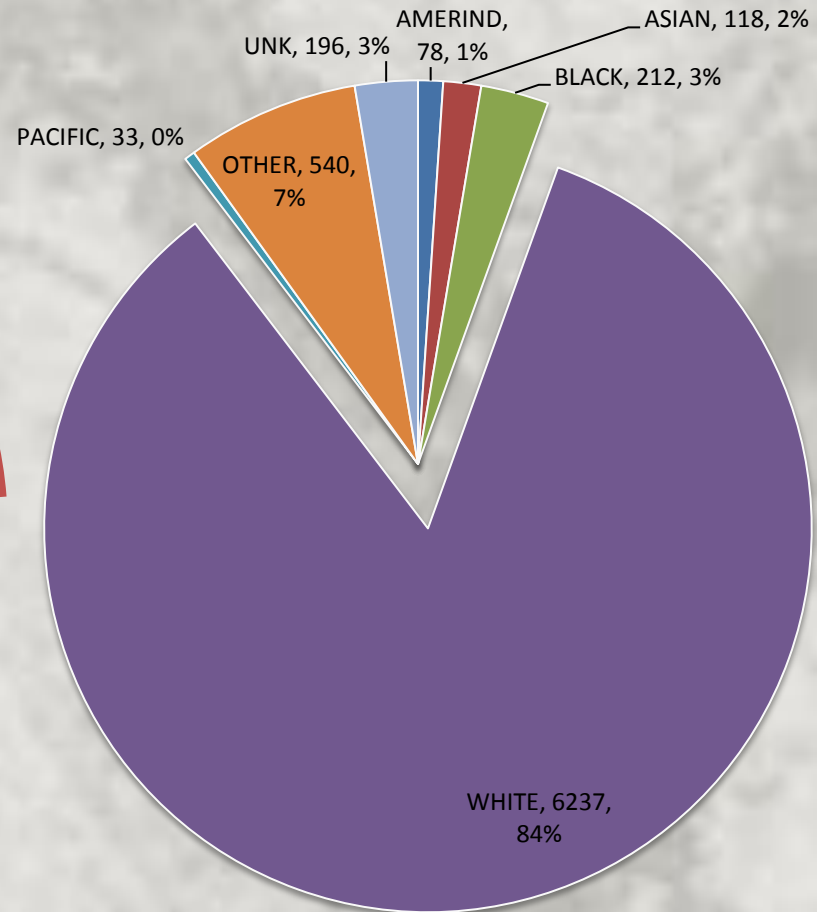
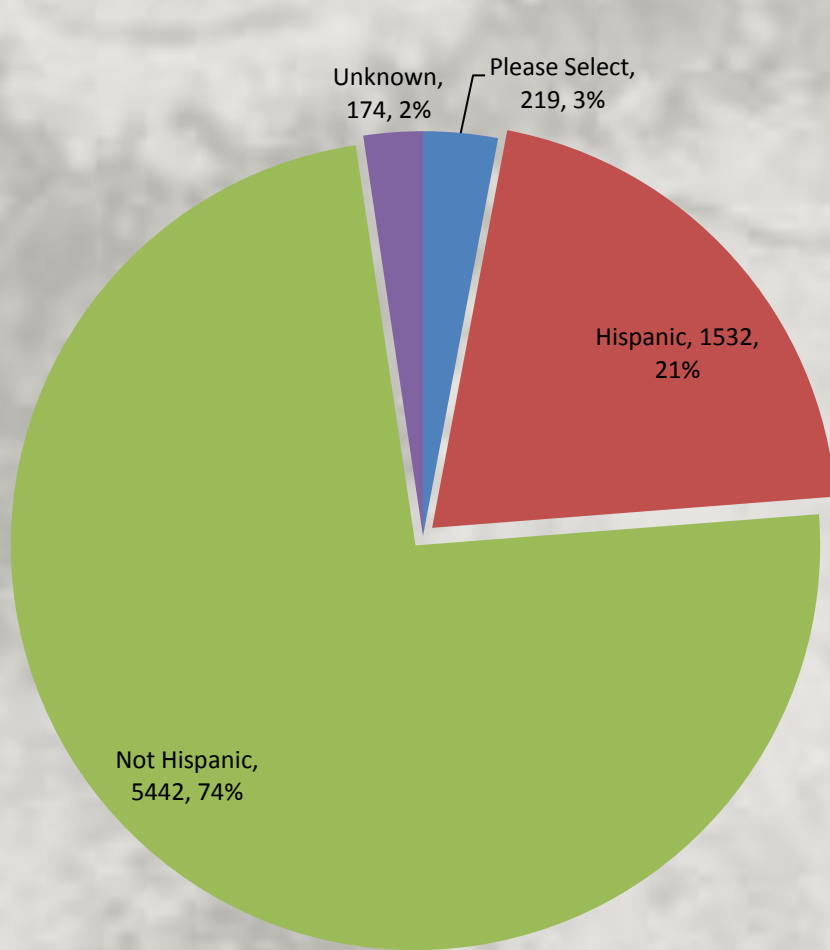
Pertussis Cases by Gender, Colorado, 2006-2015



Pertussis Cases by Age Group, Colorado, 2006-2015



Pertussis Cases by Race and Ethnicity, Colorado, 2006-2015



*Races are not mutually exclusive categories (check all that apply)

Age - Adjusting Rates

- Geocode cases to Census Tract
- Stratify case counts in Census Tract by age, sex, race, ethnicity
- Calculate crude incidence rate (100k) for each Census Tract
- Utilize US 2010 Census SF1 Data as Standard Population (2000 former gold standard) to calculate weights
- Create Age Adjusted Rates

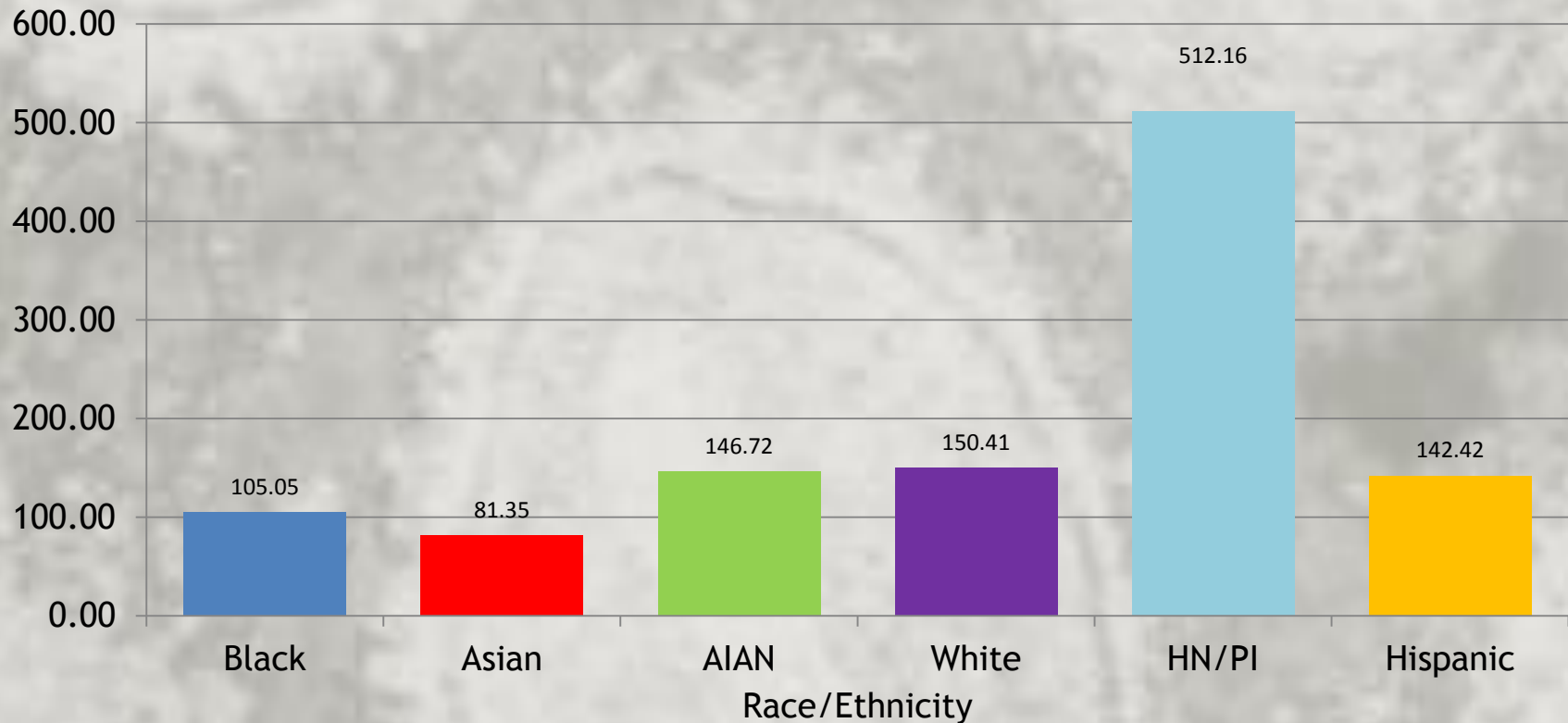
United States™
Census
2010

†Population totals from 2010 Census SF1 Race Alone Categorical Data via Guided Search Fact Finder;



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Age - Adjusted Incidence Rates of Pertussis (per 100k) by Race/Ethnicity Colorado, 2006-2015

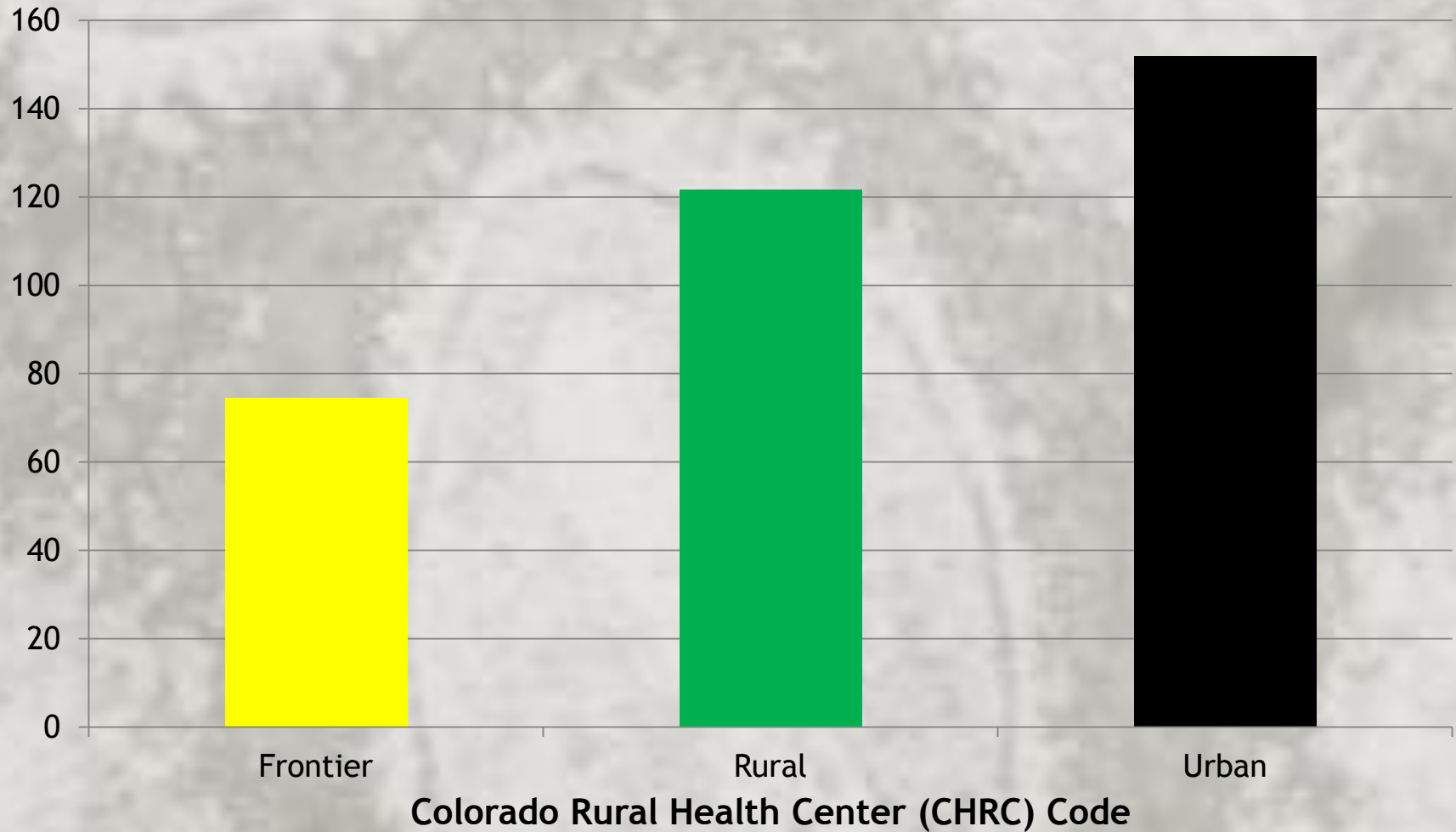


**Population totals from 2010 Census SF1 Race Alone Categorical Data via Guided Search Fact Finder;*



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Age - Adjusted Incidence Rates of Pertussis (per 100k) by CRHC Code Colorado, 2006-2015



Geospatial Clustering Methods & Statistics



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Geocoding Cases

- N = 7367 cases (2006-2015) from CEDRS (MelissaData)
- Re-geocoded using  **centrus**
- 568 (7.7%) missing Lat/Long information. **REMOVED**
- 6799 (92.3%) cases remaining for spatial analysis

Looking at Removed Cases (N=568)

average is 8.875 cases/county
median is 4 cases/county

COUNTY	Pop (% of CO Pop)	Removed Cases (N)	Removed Cases (%)
WELD	5.03%	65	11.44%
BOULDER	5.86%	55	9.68%
JEFFERSON	10.63%	55	9.68%
LA PLATA	1.02%	37	6.51%
ARAPAHOE	11.37%	32	5.63%
EL PASO	12.37%	30	5.28%
ADAMS	8.78%	27	4.75%
GRAND	0.30%	23	4.05%
TELLER	0.46%	21	3.70%
LARIMER	5.96%	19	3.35%
DOUGLAS	5.68%	18	3.17%
DENVER	11.93%	13	2.29%
EAGLE	1.04%	10	1.76%
ARCHULETA	0.24%	9	1.58%
MESA	2.92%	9	1.58%

Top 15 counties



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Obtaining Census Tract Level SES Data

The screenshot shows the Colorado Department of Local Affairs (DOLA) website. The header includes the DOLA logo and the text "COLORADO Department of Local Affairs". A navigation bar contains links: Home, Local Government, Property Taxation, Housing, Assessment Appeals, and Disaster Recovery. Below the navigation bar, a breadcrumb trail reads "Local Government > State Demography Office > GIS Maps and Data". On the left, a "Local Government" sidebar lists: Regional Managers, Local Government Capacity Building, Financial Assistance, Local Government Services, and State Demography Office. The main content area is titled "GIS Maps and Data" and lists: Webmap Gallery (Interactive Web Maps and Data Visualizations), PDF Maps (PDF Thematic Maps), GIS Data (Shapefiles and Demographic Information), and Census Resources. A blue arrow points from the "GIS Data" link to a callout box below.

Colorado Census ACS Tracts 2008-2012

Demographics

The American Community Survey (ACS) is an ongoing survey that provides data every year. The ACS measures the changing social and economic characteristics of the U.S. population. Basic [More](#)

Topics [blocks](#), [census](#), [gocode](#), [state demography office](#), [dola](#), and 11 more



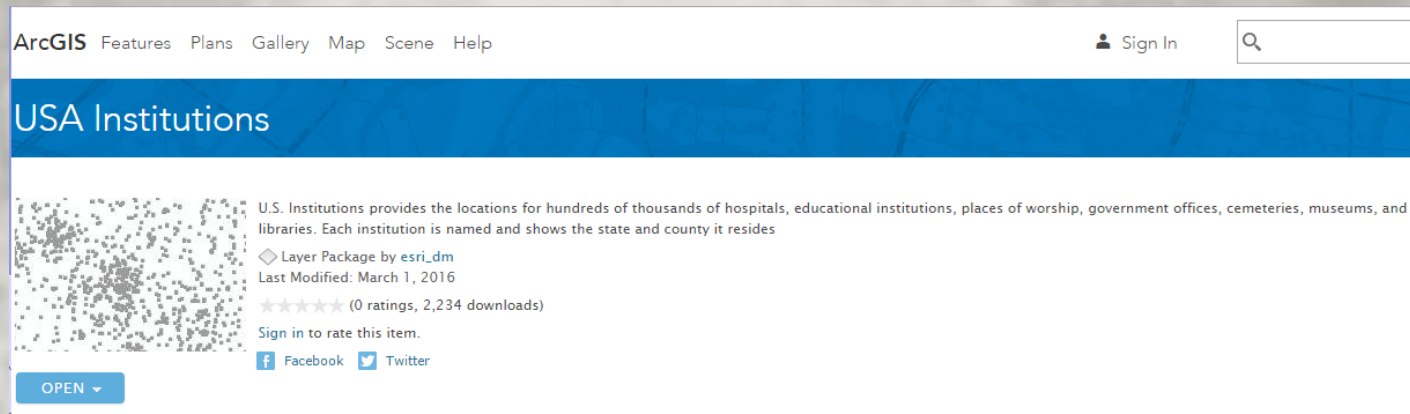
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Merging Census Tract Shapefile with other datasets...

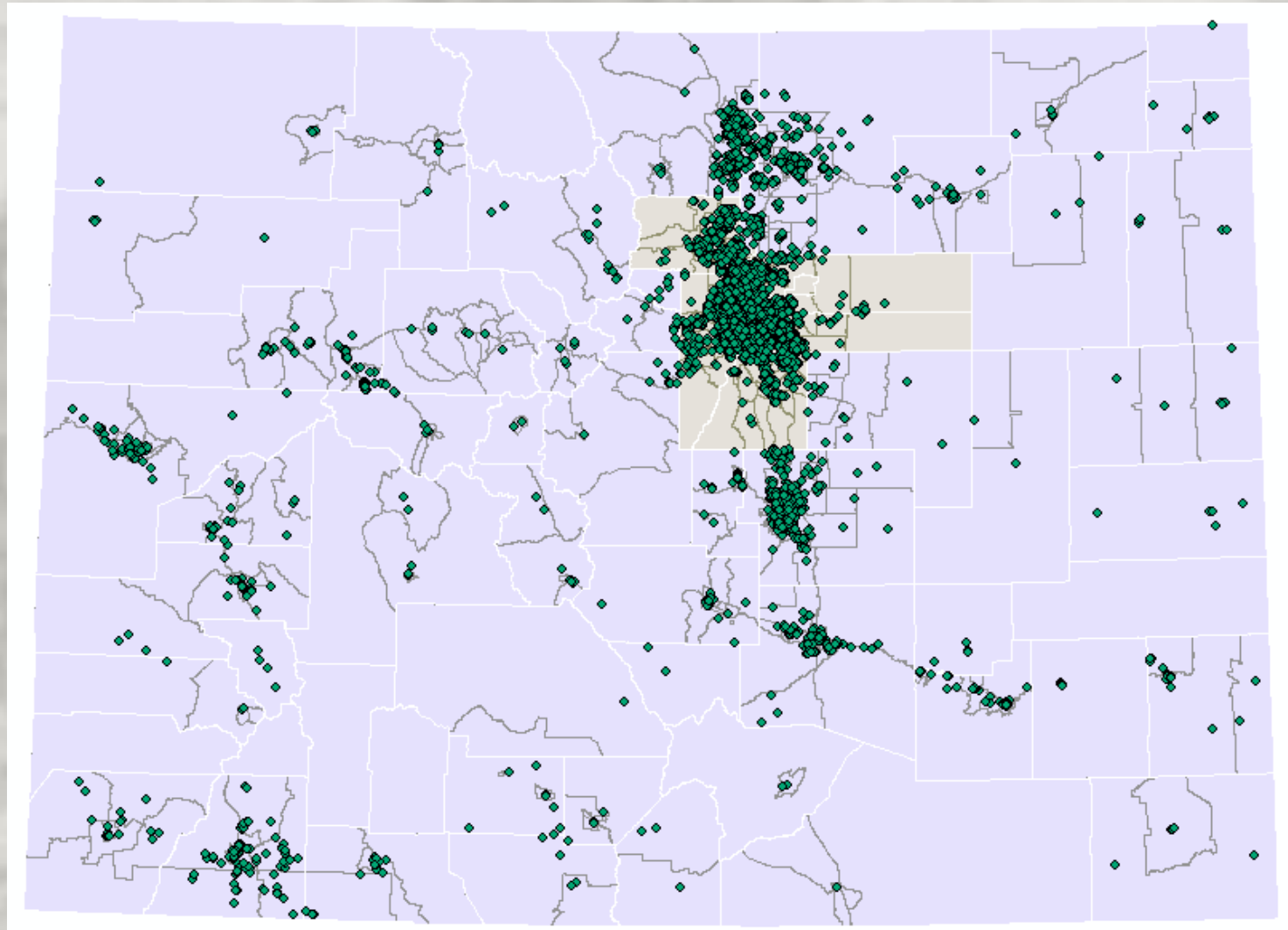
Harvard Voting District Data



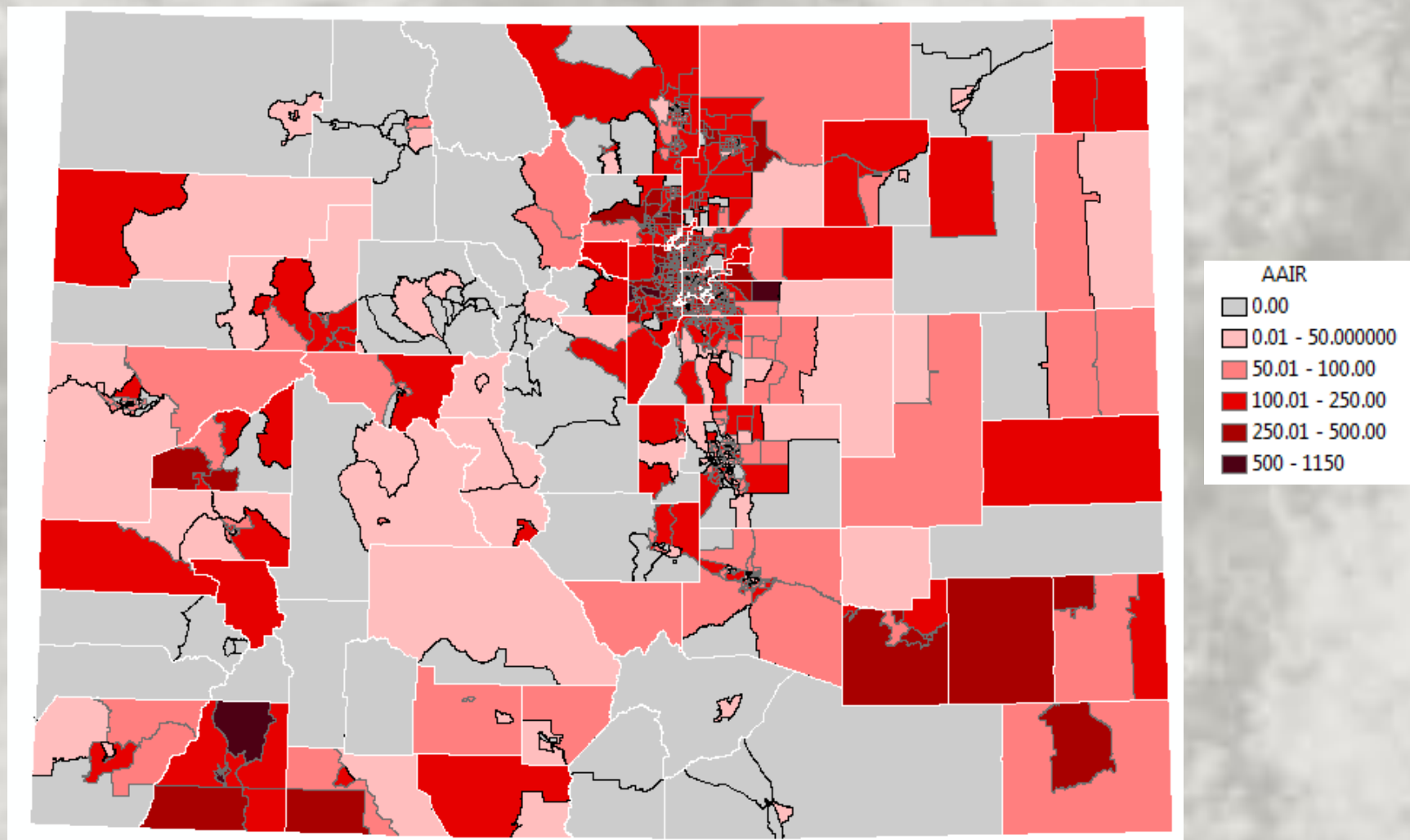
ESRI Institution Data (Places of Worship)



Confirmed & Probable Pertussis Cases Colorado, 2006-2015



Age Adjusted Incidence Rate (Per 100k) for B.pertussis, by Census Tract, Colorado 2006-2015

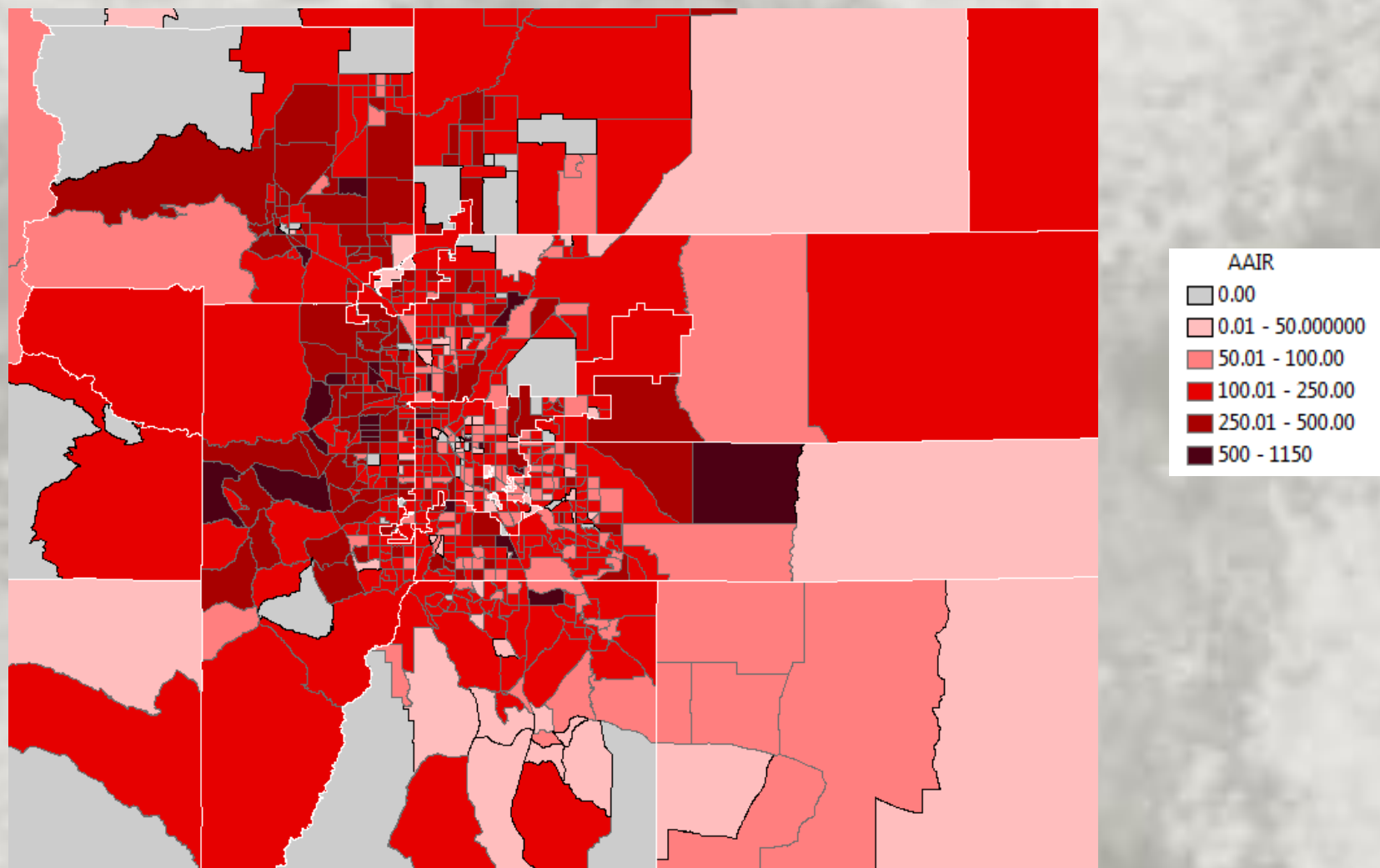


Rates calculated using US 2010 Census as Standard Population from SF1 File



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Age Adjusted Incidence Rate (Per 100k) for B.pertussis, by Census Tract, Colorado 2006-2015

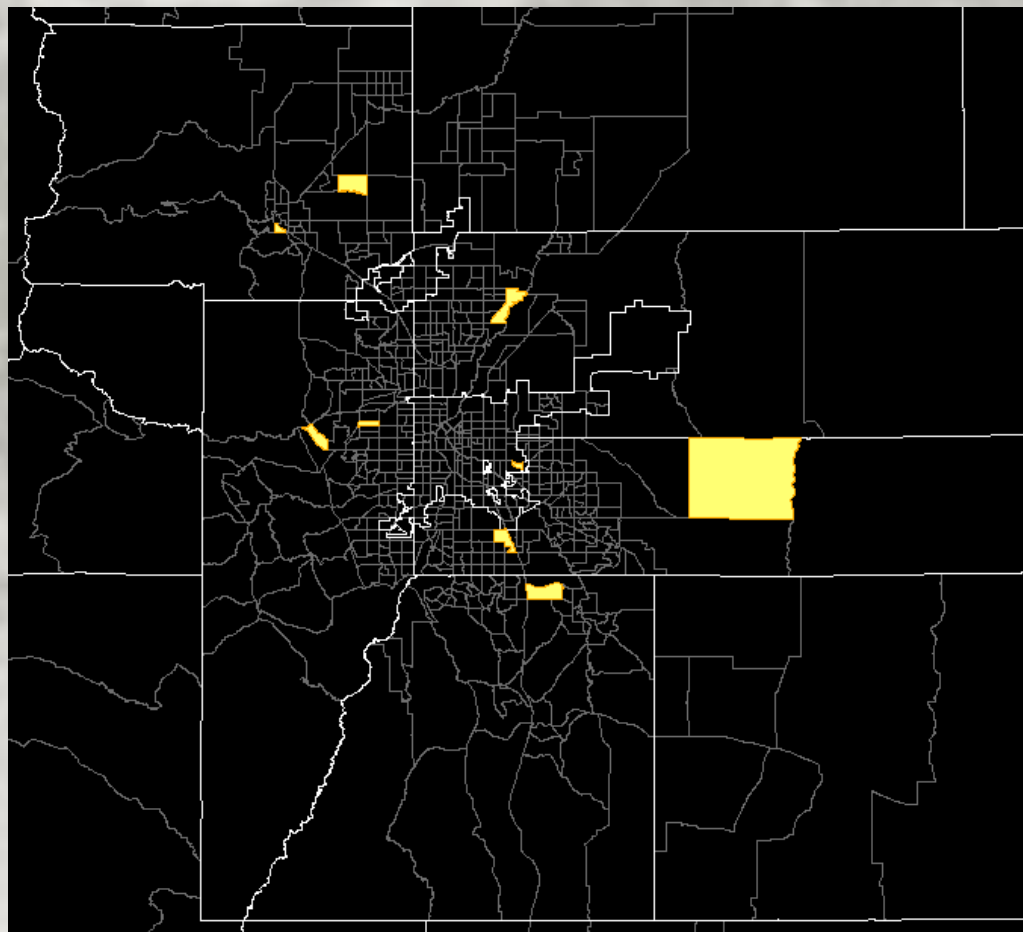


Rates calculated using US 2010 Census as Standard Population from SF1 File

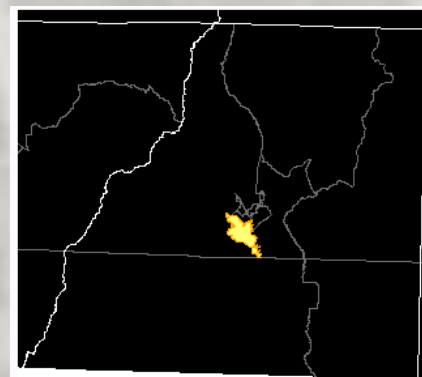


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Top 10 Census Tracts with Highest Incidence Rate (Per 100k) B.pertussis, Colorado 2006-2015



Tract	County	AAIR
10504	Jeffco	1126.78
07103	Arapahoe	1036.63
12401	Boulder	961.76
10000	Jeffco	871.98
08551	Adams	773.88
07089	Denver	716.46
06712	Arapahoe	703.09
12709	Boulder	698.94
14007	Douglas	684.29
09711	La Plata	666.49



Moran's I (Test for Spatial Autocorrelation)

10 Year Age Adjusted Incidence Rates

Moran's Index: 0.163232

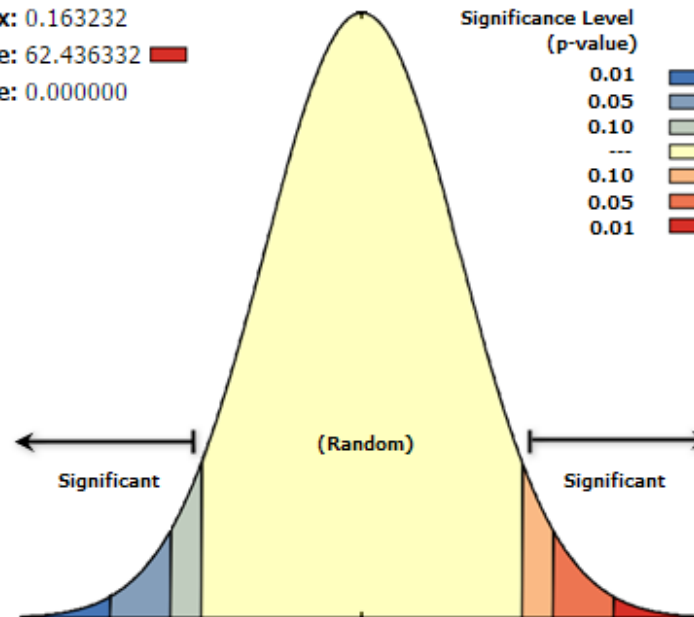
z-score: 62.436332

p-value: 0.000000

Significance Level
(p-value)

Critical Value
(z-score)

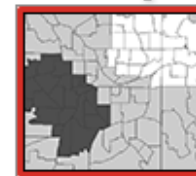
0.01	< -2.58
0.05	-2.58 - -1.96
0.10	-1.96 - -1.65
---	-1.65 - 1.65
0.10	1.65 - 1.96
0.05	1.96 - 2.58
0.01	> 2.58



Dispersed



Random



Clustered

Given the z-score of 62.4363315992, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Hot Spot Analysis (Getis-Ord Gi*) of Age Adj. Incidence Rates Pertussis, Colorado 2006-2015

Tried varying thresholds

-575570 km (default neighborhood)*

-10,000m (10km)

-5000m (5km)

-1000m (1km)

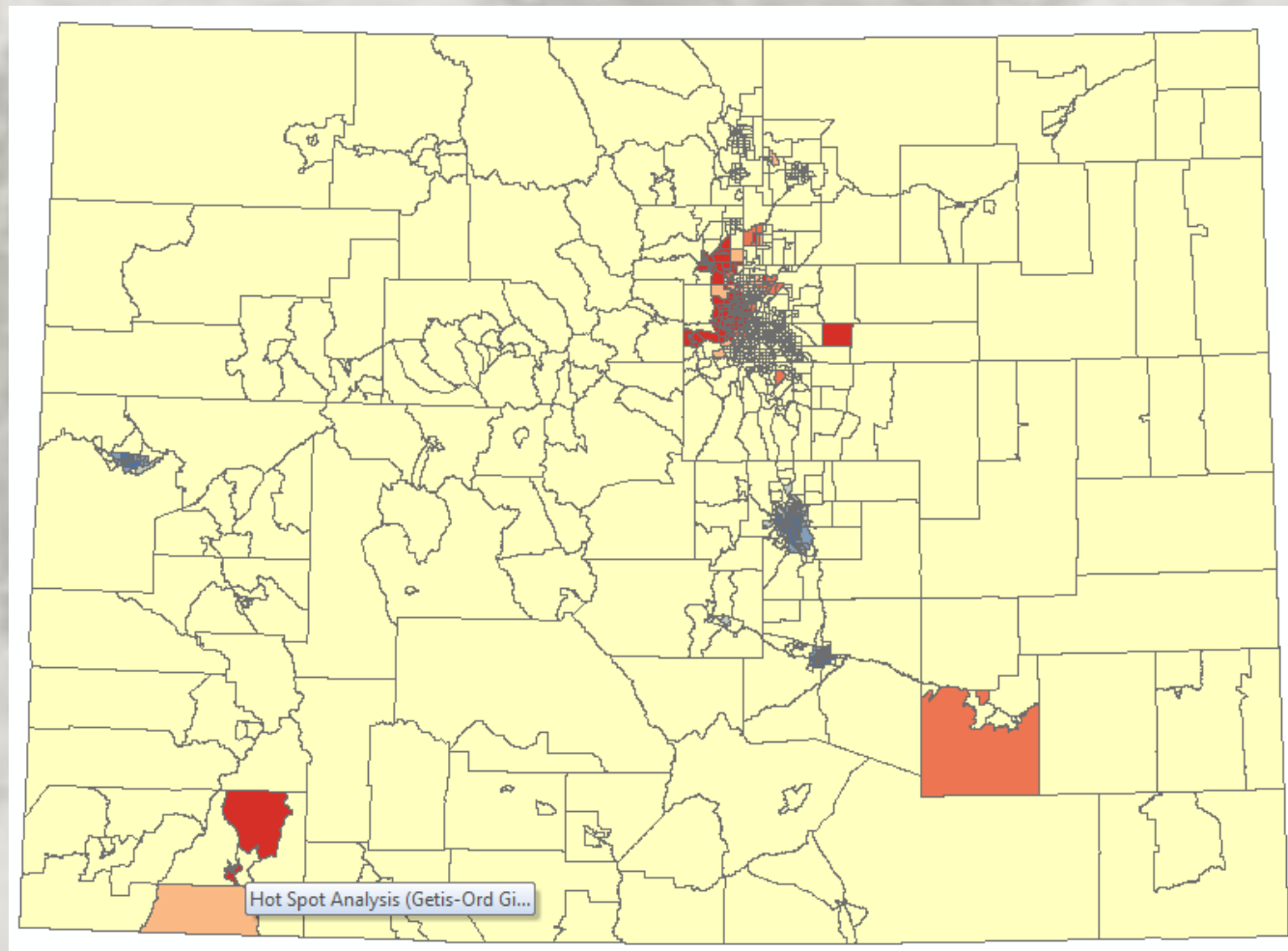
Visual assessment using Incremental Spatial
Autocorrelation “peaks” in ArcGIS ToolBox

**ensures every feature has one neighbor, biased towards larger rural census tracts*



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Hot Spot Analysis (Getis-Ord Gi*) of Age Adj. Incidence Rates B. pertussis, Colorado 2006-2015



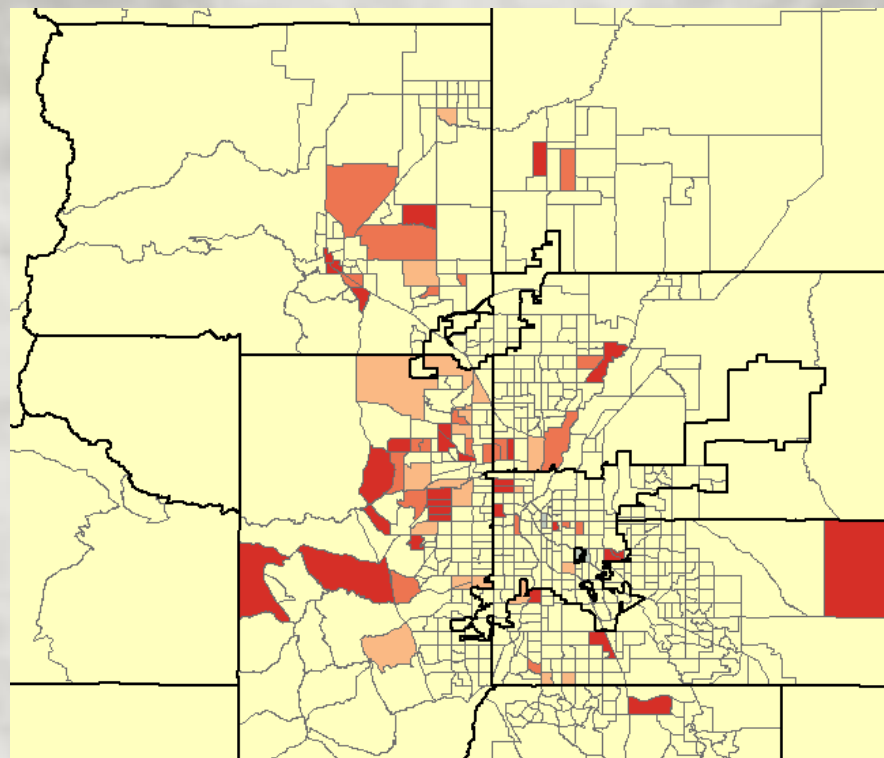
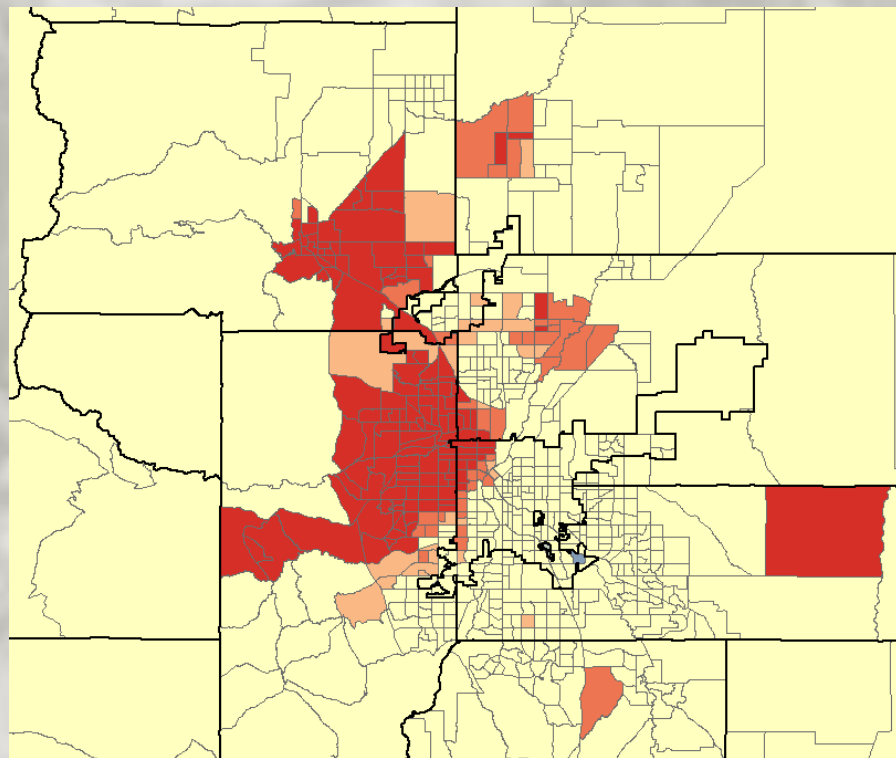
5km threshold
distances

- ☒ AAIR_HotSpots5k
Gi_Bin
- Cold Spot - 99% Confidence
- Cold Spot - 95% Confidence
- Cold Spot - 90% Confidence
- Not Significant
- Hot Spot - 90% Confidence
- Hot Spot - 95% Confidence
- Hot Spot - 99% Confidence

Hot Spot (Getis-Ord*) of Age Adjusted Incidence Rates B. pertussis, Colorado 2006-2015

5km threshold distance

1km threshold distance



- ☒ AAIR_HotSpots5k
Gi_Bin
- Cold Spot - 99% Confidence
 - Cold Spot - 95% Confidence
 - Cold Spot - 90% Confidence
 - Not Significant
 - Hot Spot - 90% Confidence
 - Hot Spot - 95% Confidence
 - Hot Spot - 99% Confidence

Denver Metro Area

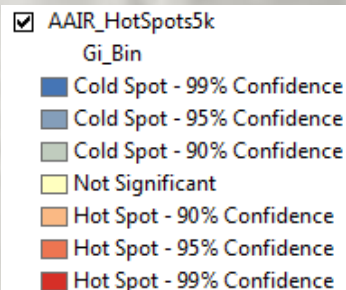
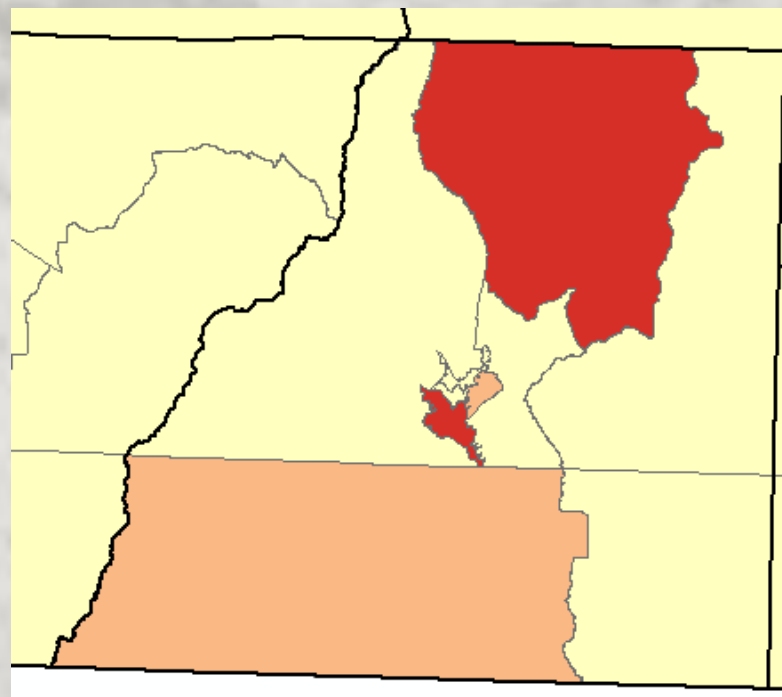
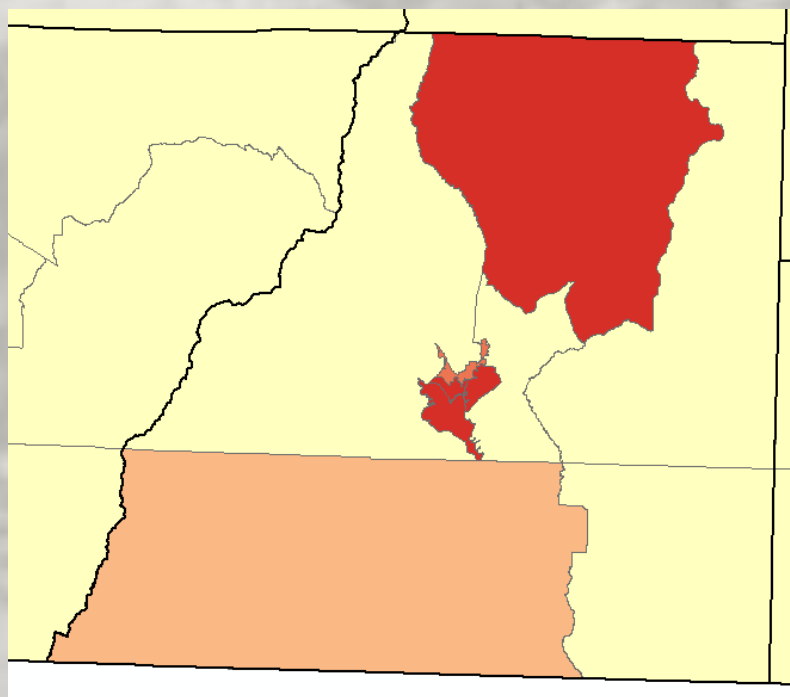


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Hot Spot (Getis-Ord*) of Age Adjusted Incidence Rates B. pertussis, Colorado 2006-2015

5km threshold distance

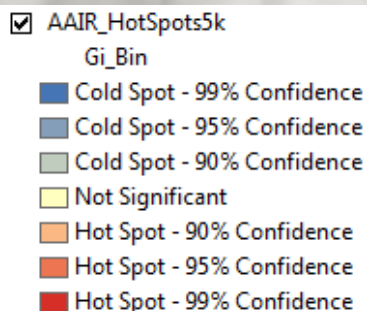
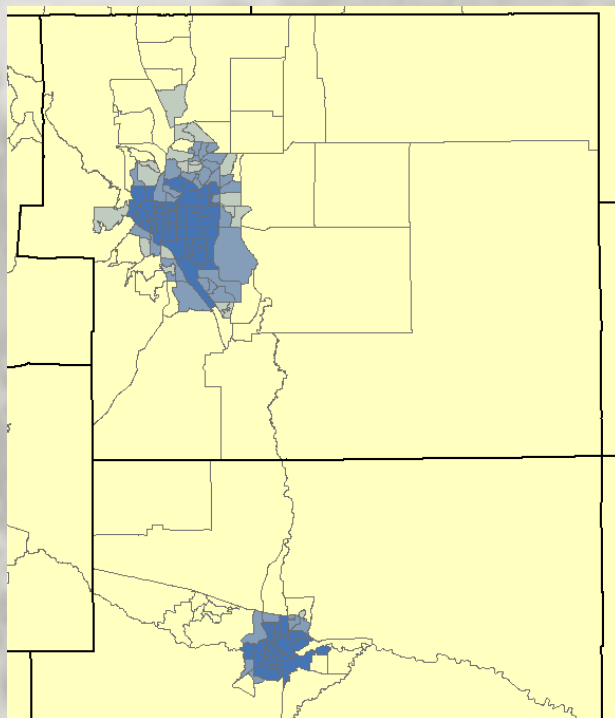
1km threshold distance



Durango Area

Hot Spot (Getis-Ord*) of Age Adjusted Incidence Rates B. pertussis, Colorado 2006-2015

5km threshold distance



Colorado Springs & Pueblo Area

1km threshold distance

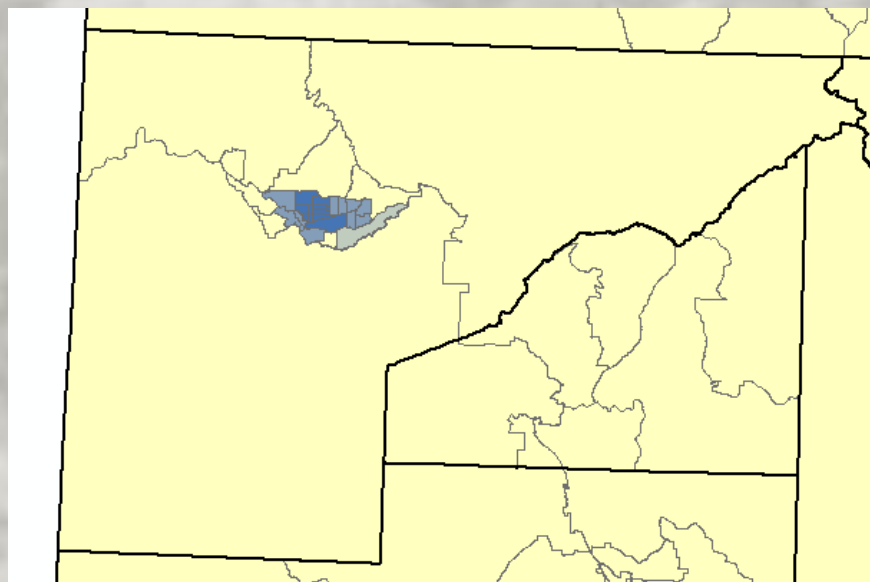
NONE



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Hot Spot (Getis-Ord*) of Age Adjusted Incidence Rates B. pertussis, Colorado 2006-2015

5km threshold distance



1km threshold distance

NONE



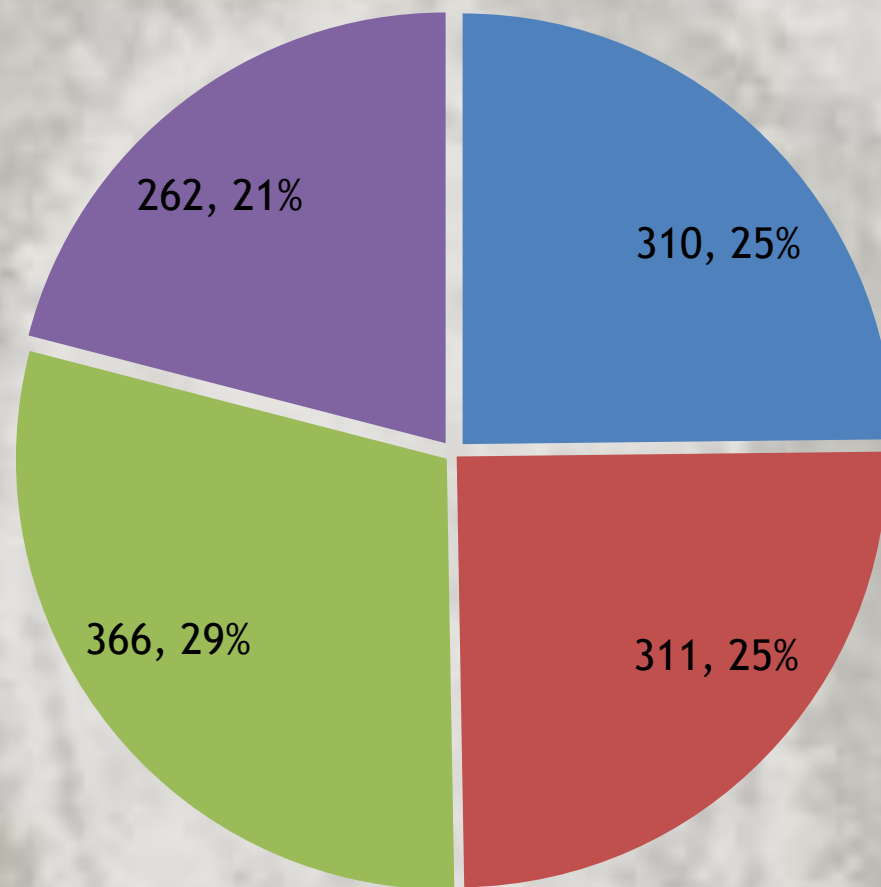
Grand Junction Area

- ☒ AAIR_HotSpots5k
- Gi_Bin
- Cold Spot - 99% Confidence
 - Cold Spot - 95% Confidence
 - Cold Spot - 90% Confidence
 - Not Significant
 - Hot Spot - 90% Confidence
 - Hot Spot - 95% Confidence
 - Hot Spot - 99% Confidence

Census Tracts in Colorado by Poverty Level*

Colorado, 2006-2015

■ <5% ■ 5 to 10% ■ 10 to 20% ■ >20%



**levels as documented in Harvard School of Public Health, Public Health Disparities Geocoding Project*

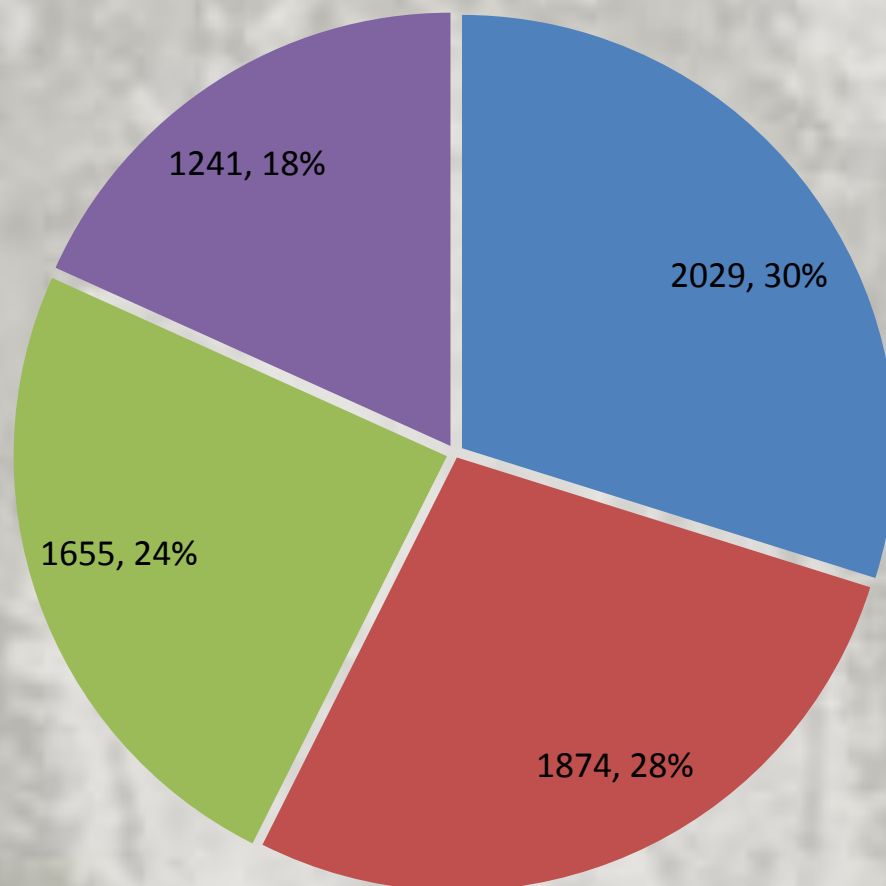


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Pertussis Cases by Poverty Level*

Colorado, 2006-2015

■ <5% ■ 5 to 10% ■ 10 to 20% ■ >20%

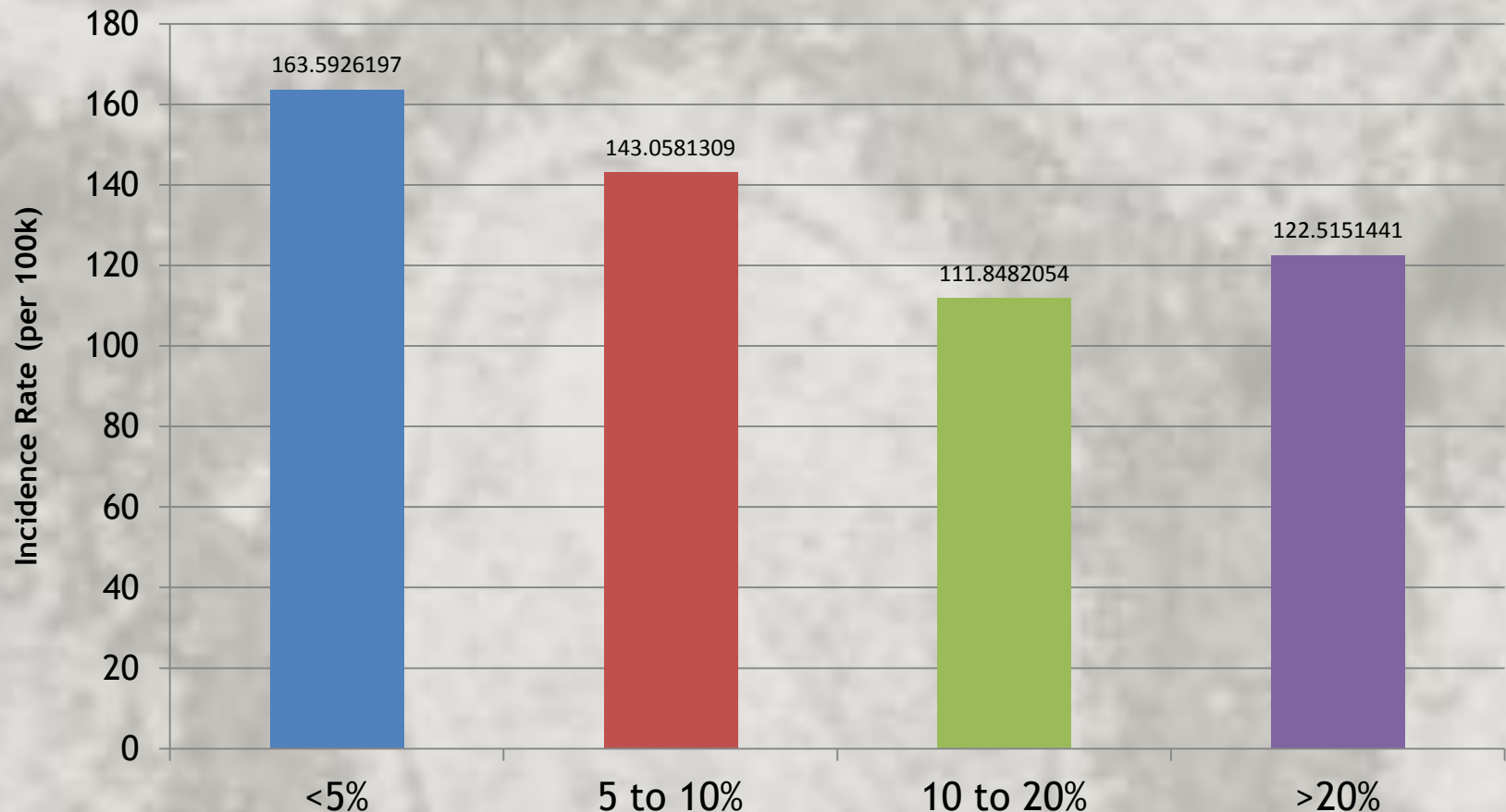


**levels as documented in Harvard School of Public Health, Public Health Disparities Geocoding Project*



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Crude Incidence Rates of Pertussis by Census Tract Poverty Level Colorado, 2006-2015



Negative Binomial Regression Analysis



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Regression Steps

Check Data Distribution

Plot Dependent vs. Independent Variable(s) to examine relationships

Check for highest correlated variables (Pearson's Correlation Coefficients)

Check for confounding variables/multicollinearity

Initial Model computation, output and interpretation

Re-check Model outputs, omission of non-significant variables

Run Null Model as comparison to final model



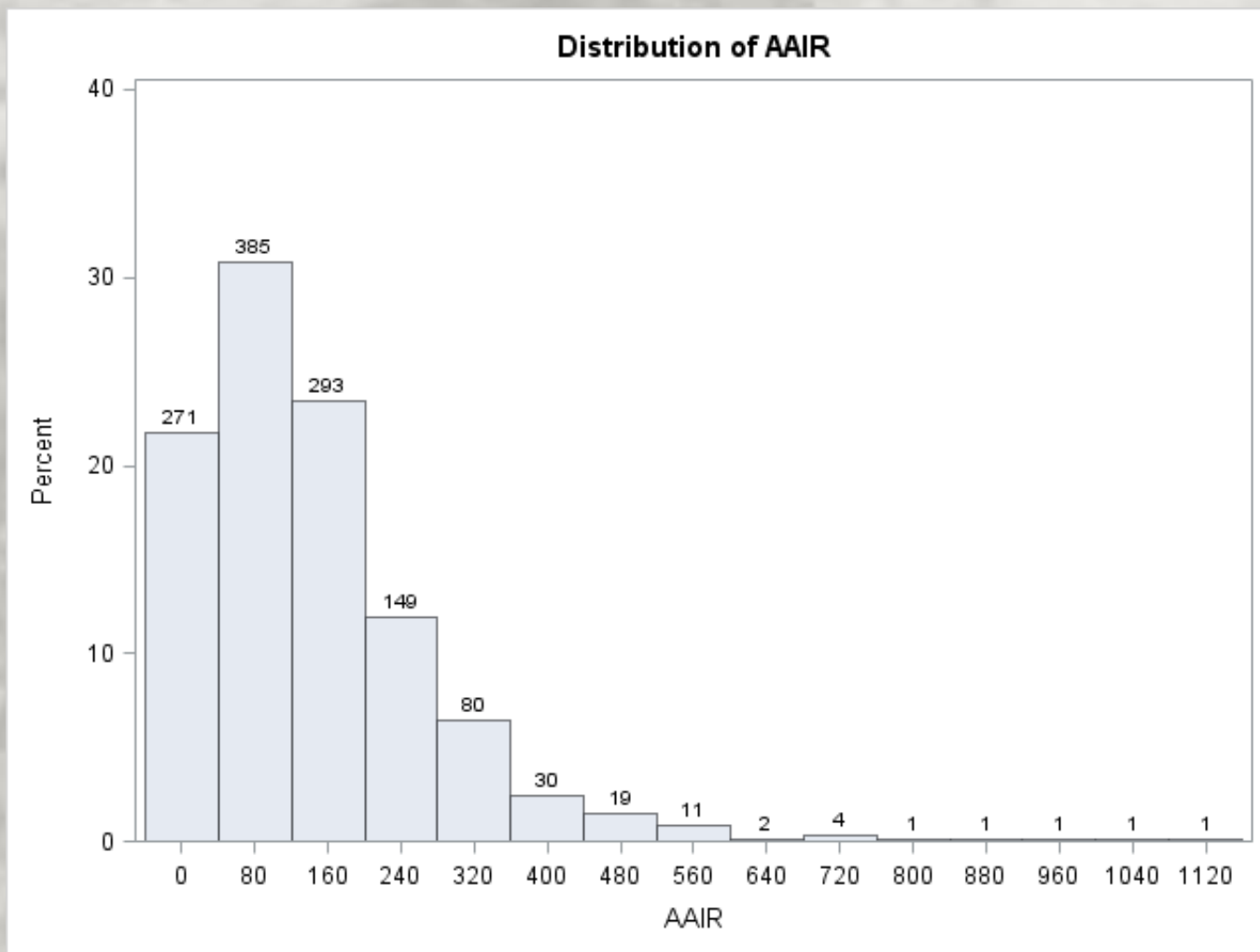
Hypothesis

Pertussis rates at the Census Tract Level are influenced by:

- Minority Race or Ethnic population distribution (census data)**
- Lower Income level status (census data)**
- Education level status (census data)**
- Voting tendencies (voting data)**
- Religious/Spiritual tendencies (church data)**



Plotting Dependent Variable



High Variance Compared to Mean...

Variable	Label	Mean	Std Dev	Minimum	Maximum	Variance
PCT_B100P	PCT_B100P	12.7292716	10.2500723	0	75.8546982	105.0639817
POVCAT	POVCAT	2.4643715	1.0796280	1.0000000	4.0000000	1.1655966
foreign_b	foreign_b	392.2770216	411.6248254	0	2517.00	169435.00
white_nh	white_nh	2825.03	1548.09	0	11363.00	2396581.47
age_10_19	age_10_19	537.5244195	368.1813581	0	4914.00	135557.51
age_20_29	age_20_29	580.6044836	422.2016154	0	3532.00	178254.20
black_nh	black_nh	152.7990392	320.4070385	0	3004.00	102660.67
asian_nh	asian_nh	107.8855084	147.0405345	0	1178.00	21620.92
Geo_id2	Geo_id2	8046841275	35863525.27	8001007801	8125963200	1.2861924E15
AAIR	AAIR	140.5083839	131.3045447	0	1126.78	17240.88
med_hh_inc	med_hh_inc	61943.81	28601.89	0	250001.00	818068033
pop0812	pop0812	4037.51	1823.45	0	12833.00	3324981.12
pop_1p	pop_1p	3984.83	1793.72	0	12698.00	3217439.11
bachl_hghr	bachl_hghr	977.5068054	725.2179967	0	4185.00	525941.14
rented	rented	535.4699760	451.7592598	0	2888.00	204086.43
hispanic	hispanic	833.0488391	870.8023571	0	5810.00	758296.75
Sum_REGVTR08_D	Sum_REGVTR08_D	724.5244193	445.6089225	0	3674.00	198567.31
Sum_REGVTR08_R	Sum_REGVTR08_R	718.0480371	570.4021363	0	5131.00	325358.60
Sum_REGVTR08_U	Sum_REGVTR08_U	655.3859087	382.7291223	0	3699.00	146481.58
Sum_REGVTR08_M	Sum_REGVTR08_M	13.4155324	11.4915111	0	112.0000000	132.0548278
Sum_REGVTR10R	Sum_REGVTR10R	700.3002391	571.8569160	0	5109.00	327020.33
Sum_REGVTR10D	Sum_REGVTR10D	649.0176142	396.3548997	0	3293.00	157097.21
Sum_REGVTR10U	Sum_REGVTR10U	616.4755805	372.2817403	0	3839.00	138593.69
Sum_REGVTR10M	Sum_REGVTR10M	14.8182546	10.5471888	0	69.0000000	111.2431909
Church_Count	Church_Count	2.4907926	2.7558423	0	21.0000000	7.5946668
Church_100lk	Church_100lk	67.3492635	82.3135600	0	742.8571167	6775.52
citz_nat	citz_nat	140.0136109	130.8851423	0	1263.00	17130.92
citz_birth	citz_birth	3645.24	1663.94	0	12505.00	2768696.00

Selecting Appropriate Regression Variables

**Dependent variable: Age-Adjusted Incidence Rate (2006-2015)
at census tract level**

Independent variables:

Age_10_19 - Estimate for Population between ages 10 to 19

Age_20_29 - Estimate for Population between ages 20 to 29

WHITE_NH - Estimate for the White, Non-Hispanic Population

ASIAN_NH - Estimate for the Asian, Non-Hispanic Population

BLACK_NH - Estimate for the Black, Non-Hispanic Population

FOREIGN_B - Estimated total population that was born outside of the United States

HISPANIC - Estimate for the Hispanic Population

RENTED - Estimated number of renter-occupied housing units

BACHL_HGHR - Estimated total population 25 yr or older with a BD, MD, PhD or Other

MED_HH_INC - Median Household Income

PCT_B100P - Percent of Population Below the 100% Federal Poverty Line

CITZ_NAT - Estimated total population that is a US Citizen by naturalization

CITZ_BIRTH - Estimated total population that is US Citizen by birth

CHURCH_COU - # of Churches/Places of Worship in a Census Tract

POPU1 - Estimated Population Less than 1 years of age (calculated)

REGVTR08_D 2008 Registered Voters - Democrats

REGVTR08_R 2008 Registered Voters - Republicans

REGVTR08_U 2008 Registered Voters - Unaffiliated

REGVTR08_M 2008 Registered Voters - Minor Party (e.g. Green, Libertarian)



Pearson's Correlation Coefficients

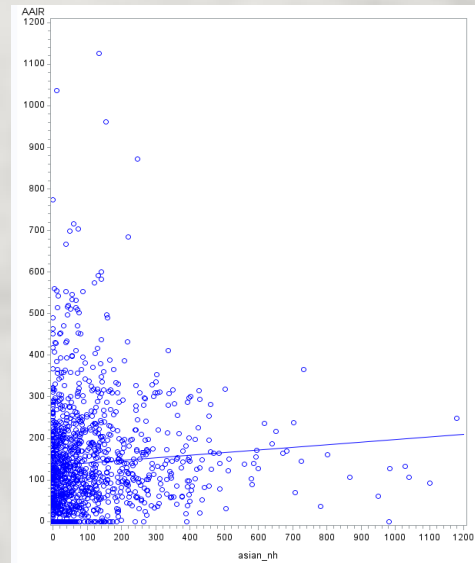
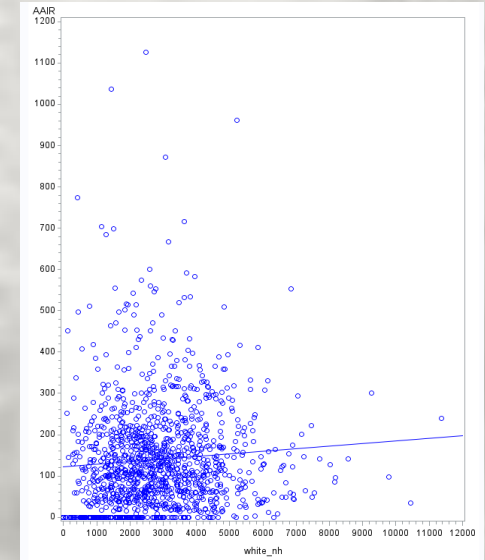
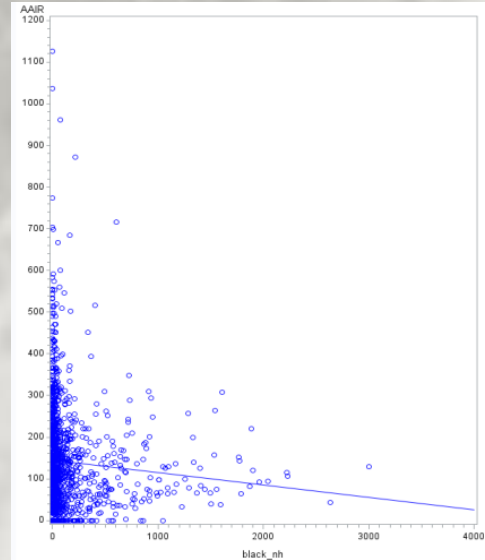
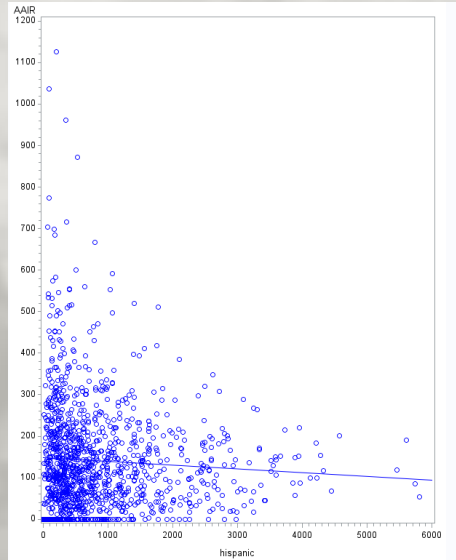
Variable	AAIR	white_nh	age_10_19	age_20_29	foreign_b	black_nh	asian_nh	hispanic	rented	bachl_hghr	med_hh_inc	citiz_nat	citiz_birth	PCT_B100P	Church_Count	POPU1	Sum_REGVTR08_R	Sum_REGVTR08_D	Sum_REGVTR08_U	Sum_REGVTR08_M
AAIR	1	0.07326	-0.00672	-0.01012	-0.02075	-0.07233	0.07106	-0.05974	-0.02563	0.16428	0.21671	0.04772	0.03178	-0.05206	-0.04027	-0.01437	-0.00866	0.15597	0.08794	0.04461
AAIR		0.0096	0.8123	0.7209	0.4637	0.0106	0.012	0.0348	0.3655	<.0001	<.0001	0.0919	0.2617	0.0659	0.1549	0.6119	0.7599	<.0001	0.0019	0.1151
white_nh	0.07326	1	0.58367	0.33133	-0.0111	-0.1012	0.25609	-0.14071	0.16363	0.76999	0.39205	0.25325	0.88595	-0.35352	0.1408	0.30681	0.72124	0.3833	0.72048	0.37475
white_nh	0.0096		<.0001	<.0001	0.695	0.0003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
age_10_19	-0.00672	0.58367	1	0.3174	0.38371	0.17959	0.36676	0.35951	0.08382	0.31989	0.1754	0.43754	0.73214	-0.0697	0.09142	0.38002	0.41291	0.22094	0.40373	0.15646
age_10_19	0.8123	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	0.003	<.0001	<.0001	<.0001	<.0001	0.0137	0.0012	<.0001	<.0001	<.0001	<.0001	<.0001
age_20_29	-0.01012	0.33133	0.3174	1	0.41916	0.28272	0.2704	0.38929	0.74609	0.18793	-0.27891	0.31445	0.51341	0.35755	0.17965	0.40304	-0.05285	0.318	0.27561	0.43636
age_20_29	0.7209	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0619	<.0001	<.0001	<.0001
foreign_b	-0.02075	-0.0111	0.38371	0.41916	1	0.51727	0.4295	0.74334	0.40948	0.02646	-0.1649	0.69969	0.28241	0.36644	0.06345	0.45692	-0.12918	0.22248	0.06884	0.09102
foreign_b	0.4637	0.695	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	0.3501	<.0001	<.0001	<.0001	<.0001	0.0249	<.0001	<.0001	<.0001	0.015	0.0013
black_nh	-0.07233	-0.1012	0.17959	0.28272	0.51727	1	0.27901	0.2928	0.29073	-0.01468	-0.15694	0.48689	0.17033	0.21918	0.06052	0.34149	-0.13099	0.226	-0.0265	0.04451
black_nh	0.0106	0.0003	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	0.6042	<.0001	<.0001	<.0001	<.0001	0.0325	<.0001	<.0001	<.0001	0.3494	0.1159
asian_nh	0.07106	0.25609	0.36676	0.2704	0.4295	0.27901	1	0.08542	0.18162	0.37741	0.22803	0.64224	0.33701	-0.09082	-0.11649	0.28781	0.12329	0.21984	0.21088	0.09715
asian_nh	0.012	<.0001	<.0001	<.0001	<.0001	<.0001		0.0025	<.0001	<.0001	<.0001	<.0001	<.0001	0.0013	<.0001	<.0001	<.0001	<.0001	<.0001	0.0006
hispanic	-0.05974	-0.14071	0.35951	0.38929	0.74334	0.2928	0.08542	1	0.33124	-0.25873	-0.35222	0.39863	0.28305	0.49004	0.16274	0.45786	-0.22628	0.15075	-0.0563	-0.02727
hispanic	0.0348	<.0001	<.0001	<.0001	<.0001	<.0001	0.0025		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0467	0.3355
rented	-0.02563	0.16363	0.08382	0.74609	0.40948	0.29073	0.18162	0.33124	1	0.15127	-0.42735	0.25034	0.31255	0.46458	0.25481	0.27831	-0.15109	0.3219	0.17144	0.42691
rented	0.3655	<.0001	0.003	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
bachl_hghr	0.16428	0.76999	0.31989	0.18793	0.02646	-0.01468	0.37741	-0.25873	0.15127	1	0.56903	0.34953	0.62031	-0.39449	-0.01415	0.1697	0.55737	0.52476	0.64236	0.41864
bachl_hghr	<.0001	<.0001	<.0001	<.0001	0.3501	0.6042	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	0.6175	<.0001	<.0001	<.0001	<.0001	<.0001
med_hh_inc	0.21671	0.39205	0.1754	-0.27891	-0.1649	-0.15694	0.22803	-0.35222	-0.42735	0.56903	1	0.16182	0.21238	-0.63872	-0.22341	-0.0026	0.43412	0.08886	0.28013	-0.04606
med_hh_inc	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	0.9269	<.0001	0.0017	<.0001	0.1038
citiz_nat	0.04772	0.25325	0.43754	0.31445	0.69969	0.48689	0.64224	0.39863	0.25034	0.34953	0.16182	1	0.4446	0.00067	-0.04386	0.42758	0.12103	0.325	0.2453	0.08917
citiz_nat	0.0919	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	0.981	0.1213	<.0001	<.0001	<.0001	<.0001	0.0016
citiz_birth	0.03178	0.88595	0.73214	0.51341	0.28241	0.17033	0.33701	0.28305	0.31255	0.62031	0.21238	0.4446	1	-0.12842	0.2064	0.52821	0.58213	0.454	0.65119	0.33763
citiz_birth	0.2617	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
PCT_B100P	-0.05206	-0.35352	-0.0697	0.35755	0.36644	0.21918	-0.09082	0.49004	0.46458	-0.39449	-0.63872	0.00067	-0.12842	1	0.21388	0.12617	-0.39766	0.01555	-0.21965	0.0997
PCT_B100P	0.0659	<.0001	0.0137	<.0001	<.0001	<.0001	0.0013	<.0001	<.0001	<.0001	<.0001	0.981	<.0001		<.0001	<.0001	<.0001	0.583	<.0001	0.0004
Church_Count	-0.04027	0.1408	0.09142	0.17965	0.06345	0.06052	-0.11649	0.16274	0.25481	-0.01415	-0.22341	-0.04386	0.2064	0.21388	1	0.05732	0.05754	0.09509	0.04561	0.10109
Church_Count	0.1549	<.0001	0.0012	<.0001	0.0249	0.0325	<.0001	<.0001	<.0001	0.6175	<.0001	0.1213	<.0001	<.0001		0.0428	0.042	0.0008	0.1071	0.0003
POPU1	-0.01437	0.30681	0.38002	0.40304	0.45692	0.34149	0.28781	0.45786	0.27831	0.1697	-0.0026	0.42758	0.52821	0.12617	0.05732	1	0.1147	0.24369	0.22915	0.10579
POPU1	0.6119	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.9269	<.0001	<.0001	<.0001	0.0428		<.0001	<.0001	<.0001	0.0002
Sum_REGVTR08_R	-0.00866	0.72124	0.41291	-0.05285	-0.12918	-0.13099	0.12329	-0.22628	-0.15109	0.55737	0.43412	0.12103	0.58213	-0.39766	0.05754	0.1147	1	0.27801	0.72979	0.21681
Sum_REGVTR08_R	0.7599	<.0001	<.0001	0.0619	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.042	<.0001		<.0001	<.0001	<.0001
Sum_REGVTR08_D	0.15597	0.3833	0.22094	0.318	0.22248	0.226	0.21984	0.15075	0.3219	0.52476	0.08886	0.325	0.454	0.01555	0.09509	0.24369	0.27801	1	0.73951	0.67797
Sum_REGVTR08_D	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0017	<.0001	<.0001	0.583	0.0008	<.0001	<.0001		<.0001	<.0001
Sum_REGVTR08_U	0.08794	0.72048	0.40373	0.27561	0.06884	-0.0265	0.21088	-0.0563	0.17144	0.64236	0.28013	0.2453	0.65119	-0.21965	0.04561	0.22915	0.72979	0.73951	1	0.67221
Sum_REGVTR08_U	0.0019	<.0001	<.0001	<.0001	0.015	0.3494	<.0001	0.0467	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.1071	<.0001	<.0001	<.0001		<.0001
Sum_REGVTR08_M	0.04461	0.37475	0.15646	0.43636	0.09102	0.04451	0.09715	-0.02727	0.42691	0.41864	-0.04606	0.08917	0.33763	0.0997	0.10109	0.10579	0.21681	0.67797	0.67221	1
Sum_REGVTR08_M	0.1151	<.0001	<.0001	<.0001	0.0013	0.1159	0.0006	0.3355	<.0001	<.0001	0.1038	0.0016	<.0001	0.0004	0.0003	0.0002	<.0001	<.0001	<.0001	



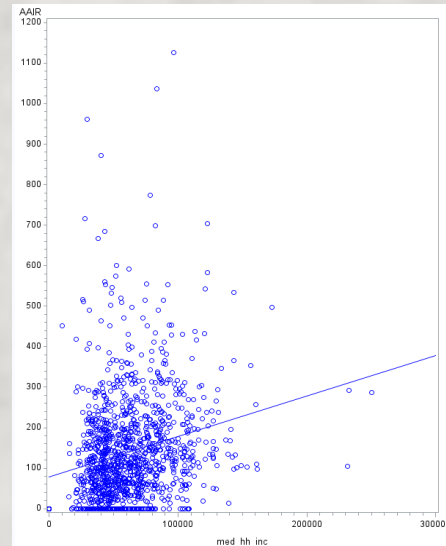
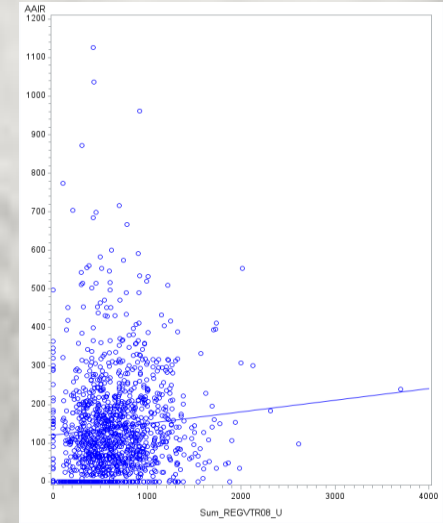
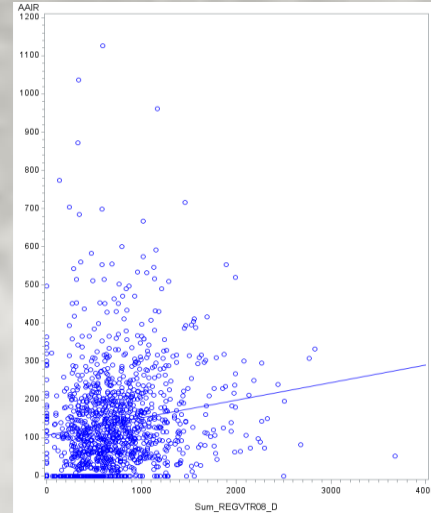
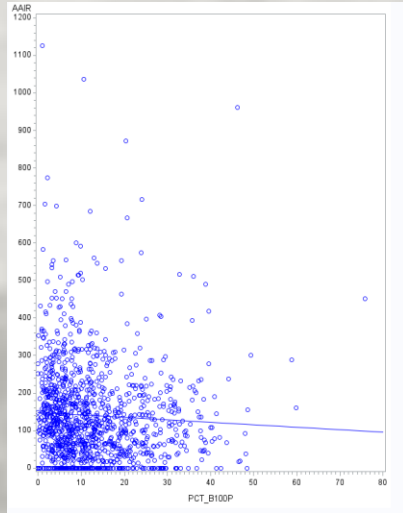
Pearson's Correlation Coefficients

AAIR	white_nh	black_nh	asian_nh	hispanic	bachl_hghr	med_hh_inc	citz_nat	PCT_B100P	Sum_REGVTR 08_D	Sum_REGV TR08_U
1	0.07326	-0.07233	0.07106	-0.05974	0.16428	0.21671	0.04772	-0.05206	0.15597	0.08794
	<i>0.0096</i>	<i>0.0106</i>	<i>0.012</i>	<i>0.0348</i>	<i><.0001</i>	<i><.0001</i>	<i>0.0919</i>	<i>0.0659</i>	<i><.0001</i>	<i>0.0019</i>

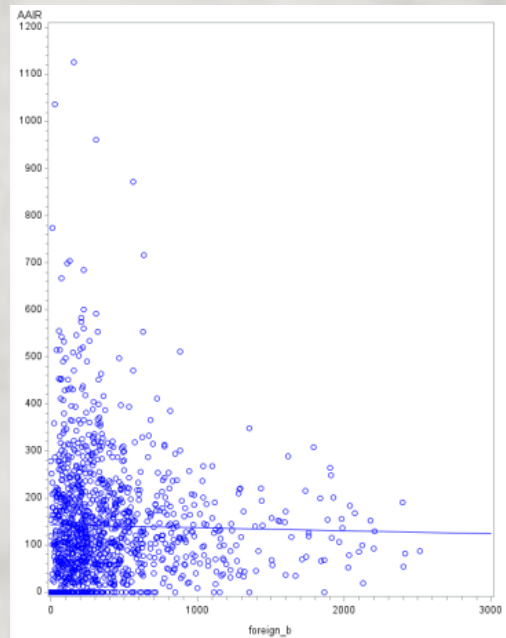
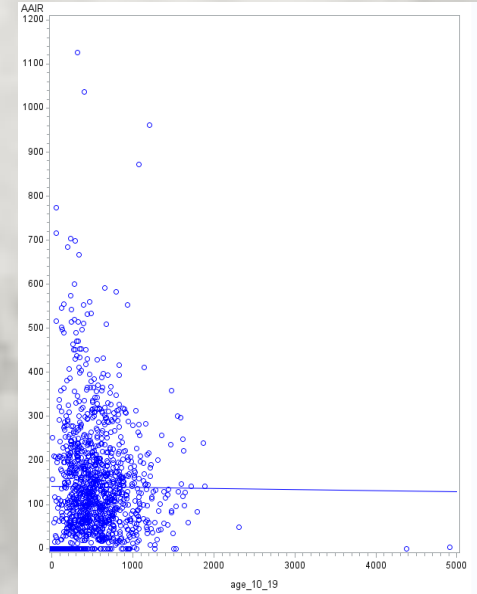
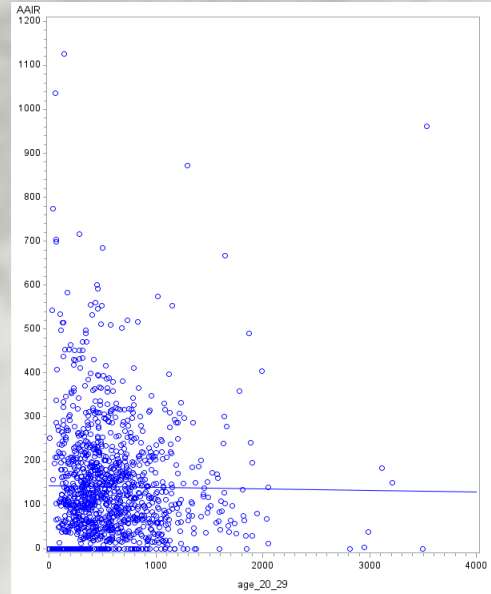
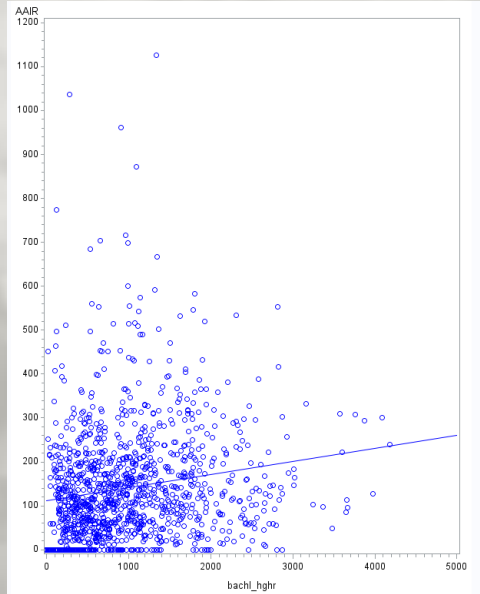
Graphing Variable Relationships



Graphing Variable Relationships



Graphing Variable Relationships



Goodness of Fit Model

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Deviance	1239	1531.8119	1.2363
Scaled Deviance	1239	1531.8119	1.2363
Pearson Chi-Square	1239	718.1212	0.5796
Scaled Pearson X2	1239	718.1212	0.5796
Log Likelihood		759265.1383	
Full Log Likelihood		-7313.4598	
AIC (smaller is better)		14648.9197	
AICC (smaller is better)		14649.1331	
BIC (smaller is better)		14705.3508	

Analysis Of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	3.6737	0.2055	3.2708	4.0765	319.46	<.0001
white_nh	1	0.0001	0.0001	-0.0000	0.0002	1.02	0.3113
black_nh	1	-0.0004	0.0001	-0.0006	-0.0001	9.85	0.0017
asian_nh	1	0.0003	0.0003	-0.0003	0.0009	0.97	0.3244
hispanic	1	-0.0000	0.0001	-0.0001	0.0001	0.61	0.4338
bachl_hghr	1	-0.0001	0.0001	-0.0003	0.0001	0.93	0.3342
med_hh_inc	1	0.0000	0.0000	0.0000	0.0000	35.05	<.0001
PCT_B100P	1	0.0191	0.0051	0.0091	0.0291	14.07	0.0002
Sum_REGVTR08_D	1	0.0009	0.0002	0.0005	0.0012	25.48	<.0001
Sum_REGVTR08_U	1	-0.0007	0.0002	-0.0012	-0.0003	11.27	0.0008
Dispersion	1	1.4779	0.0583	1.3679	1.5967		

Re-run with Repeat Statement Order

GEE Fit Criteria	
QIC	-2619956.998
QICu	-2619954.309

Analysis Of GEE Parameter Estimates						
Empirical Standard Error Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	3.6737	0.1389	3.4014	3.9459	26.45	<.0001
white_nh	0.0001	0.0000	-0.0000	0.0001	1.47	0.1404
black_nh	-0.0004	0.0001	-0.0005	-0.0002	-4.56	<.0001
asian_nh	0.0003	0.0002	-0.0000	0.0006	1.79	0.0739
hispanic	-0.0000	0.0000	-0.0001	0.0000	-1.22	0.2237
bachl_hghr	-0.0001	0.0001	-0.0003	0.0000	-1.53	0.1268
med_hh_inc	0.0000	0.0000	0.0000	0.0000	9.89	<.0001
PCT_B100P	0.0191	0.0040	0.0112	0.0270	4.72	<.0001
Sum_REGVTR08_D	0.0009	0.0001	0.0007	0.0011	8.37	<.0001
Sum_REGVTR08_U	-0.0007	0.0001	-0.0010	-0.0004	-4.96	<.0001

Drop: WHITE_NH, ASIAN_NH , HISPANIC, BACHL_HGHR



FINAL MODEL

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Deviance	1243	1531.7886	1.2323
Scaled Deviance	1243	1531.7886	1.2323
Pearson Chi-Square	1243	720.3770	0.5795
Scaled Pearson X2	1243	720.3770	0.5795
Log Likelihood		759264.0567	
Full Log Likelihood		-7314.5414	
AIC (smaller is better)		14643.0829	
AICC (smaller is better)		14643.1731	
BIC (smaller is better)		14678.9936	

Analysis Of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	3.7484	0.1823	3.3910	4.1058	422.61	<.0001
black_nh	1	-0.0004	0.0001	-0.0006	-0.0001	10.53	0.0012
med_hh_inc	1	0.0000	0.0000	0.0000	0.0000	42.97	<.0001
PCT_B100P	1	0.0175	0.0048	0.0081	0.0269	13.31	0.0003
Sum_REGVTR08_D	1	0.0008	0.0001	0.0005	0.0011	27.46	<.0001
Sum_REGVTR08_U	1	-0.0006	0.0002	-0.0009	-0.0003	13.22	0.0003
Dispersion	1	1.4803	0.0584	1.3702	1.5993		

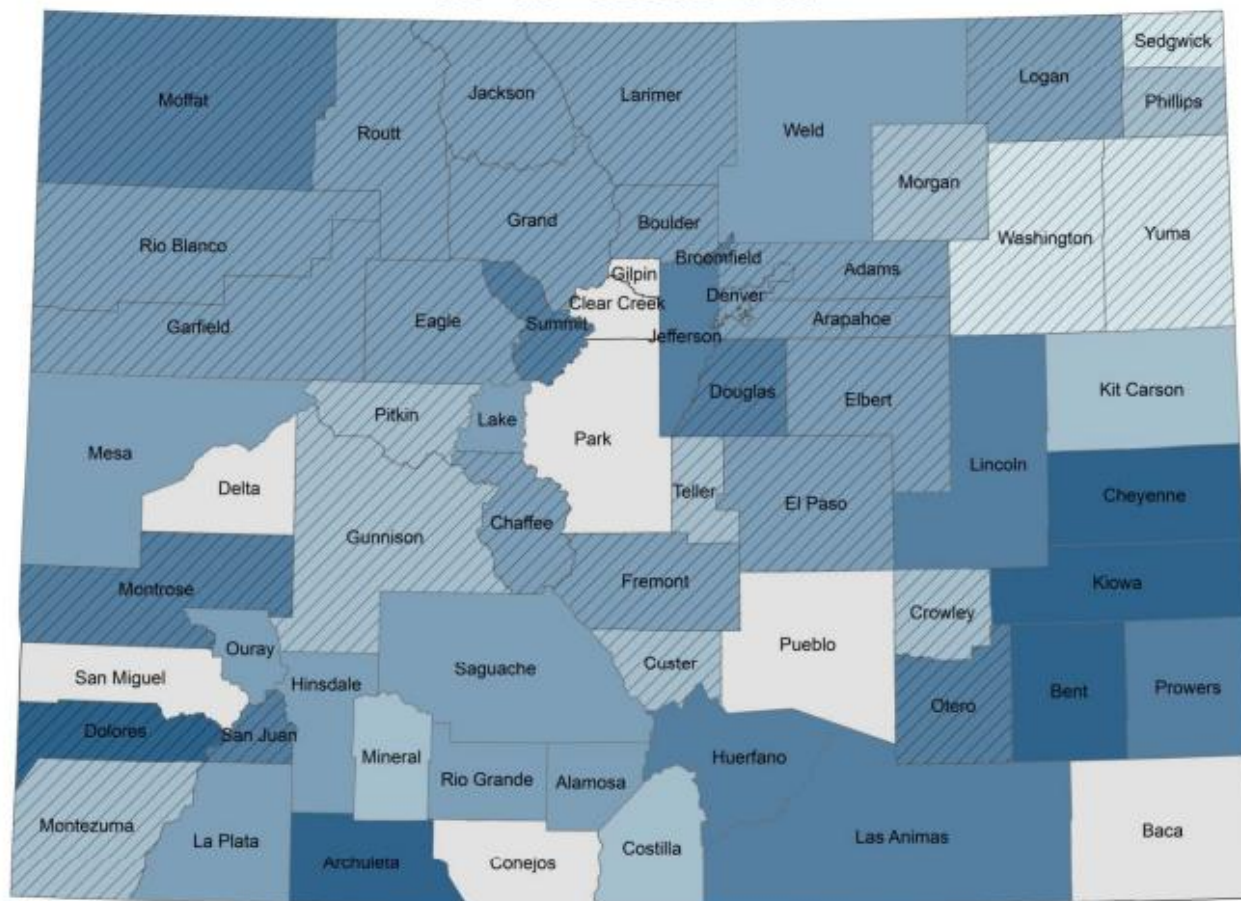


Null Model (No Variables)

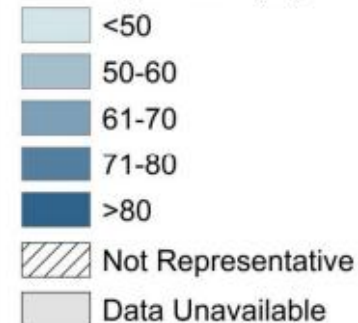
Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Deviance	1248	1531.2715	1.2270
Scaled Deviance	1248	1531.2715	1.2270
Pearson Chi-Square	1248	688.7962	0.5519
Scaled Pearson X2	1248	688.7962	0.5519
Log Likelihood		759223.4161	
Full Log Likelihood		-7355.1821	
AIC (smaller is better)		14714.3641	
AICC (smaller is better)		14714.3737	
BIC (smaller is better)		14724.6243	

Analysis Of Maximum Likelihood Parameter Estimates							
Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept	1	4.9453	0.0356	4.8755	5.0150	19304.7	<.0001
Dispersion	1	1.5751	0.0614	1.4593	1.7002		

Tdap 13-17 Years Old



County Immunization Coverage Level (%)



Average Coverage Level

CO: 90%
US: 88%
Health People
2020 Goal: 80%

Date Created: October, 2015

Data Source: Colorado Immunization Information System



COLORADO
Department of Public
Health & Environment