Iowa County-level Vulnerability Assessments for Risk of Opioid Overdoses and Rapid Dissemination of HIV and Hepatitis C

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Acknowledgements

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Report Main Body

Summary

This report summarizes the development of county-level vulnerability assessments for risk of opioid overdoses and rapid dissemination (i.e., outbreaks) of human immunodeficiency virus (HIV) and hepatitis C virus (HCV) infection. The analysis was completed in two parts as follows: 1) a vulnerability assessment for risk rapid dissemination of HIV and HCV infections; and 2) a vulnerability assessment for risk of opioid overdoses. This work was funded by a grant from the Centers for Disease Control and Prevention as part of the Opioid Prevention in States – Surge Support (OPIS – S2) Cooperative Agreement for Emergency Response.

PART 1 – Vulnerability risk of an HIV / HCV outbreak

BACKGROUND

The well-documented HIV outbreak in Scott County, Indiana, between 2014 and 2015 was ultimately demonstrated to have been caused by sharing of needles and injection equipment by people who were injecting oxymorphone (Opana). Of the now over 200 people diagnosed with HIV during that outbreak, 92% were also diagnosed with HCV. Research since the outbreak has concluded that it could have been prevented had health officials acted on warnings sooner (Gonsalves & Crawford, 2018). The belated response came after the peak of the epidemic, and likely had little effect on its trajectory.

With concern that this type of outbreak could occur elsewhere in the U.S., the CDC developed a vulnerability index to identify other counties at similar risk of rapid dissemination of HIV and HCV infections (Van Handel, et al., 2016). The index included variables that were associated with acute HCV infection and injection drug use, including racial makeup of the population, socioeconomic factors, drug overdose rates, prescription opioid sales (measured as the morphine milligram equivalent [MME]), and buprenorphine-prescribing capacity of providers in the county. Only variables with data available for all U.S. counties were included. Once the researchers developed an index, they calculated a vulnerability score for each county, and ranked counties accordingly. Among the 220 U.S. counties identified by CDC as the most vulnerable, none was in Iowa. However, county-level data available to the CDC was significantly limited. For example, HCV diagnoses were not included, since many states do not conduct hepatitis C surveillance. Since the release of the CDC vulnerability index study, several states have conducted their own vulnerability assessments using local data and found additional counties at risk and/or significantly different relative rankings of counties from CDC (Rickles, et al., 2018).

To identify the relative risk of county-level vulnerability to rapid dissemination of HCV or HIV and to opioid overdoses, the Iowa Department of Public Health (IDPH) contracted with the Center for Disease Analysis Foundation (CDAF) to develop a county-level vulnerability index assessment for Iowa.

METHODS

Dependent variable selection

County-level vulnerability to rapid dissemination of HIV or HCV was indicated by the number of newly diagnosed cases of chronic HCV in 2016. Due to changes in case definitions and few reports of acute hepatitis C infection, acute case data were not available for Iowa counties in 2016. Chronic cases of HCV in all ages were used as a proxy for all incident cases in the state. For the regression model, the dependent

variable was modeled as the rate of all HCV cases per 100,000 population.To ensure the most representative model results, counts of all HCV cases, as well as counts and the rate of HCV in the population under the age of 40 (as a proxy for more recent infection), were explored as alternative dependent variables. The rate of all HCV cases (all ages) was chosen as the dependent variable as there were more data available (versus among those less than the age of 40) and the number of diagnoses per 100,000 population allowed for the weighting of population centers (versus unweighted count data).

Independent variable selection

Fifty-three county-level variables were identified as possible predictors of rapid HIV or HCV dissemination (defined as two or more associated cases of disease). The variables were chosen based on previous studies and based on availability of county-level data in Iowa (Van Handel, et al., 2016; Rickles, et al., 2018). All count data were transformed into counts per 100,000 persons based on the population size of each county. Because of the large number of potential predictor variables (n=53), there were three different dimension-reduction techniques used to reduce inter-correlation and explained variance. Variables were reduced by 1) empirical review, 2) variance test, and 3) correlation test.

All 53 of the initial variables (Tables 1a – 1c) were characterized into three groups with subcategories:

1. Socioeconomic and demographic factors
2. Health-related factors
3. Substance abuse disorders

Table 1a. Possible Predictor Variables: Socioeconomic and Demographic Factors

Demographic	Urbanization	Housing	Crime	Income
▪ Total population[1] ▪ Population ages 18-29[1] ▪ Non-Hispanic White population[1] ▪ Population decline since 2010[1] ▪ Never married[1] ▪ Church adherents[2] ▪ No high school diploma[1] ▪ Female head of household[1]	▪ Population per square mile[1] ▪ Urban-rural classification[4] ▪ Homes with no phone service[1]	▪ Total housing units[1] ▪ Occupied housing units[1] ▪ Vacant housing units[1] ▪ Mobile homes[1] ▪ Crowded housing units[1]	▪ Drug trafficking 'hot zone'[5] ▪ Crimes against persons ▪ Crimes against property[6] ▪ Crimes against society[6]	▪ Vehicle access[1] ▪ Per capita income[1] ▪ People living in poverty[1] ▪ Unemployed[1] ▪ Gini coefficient[1]

Table 1b. Possible Predictor Variables: Health-Related

Access to Care	Health Outcome
▪ Mental health providers[7] ▪ Uninsured[1] ▪ Urgent care facilities[8] ▪ Primary care providers[3] ▪ Specialty care providers[3] ▪ Drug coalitions[12] ▪ Methadone clinics[13] ▪ Buprenorphine providers[14]	▪ Premature deaths[9] ▪ Adults reporting poor/fair health[9] ▪ Poor physical health days[9] ▪ Poor mental health days[9] ▪ Injury-related deaths[9] ▪ Adult smokers[9] ▪ Teen births[1] ▪ Disabled population[1] ▪ HIV incidence[10] ▪ HIV cases due to injection drug use (IDU)[10] ▪ Sexually transmitted disease (STD) cases[11] ▪ Syphilis cases[11]

Table 1c. Possible Predictor Variables: Substance Abuse Disorders

Usage	Deaths
▪ Morphine milligram equivalent (MME) for all drugs[15] ▪ MME for medication assisted treatment[15] ▪ Nonfatal overdoses, all drugs[16] ▪ Nonfatal overdoses, narcotics[16] ▪ Nonfatal overdoses, psychotropics[16] ▪ Drug treatment admission[17]	▪ Deaths related to all drugs[18] ▪ Deaths related to opioid and heroin[18]

[1]U.S. Census Bureau (2018)
[2]Association of Religious Data Archive (2018)
[3]Iowa Health Professions Tracking Center (2019)
[3]Iowa Department of Public Health
[4]U.S. DHHS, CDC (2017)
[5]U.S. Department of Justice (2018)
[6]Iowa Department of Public Safety (2018)
[7]U.S. DHHS, CMS (2014)
[8]Department of Homeland Security (2017)
[9]Robert Wood Johnson Foundation (2018)

[10]IDPH, Bureau of HIV, STD, & Hepatitis (2018a)
[11]IDPH, Bureau of HIV, STD, & Hepatitis (2018b)
[12]IDPH, Bureau of Substance Abuse (2019a)
[13]IDPH, Bureau of Substance Abuse (2019b)
[14]U.S. DHHS, SAMHSA (2019)
[15]IDPH, Bureau of Substance Abuse (2019c)
[16]IDPH, Bureau of Substance Abuse (2018a)
[17]IDPH, Bureau of Substance Abuse (2018b)
[18]IDPH, Bureau of Vital Statistics (2018)

An empirical review was conducted by a panel of local experts, including people from harm reduction organizations, academia, law enforcement, public health, and other state governmental agencies. The group discussed variables that were not good predictors or could be better explained by other measures. They then voted on variables that should be kept in the analysis. Surveyed variables that received no votes for inclusion were automatically removed. Following the empirical review, 38 variables remained.

The 38 remaining variables were then assessed for variance of data across counties. The purpose of assessing for variance was to determine whether the data for some variables varied enough across counties to be useful in the analysis. Using the Microsoft Excel® (version 365) variance function, any variable with a variance equal to zero was removed; 10 variables were removed using this method. This reduced the number of variables to 28.

Next, the dependence of the 28 variables was tested using a correlation matrix. In variable pairs that were highly correlated (correlation coefficient ≥0.7 or ≤-0.7), one variable in each pair was removed based on discussions with the Iowa Department of Public Health (IDPH). The correlation matrix is shown in Appendix A; three additional variables were removed. This reduced the number of variables to 25.

Regression analysis

The 25 remaining variables were used to model HCV diagnosis rates by county as a proxy for the vulnerability to rapid dissemination of HIV and HCV. Of the 25 variables, 17 were found to be statistically significant in the Poisson regression model. Following the CDC methodology, a parsimonious model (meaning a simple model with the best predictive power) was found using a backwards stepwise regression procedure (Van Handel, et al., 2018). The purpose of this procedure is to reduce the number of predictors by eliminating one variable at a time to determine which remaining variables best predict the outcome. All non-statistically significant variables were removed and then added back individually, retaining variables only at the P < 0.05 level. The regression model was built using the fit model functionality in JMP® 14. The results of the regression model are shown in Table 2, and Appendices C through V show the values of each of the 17 variables for each county.

Table 2. Results of the Generalized Linear Model – Poisson Distribution, 17 Variables

Variable	Coefficient Estimate	Standard Error	P – value
Female head of household /100,000	-0.00012	3.67E-05	0.00115
Mobile homes / 100,000 pop.	6.18E-05	1.46E-05	0.00003
Crimes against property / 100,000 pop.	0.00014	1.76E-05	0
Percent unemployed (adult population)	-0.09144	0.02847	0.00122
Mental health providers / 100,000 pop.	0.01457	0.0029	0
Primary care providers / 100,000 pop.	-0.00752	0.0009	0
Methadone clinics / 100,000 pop.	0.05221	0.0141	0.00032
Premature deaths / 100,000 pop.	0.00119	0.00025	0
Percent of the adult population that smokes	1.68098	0.45299	0.00019
HIV cases due to injection drug use / 100,000 pop.	0.01994	0.00643	0.00259
Syphilis cases / 100,000 pop.	0.01398	0.00316	0.00001
Non-fatal overdoses, all drugs / 100,000 pop.	0.00532	0.00068	0
Non-fatal overdose, psychotropics/ 100,000 pop.	-0.00601	0.00163	0.0002
Drug treatment admissions / 100,000 pop.	0.00076	0.00017	0.00001
Vacant housing units / 100,000 pop.	3E-05	1.02E-05	0.00375
Uninsured / 100,000 pop.	-0.01804	0.00855	0.03266
STD cases / 100,000 pop.	0.00031	0.00014	0.0266

The coefficient estimate is a value to describe the relationship between the predictor variable and the outcome. The standard error is an estimate of the standard deviation of the coefficient. It is a measure of precision.

Index scoring

The vulnerability of each county in Iowa was calculated using the regression coefficients (β) and observed variable values (X) for each county in the following equation:

$$Score_j = \beta_1 X_1 + \cdots + \beta_p X_p$$

Counties were ranked from 1 to 99, with lower scores indicating a higher vulnerability. Scores for each county can be found in Appendix B.

To account for uncertainty in this analysis, SAS® (Studio 3.8) was used to simulate 95% confidence intervals (CI) for each county's rank. This was done using random and weighted population distributions and regression coefficients from the analysis. There were 10,000 samples drawn and vulnerability ranking was calculated for each county. These observations were then aggregated and ranked, generating 95% confidence intervals.

RESULTS

Seventeen variables were found to be statistically significant ($P < 0.05$) based on the Poisson regression model. After accounting for uncertainty, the relative vulnerability rankings of all Iowa counties can be found in Table 3, where the top ranked counties have been identified as those with the highest vulnerability to rapid dissemination of HIV or HCV. Figure 1 displays the same data in a map view.

Of the top 11 most vulnerable counties (there was a tie for #10), four are among the 10 most populous counties in Iowa (Pottawattamie, Polk, Woodbury, and Scott). However, the top four most vulnerable counties do not contain large metropolitan areas, and all have fewer than 40,000 county residents. Appanoose County in south central Iowa had a population of 12,352 in 2017.

Unlike in some other states, no arbitrary level of vulnerability was selected for counties. The counties are ranked on a continuum. Further study may be warranted to determine the most important or influential variables in each of the counties. These variables are the so-called "social determinants of health" that underlie many poor health conditions. Crime, lack of affordable housing, unemployment, and the lack of availability of primary care and mental health providers were the most important predictors of hepatitis C diagnoses in Iowa (see Table 2).

Table 3. HIV/HCV Vulnerability Ranking of Iowa Counties

Rank	County	Rank	County	Rank	County
1	Wapello	34a	Buchanan	66b (tie)	Butler
2	Appanoose	34b (tie)	Jackson	68	Calhoun
3	Des Moines	36	Tama	69	Humboldt
4	Lee	37a	Adair	70a	Clayton
5	Pottawattamie	37b (tie)	Hardin	70b	Poweshiek
6	Webster	39a	Louisa	70c (tie)	Floyd
7	Polk	39b	Clay	73	Delaware
8	Clinton	39c (tie)	Fayette	74a	Kossuth
9	Woodbury	42	Mills	74b	Plymouth
10a	Scott	43a	Van Buren	74c	Ringgold
10b (tie)	Greene	43b (tie)	Muscatine	74d (tie)	Hamilton
12	Jasper	45a	Warren	78	O'Brien
13	Clarke	45b (tie)	Allamakee	79a	Bremer
14	Mahaska	47	Monona	79b (tie)	Cedar
15	Linn	48	Dickinson	81	Osceola
16a	Cerro Gordo	49	Palo Alto	82	Howard
16b (tie)	Lucas	50	Henry	83	Winneshiek
18	Black Hawk	51a	Marion	84a	Washington
19a	Cass	51b	Winnebago	84b (tie)	Buena Vista
19b (tie)	Marshall	51c (tie)	Crawford	86	Sac
21	Monroe	54a	Taylor	87	Guthrie
22	Pocahontas	54b	Dubuque	88	Wayne
23a	Harrison	54c	Decatur	89	Iowa
23b (tie)	Fremont	54d (tie)	Story	90	Carroll
25	Johnson	58	Emmet	91	Shelby
26a	Montgomery	59	Jones	92	Chickasaw
26b	Page	60	Cherokee	93	Ida
26c (tie)	Jefferson	61	Adams	94	Lyon
29a	Union	62a	Hancock	95	Franklin
29b (tie)	Worth	62b (tie)	Madison	96a	Mitchell
31	Boone	64	Wright	96b (tie)	Dallas
32a	Audubon	65	Benton	98	Davis
32b (tie)	Keokuk	66a	Grundy	99	Sioux
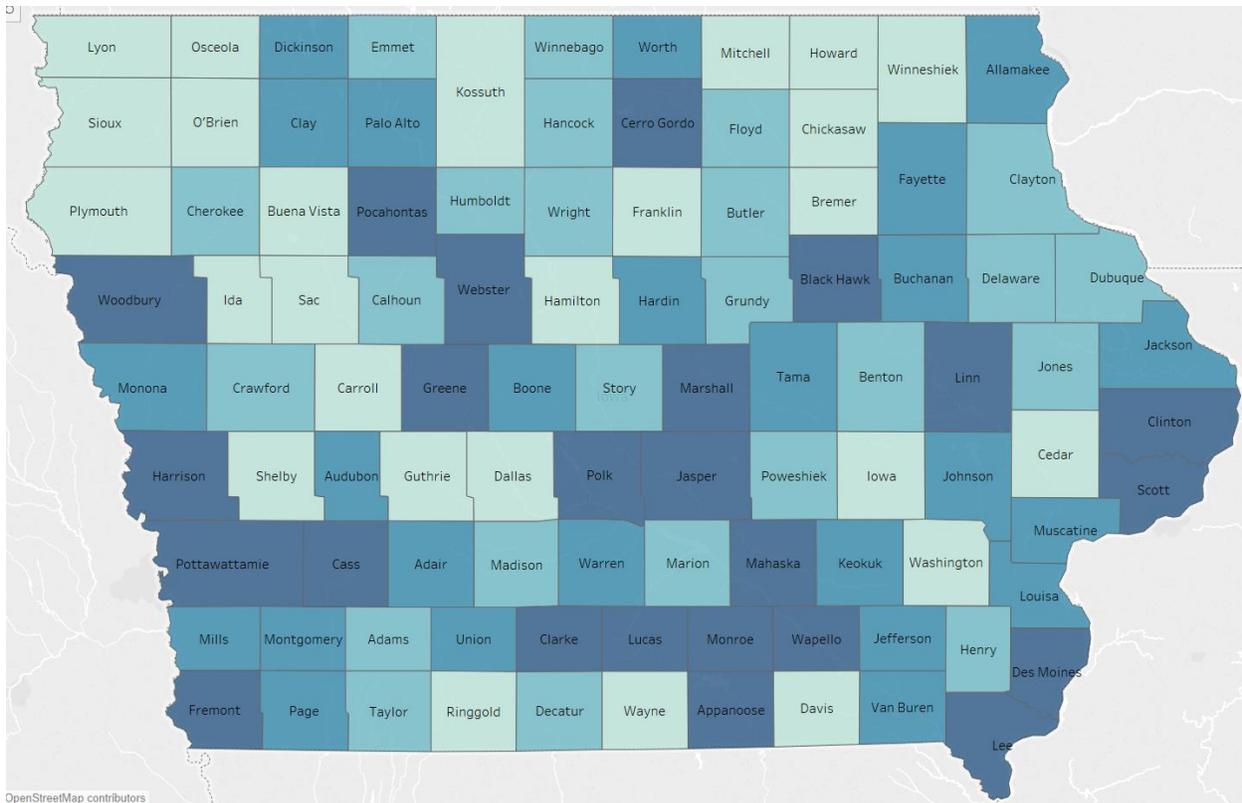
Figure 1. Map of HIV/HCV Vulnerability Ranking of Iowa Counties. Darker blue indicates higher vulnerability.

PART 2 – Vulnerability assessment for risk of opioid overdoses

METHODS

Variable Selection

Due to limitations in the data, the vulnerability index for the risk of opioid overdoses was developed using the average rankings method. This method uses no dependent variable, and weights each of the chosen independent variables equally. Based on recommendations from the Council of State and Territorial Epidemiologists, one variable from the previously described list of 53 indicators was chosen from each of the following categories: socioeconomics, crime, prescriptions, and mortality. The variables chosen for this analysis were:

1. Socioeconomics – Percent of the population living in poverty
    IDPH expert consensus

2. Crime – Property crimes / 100,000 pop. persons
    Chosen to remain consistent with the HIV/HCV index

3. Prescriptions – Total MME of opioids / 100,000 pop. persons
    IDPH expert consensus

4. Mortality – Overdose deaths involving opioids / 100,000 pop.

IDPH expert consensus

First, each county was ranked from low to high independently in each of the four categories. The average of each of these four ranks was taken to calculate the final overall vulnerability rank. Counties were ranked from 1 to 99, with lower scores indicating a higher vulnerability.

RESULTS

The vulnerability of Iowa counties to opioid overdoses can be found in Table 4, where the top ranked (most vulnerable) counties have been identified. Figure 2 displays the same data in a map view.

Six of the top 10 Iowa counties most vulnerable to opioid overdoses were also identified in the top 10 counties vulnerable to rapid dissemination of HIV and HCV (Wapello County, Appanoose County, Des Moines County, Lee County, Pottawattamie County, Polk County and Clinton County). This indicates a good alignment in the two different methodologies. Other counties included Jefferson, Montgomery, Cerro Gordo and Johnson.

Table 4. Opioid Overdose Vulnerability Ranking of Iowa Counties

Rank	County	Rank	County	Rank	County
1	Lee	34	Monona	67	Poweshiek
2	Des Moines	35	Van Buren	68	Adair
3	Jefferson	36	Marion	69	Ringgold
4	Wapello	37	Allamakee	70	Bremer
5	Montgomery	38	Madison	71	Tama
6	Cerro Gordo	39	Fayette	72	Kossuth
7	Appanoose	40	Linn	73	Adams
8	Johnson	41	Mills	74	Jones
9	Clinton	42	Buena Vista	75	Delaware
10	Polk	43	Greene	76	Pocahontas
11	Clarke	44	Plymouth	77	Louisa
12	Union	45	Henry	78	Dallas
13	Woodbury	46	Osceola	79	Guthrie
14	Pottawattamie	47	Audubon	80	O'Brien
15	Scott	48	Humboldt	81	Buchanan
16	Dubuque	49	Monroe	82	Winnebago
17	Black Hawk	50	Warren	83	Iowa
18	Decatur	51	Fremont	84	Keokuk
19	Story	52	Wayne	85	Winneshiek
20	Harrison	53	Taylor	86	Benton
21	Emmet	54	Cherokee	87	Sioux
22	Boone	55	Jackson	88	Clayton
23	Webster	56	Franklin	89	Grundy
24	Calhoun	57	Crawford	90	Lyon
25	Jasper	58	Hamilton	91	Chickasaw
26	Mahaska	59	Muscatine	92	Washington
27	Cass	60	Wright	93	Shelby
28	Page	61	Davis	94	Hancock
29	Marshall	62	Hardin	95	Palo Alto
30	Clay	63	Howard	96	Sac
31	Carroll	64	Ida	97	Cedar
32	Floyd	65	Worth	98	Butler
33	Lucas	66	Dickinson	99	Mitchell
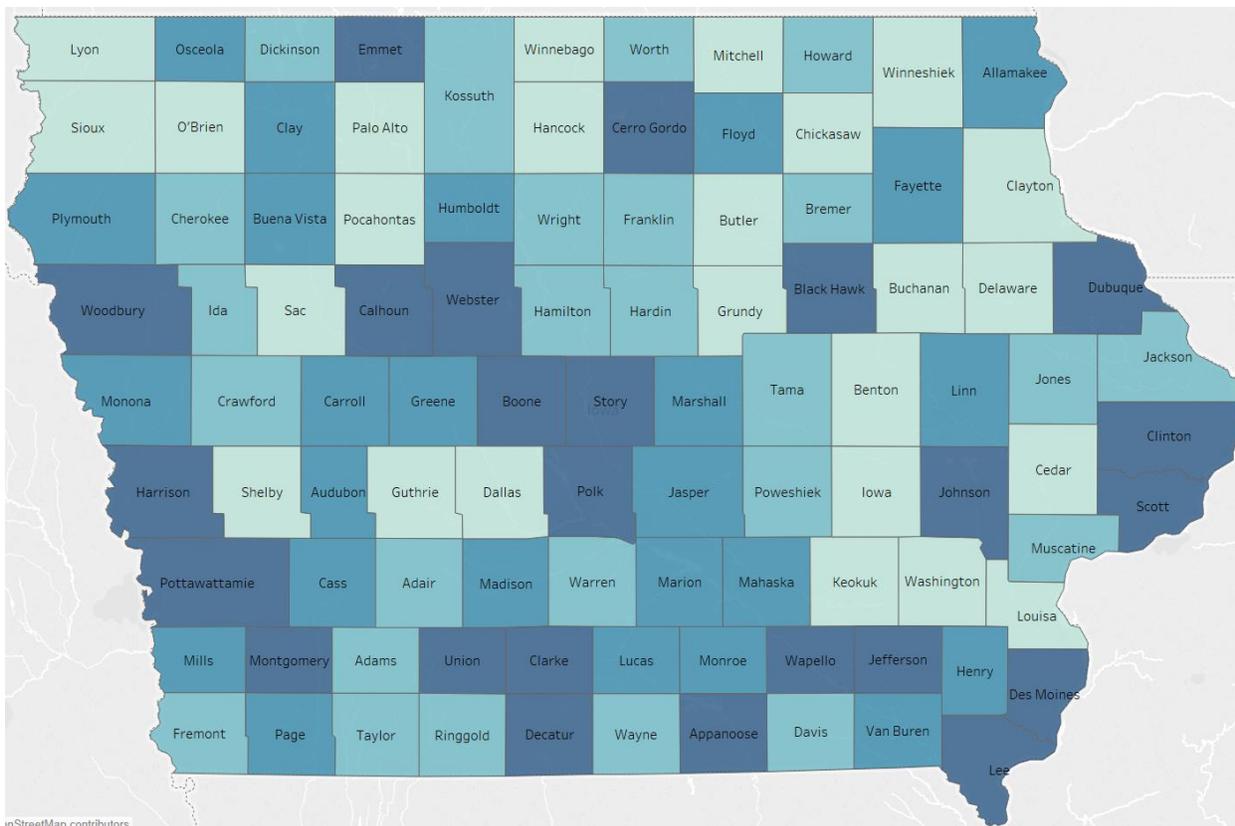
Figure 2. Map of Opioid Overdose Vulnerability Ranking of Iowa Counties. Darker blue indicates higher vulnerability.

DISCUSSION AND FOLLOW UP WITH COUNTIES

The primary goal of county-level HIV/HCV or opioid overdose vulnerability designation is to encourage state policy makers and community stakeholders to collaborate around prevention and response planning. While the variables utilized to determine such a designation have been used by other states and the CDC to identify indicators of social vulnerability, community feedback on the results is imperative to gain an "on-the-ground" perspective. To that end, IDPH hosted a series of community town hall meetings and invited key stakeholders to learn about the assessment and provide feedback on potential next steps for their respective counties.

Community town hall meetings were hosted in eight counties identified as most vulnerable to rapid dissemination of HIV or HCV, or to opioid overdoses. To date, meetings have been held in Des Moines, Wapello, Appanoose, Clinton, Polk, Webster, Scott, and Pottawattamie counties. Local public health staff, disease intervention specialists, harm reduction providers, emergency medical providers, law enforcement, substance use disorder treatment staff, local government leadership, and people directly impacted by substance use were all invited to attend the meetings. Attendees listened to a presentation by state health department staff outlining the findings from the assessments and a "state of the state" of drug user health service provision in the state. A stakeholder discussion was then facilitated to learn about activities around HIV, HCV, and opioid overdose prevention efforts existing in the respective county.

CONCLUSIONS

The Vulnerability Index Assessment component of the Opioid Prevention in States - Surge Support (OPIS-S2) funding opportunity presented states with the opportunity to use available local data to identify counties most at-risk for rapid dissemination of HIV and HCV, and for opioid overdoses among people who use and inject drugs. While the results of the vulnerability index assessment will be useful in determining direct resource allocation to counties in need of additional coordination and support, the assessment also builds on several activities currently being pursued at IDPH.

The vulnerability index assessment results will be especially useful in administering programs through CDC's *Overdose Data to Action* grant, which seeks to support states in the development of statewide data management systems to record instances of opioid overdose and subsequent follow-up and support service provision. This grant and the *State Opioid Response* grant from the Substance Abuse and Mental Health Services Administration (SAMHSA) will support the funding and selection of "Opioid Response Teams" that will be employed to provide direct intervention after an opioid overdose crisis. Selection of these teams will be prioritized in identified vulnerable counties.

The vulnerability index assessment results will also be used in IDPH's HIV and hepatitis strategic planning and programmatic planning efforts. As the state prepares to launch its own "Ending the HIV Epidemic" planning process, the assessment results will be used to highlight priority counties to address disparate distribution of HIV and hepatitis C. The findings may also impact future county-level funding formulas to prioritize funding to counties in highest need of additional support.

Bibliography

Association of Religious Data Archive (2018). U.S. Religion Census: Religious Congregations and Membership Study, 2010. Retrieved from http://www.thearda.com.

Gonsalves, G. S., & Crawford, F. W. (2018.) Dynamics of the HIV outbreak and response in Scott County, IN, USA, 2011-2015: A modelling study. *Lancet HIV, 5,* e569-77. http://dx.doi.org/10.1016/S2352-3018(18)30176-0.

Iowa Department of Public Health, Bureau of Health Statistics (2018). Overdose mortality. Unpublished raw data.

Iowa Department of Public Health, Bureau of HIV, STD, and Hepatitis (2018a). HIV incidence. Unpublished raw data.

Iowa Department of Public Health, Bureau of HIV, STD, and Hepatitis (2018b). STI incidence. Unpublished raw data.

Iowa Department of Public Health, Bureau of Substance Abuse (2018a). Nonfatal drug overdoses. Unpublished raw data.

Iowa Department of Public Health, Bureau of Substance Abuse (2018b). Drug treatment admissions. Unpublished raw data.

Iowa Department of Public Health, Bureau of Substance Abuse (2019a). Local drug coalitions in Iowa. Unpublished raw data.

Iowa Department of Public Health, Bureau of Substance Abuse (2019b). Methadone clinic locations. Unpublished raw data.

Iowa Department of Public Health, Bureau of Substance Abuse (2019c). Prescription monitoring program. Unpublished raw data.

Iowa Department of Public Safety (2018). Uniform Crime Reports. Retrieved from http://www.dps.state.ia.us/commis/ucr/.

Iowa Health Professions Tracking Center, Office of Statewide Clinical Education Programs (OSCEP), UI Carver College of Medicine (2019.) Retrieved April, 2019. Unpublished raw data.

Rickles, M., Rebeiro, P. F., Sizemore, L., Juarez, P., Mutter, M., Wester, C., & McPheeters, M. (2018.) Tennessee's in-state vulnerability assessment for a "rapid dissemination of human immunodeficiency virus or hepatitis C virus infection" event utilizing data about the opioid epidemic. *Clinical Infectious Diseases, 66*(11), 1722-32. https://www.ncbi.nlm.nih.gov/pubmed/29228122

Robert Wood Johnson Foundation County Health Rankings (2018). County health rankings: Iowa 2016. Retrieved from https://www.countyhealthrankings.org/app/iowa/2016/overview

U.S. Census Bureau (2018). American Community Survey. Retrieved from https://www.census.gov/programs-surveys/acs.

U.S. Department of Health and Human Services (DHHS), Centers for Disease Control and Prevention [CDC]. (2017). National Center for Health Statistics: NCHS urban-rural classification scheme for counties. Retrieved from https://www.cdc.gov/nchs/data_access/urban_rural.htm

U.S. Department of Health and Human Services [DHHS], Centers for Medicare & Medicaid Services [CMS]. (2014). National Provider Identification. Retrieved from https://www.cms.gov/Regulations-and-Guidance/Administrative-Simplification/NationalProvIdentStand/DataDissemination

U.S. Department of Health and Human Services [DHHS], Substance Abuse and Mental Health Services Administration [SAMHSA]. (2019.) Buprenorphine practitioner locator. Retrieved from https://www.samhsa.gov/medication-assisted-treatment/practitioner-program-data/treatment-practitioner-locator

U.S. Department of Homeland Security (2017). Homeland Infrastructure Foundation-Level Data (HIFLD): Urgent care facilities. Retrieved from https://hifld-geoplatform.opendata.arcgis.com/datasets/urgent-care-facilities

U.S. Department of Justice, Drug Enforcement Administration. (2018). Drug Enforcement Administration Programs: High Intensity Drug Trafficking Areas (HIDTAs). Retrieved from https://www.dea.gov/hidta.

Van Handel, M. M., Rose, C. E., Hallisey, E. J., Kolling, J. L., Zibbell, J. E., Lewis, B., Bohm, M. K., Jones, C. M., Flanagan, B. E., Siddiqi A. E., Igbal, K., Dent, A. L., Mermin, J. H., McCray, E., Ward, J. W., & Brooks, J. T. (2016.) County-level vulnerability assessment for rapid dissemination of HIV or HCV infections among persons who inject drugs, United States. Journal of Acquired Immune Deficiency Syndrome, 73(3): 322-331. https://www.ncbi.nlm.nih.gov/pubmed/27763996

Appendix A – Correlation Matrix of Variables Assessed for Variance between Iowa Counties

|	Non-hispanic white/100K	Percent with no high school diploma	Population per sq mile	Total Housing Units/100K	Vacant Housing Units/100K	Female head of household/100K	Mobile Homes/100K	Crimes against property/100K	Crimes against society/100K	Percent w/ vehicle access	Percent of people living in poverty	Percent unemployed	Rate of Mental Health Providers/ 100K	Percent Uninsured	Rate of Primary Care Providers / 100K	Methadone clinics/100K	Buprenorphine Providers/100K	Premature Deaths/100K	HIV/100,000	HIV - IDU related/100,000	STD rate/100,000	Syphilis rate/100,000	Total MME/100,000	Nonfatal Overdose, all drugs/100K	Nonfatal Overdose, narcotics/100K	Nonfatal Overdose, pyschotropics/100K	Treatment admission, primary total/100K	Drug Overdose deaths/100K
Non-hispanic white/100K	1.00																											
Percent with no high school diploma	-0.26	1.00																										
Population per sq mile	-0.56	-0.12	1.00																									
Total Housing Units/100K	0.41	-0.13	-0.28	1.00																								
Vacant Housing Units/100K	0.46	-0.25	-0.26	0.78	1.00																							
Female head of household/100K	-0.30	0.30	0.21	-0.04	0.03	1.00																						
Mobile Homes/100K	0.06	0.18	-0.11	0.32	-0.02	-0.09	1.00																					
Crimes against property/100K	-0.56	0.02	0.53	-0.20	-0.16	0.45	0.00	1.00																				
Crimes against society/100K	-0.36	-0.02	0.32	-0.13	-0.06	0.31	0.03	0.73	1.00																			
Percent w/ vehicle access	0.15	-0.26	-0.12	-0.08	-0.05	-0.33	-0.13	-0.37	-0.30	1.00																		
Percent of people living in poverty	-0.37	0.42	0.10	-0.06	-0.05	0.42	0.16	0.29	0.17	-0.61	1.00																	
Percent unemployed	-0.39	0.24	0.23	-0.13	-0.16	0.47	0.19	0.47	0.43	-0.37	0.46	1.00																
Rate of Mental Health Providers/ 100K	-0.45	-0.15	0.36	-0.20	-0.12	0.07	-0.06	0.36	0.30	-0.19	0.25	0.08	1.00															
Percent Uninsured	-0.05	0.54	-0.11	-0.01	-0.19	0.12	0.32	-0.04	-0.05	-0.52	0.48	0.11	-0.06	1.00														
Rate of Primary Care Providers / 100K	-0.24	-0.07	0.26	-0.01	-0.05	-0.03	-0.01	0.33	0.23	-0.28	0.13	0.00	0.43	0.05	1.00													
Methadone clinics/100K	0.01	-0.03	0.03	-0.07	0.04	0.06	-0.13	0.13	0.10	-0.13	0.07	-0.01	0.15	-0.18	0.26	1.00												
Buprenorphine Providers/100K	-0.02	0.15	-0.05	0.08	0.13	0.02	-0.03	0.04	0.06	-0.28	0.13	0.01	-0.05	0.07	0.16	0.04	1.00											
Premature Deaths/100K	0.18	0.16	-0.16	0.24	0.34	0.20	0.10	0.17	0.12	-0.25	0.27	0.29	-0.14	0.11	-0.01	0.08	0.22	1.00										
HIV/100,000	-0.56	0.12	0.66	-0.28	-0.27	0.38	0.00	0.61	0.45	-0.17	0.12	0.34	0.35	-0.01	0.28	0.00	0.05	-0.02	1.00									
HIV - IDU related/100,000	-0.01	-0.02	-0.02	0.01	0.04	0.03	-0.01	0.06	0.18	0.06	-0.04	-0.11	-0.04	-0.01	-0.07	-0.03	-0.08	-0.05		1.00								
STD rate/100,000	-0.61	0.12	0.57	-0.33	-0.34	0.47	-0.04	0.68	0.46	-0.32	0.41	0.45	0.43	0.07	0.20	0.09	0.03	0.05	0.03	0.03	1.00							
Syphilis rate/100,000	-0.43	0.10	0.42	-0.28	-0.33	0.16	-0.05	0.38	0.28	-0.05	0.15	0.38	0.24	0.02	0.15	-0.04	-0.12	0.03	0.00		0.45	1.00						
Total MME/100,000	-0.09	-0.11	0.17	0.10	0.16	0.20	0.07	0.53	0.42	-0.42	0.30	0.33	0.16	0.06	0.39	0.14	0.15	0.32	0.10		0.25	0.21	1.00					
Nonfatal Overdose, all drugs/100K	-0.04	0.05	0.16	0.00	0.00	0.17	0.13	0.38	0.19	-0.32	0.26	0.33	0.01	0.18	0.25	0.07	0.16	0.30	-0.03		0.25	0.16	0.42	1.00				
Nonfatal Overdose, narcotics/100K	-0.05	0.06	0.19	0.01	0.02	0.17	0.13	0.40	0.25	-0.36	0.26	0.33	0.02	0.20	0.23	0.01	0.13	0.18	-0.01		0.22	0.11	0.44	0.91	1.00			
Nonfatal Overdose, pyschotropics/100K	-0.01	0.01	0.02	-0.02	-0.02	0.09	0.06	0.13	-0.03	-0.06	0.12	0.16	-0.02	0.04	0.15	0.14	0.13	0.35	-0.04		0.18	0.16	0.14	0.62	0.23	1.00		
Treatment admission, primary total/100K	-0.20	0.19	0.08	0.09	0.17	0.41	-0.07	0.53	0.48	-0.40	0.34	0.41	0.13	0.11	0.10	0.12	0.12	0.33	0.04		0.40	0.21	0.57	0.22	0.26	0.02	1.00	
Drug Overdose deaths/100K	-0.08	0.02	0.12	0.00	0.03	0.11	0.02	0.18	0.15	-0.08	0.12	0.22	0.05	0.05	0.01	0.04	0.01	0.31	0.29	-0.10	0.13	0.03	0.07	0.16	0.05	0.28	0.15	1.00

Appendix B – Index Scores by County

County	Final Score	County	Final Score	County	Final Score
Wapello	8.74	Buchanan	7.13	Butler	6.78
Appanoose	8.32	Jackson	7.13	Calhoun	6.77
Des Moines	8.21	Tama	7.12	Humboldt	6.76
Lee	8.10	Adair	7.10	Clayton	6.72
Pottawattamie	8.01	Hardin	7.10	Poweshiek	6.72
Webster	7.95	Louisa	7.09	Floyd	6.72
Polk	7.86	Clay	7.09	Delaware	6.70
Clinton	7.85	Fayette	7.09	Kossuth	6.68
Woodbury	7.83	Mills	7.07	Plymouth	6.68
Scott	7.74	Van Buren	7.06	Ringgold	6.68
Greene	7.74	Muscatine	7.06	Hamilton	6.68
Jasper	7.68	Warren	7.02	O'Brien	6.67
Clarke	7.63	Allamakee	7.02	Bremer	6.66
Mahaska	7.62	Monona	7.01	Cedar	6.66
Linn	7.58	Dickinson	6.98	Osceola	6.64
Cerro Gordo	7.56	Palo Alto	6.97	Howard	6.62
Lucas	7.56	Henry	6.96	Winneshiek	6.61
Black Hawk	7.54	Marion	6.95	Washington	6.60
Cass	7.48	Winnebago	6.95	Buena Vista	6.60
Marshall	7.48	Crawford	6.95	Sac	6.60
Monroe	7.44	Taylor	6.94	Guthrie	6.59
Pocahontas	7.43	Dubuque	6.94	Wayne	6.58
Harrison	7.40	Decatur	6.94	Iowa	6.53
Fremont	7.40	Story	6.94	Carroll	6.52
Johnson	7.36	Emmet	6.93	Shelby	6.51
Montgomery	7.33	Jones	6.92	Chickasaw	6.49
Page	7.33	Cherokee	6.90	Ida	6.46
Jefferson	7.33	Adams	6.89	Lyon	6.44
Union	7.24	Hancock	6.87	Franklin	6.43
Worth	7.24	Madison	6.87	Mitchell	6.39
Boone	7.20	Wright	6.86	Dallas	6.39
Audubon	7.17	Benton	6.82	Davis	6.15
Keokuk	7.17	Grundy	6.78	Sioux	5.92

Appendix C –Variable – Female Heads of Household (Rates)
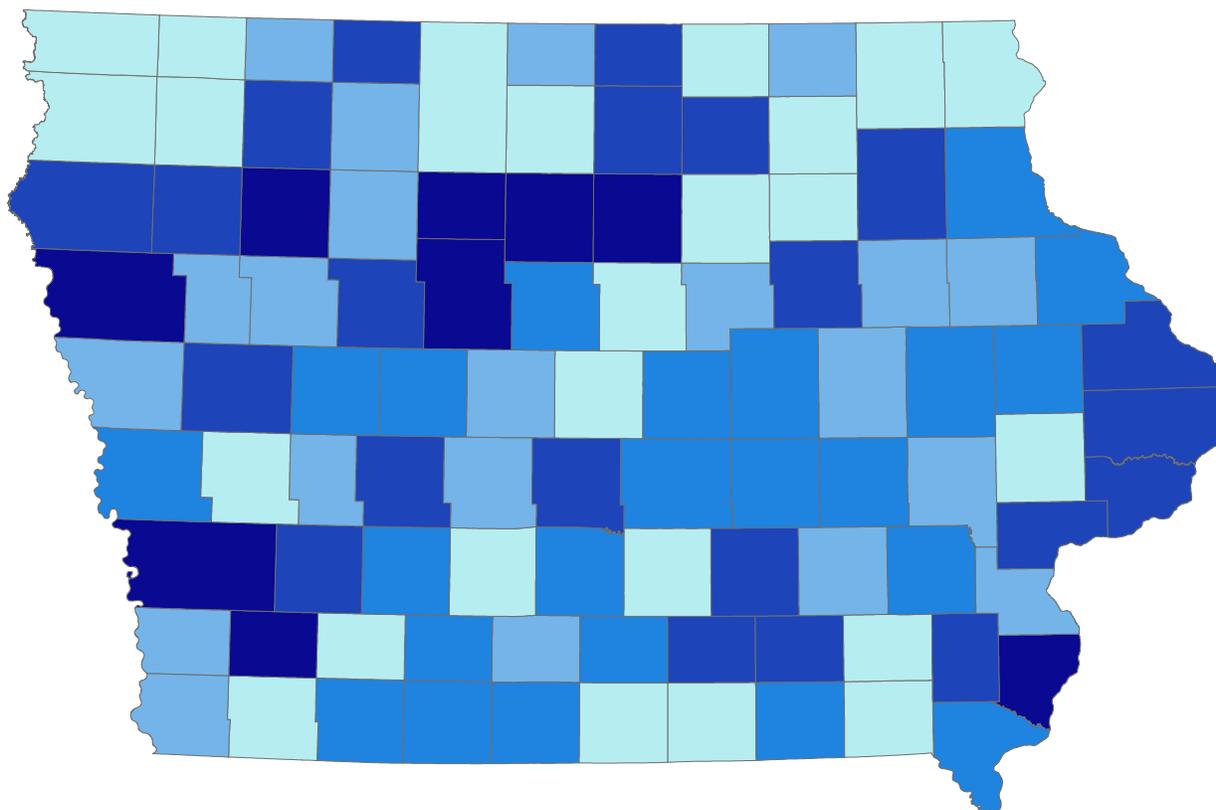
Female Head of Household/100K
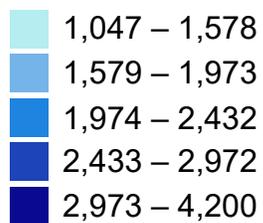
- 1,047 – 1,578
- 1,579 – 1,973
- 1,974 – 2,432
- 2,433 – 2,972
- 2,973 – 4,200

Jenks Natural Breaks Classification

Appendix D – Demographic– Mobile Homes (Rates)

Mobile homes/100K

- 190 – 1,010
- 1,011 – 1,868
- 1,869 – 3,061
- 3,062 – 5,031
- 5,032 – 7,228

Jenks Natural Breaks Classification

Property Crimes/100K

- 40 – 752
- 753 – 1,336
- 1,337 – 2,233
- 2,234 – 3,869
- 3,870 – 6,339
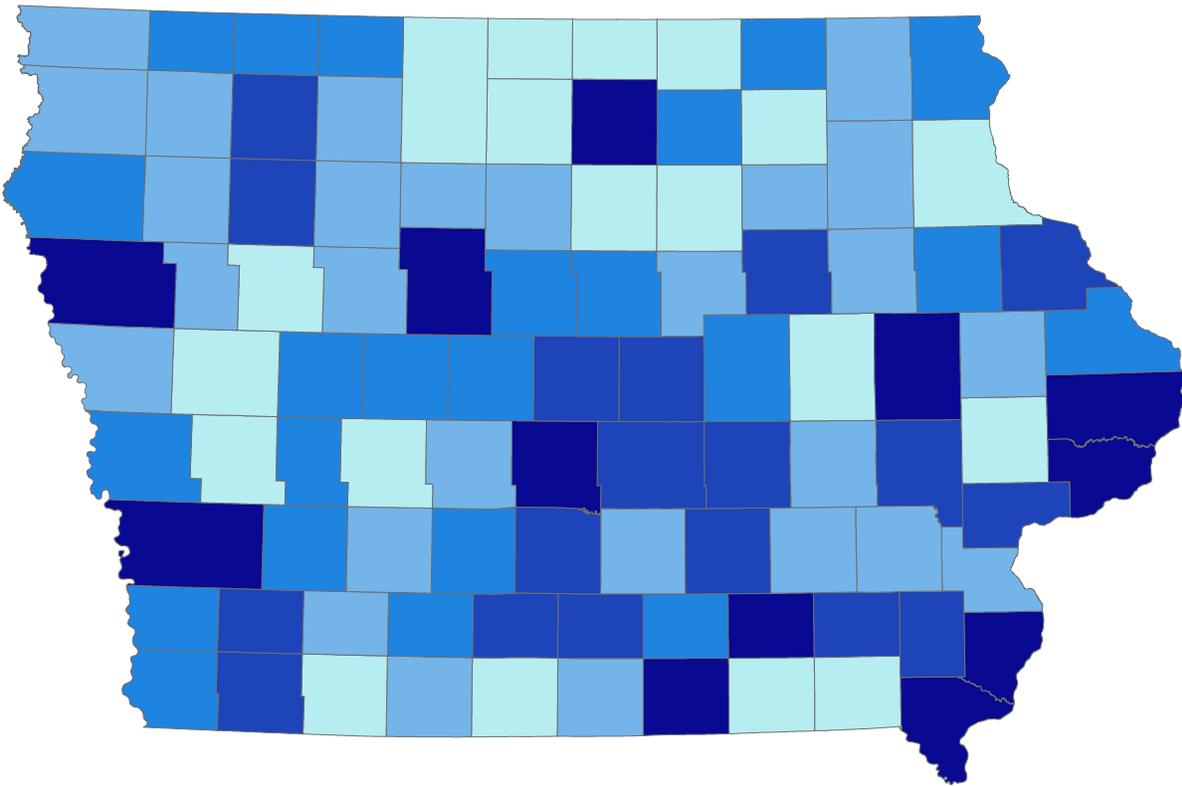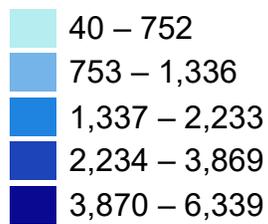
Jenks Natural Breaks Classification

Appendix F – Demographic– Unemployment (Percent)

Percent Unemployed (Adult)

- 1.1 – 1.9
- 2.0 – 2.6
- 2.7 – 3.2
- 3.3 – 4.0
- 4.1 – 5.2
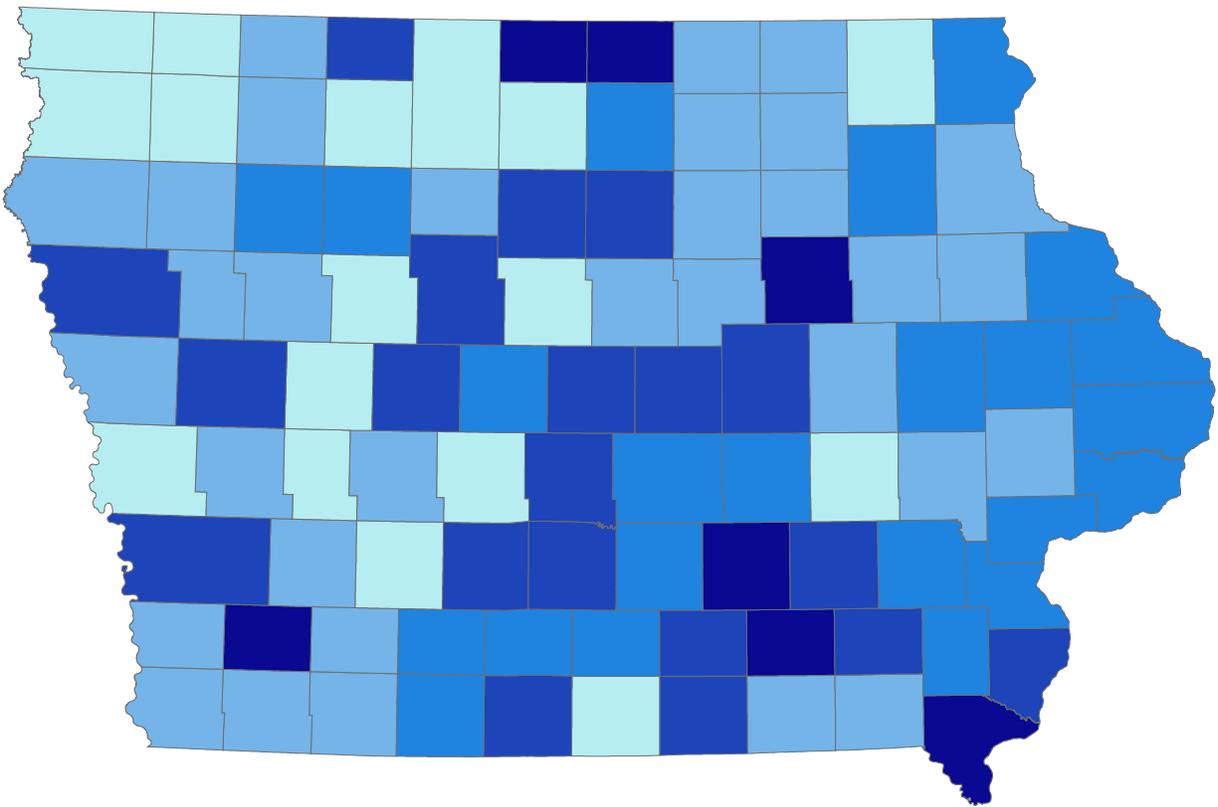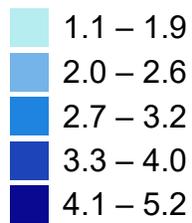
Jenks Natural Breaks Classification

Appendix G – Access to Care – Mental Health Providers (Rates)

**Mental Health
Providers/100K**

- 0.0 – 1.3
- 1.4 – 6.9
- 7.0 – 12.5
- 12.6 – 24.3
- 24.4 – 54.9
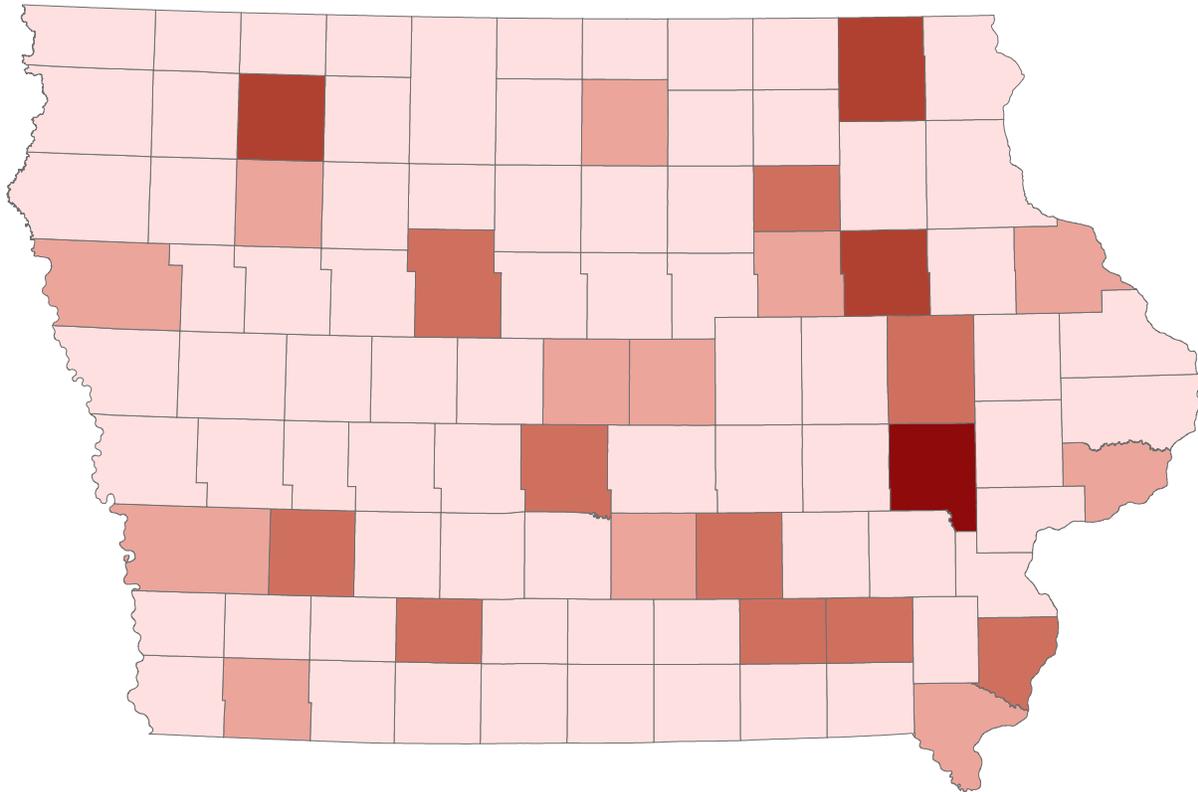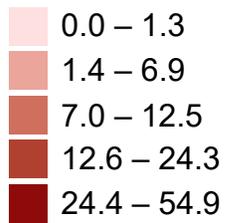
Jenks Natural Breaks Classification

Appendix H – Access to Care – Primary Care Providers (Rates)
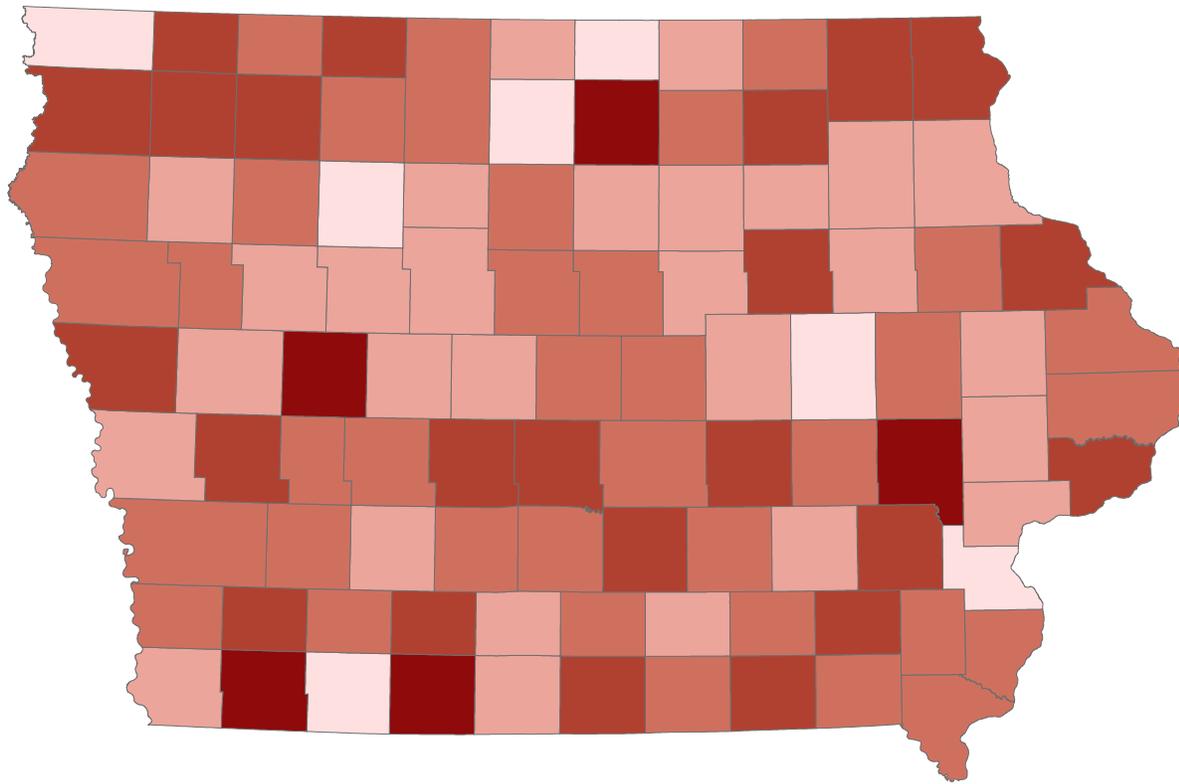
Primary Care Providers/100K
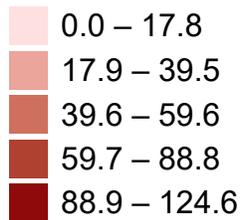
- 0.0 – 17.8
- 17.9 – 39.5
- 39.6 – 59.6
- 59.7 – 88.8
- 88.9 – 124.6

Jenks Natural Breaks Classification

Methadone Clinics/100K

- 0.0 – 0.2
- 0.3 – 1.0
- 1.1 – 2.1
- 2.2 – 3.0
- 3.1 – 7.5
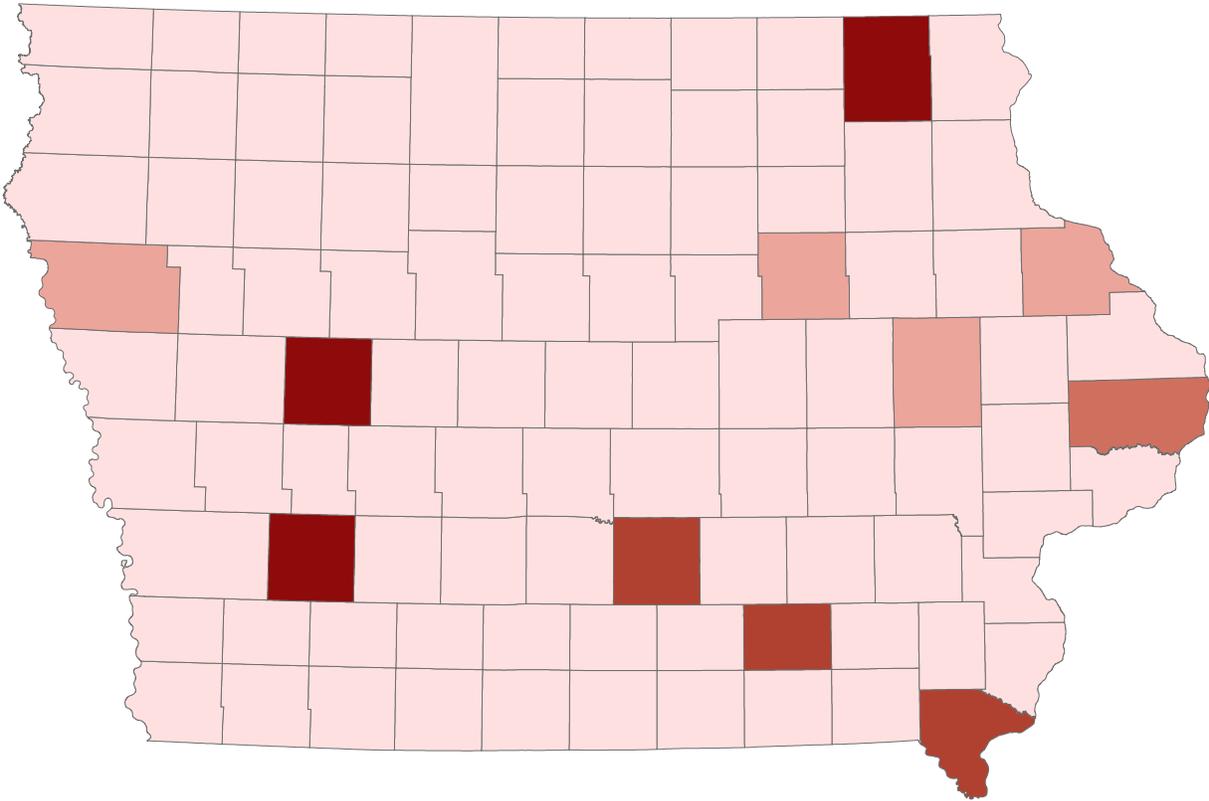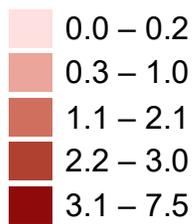
Jenks Natural Breaks Classification
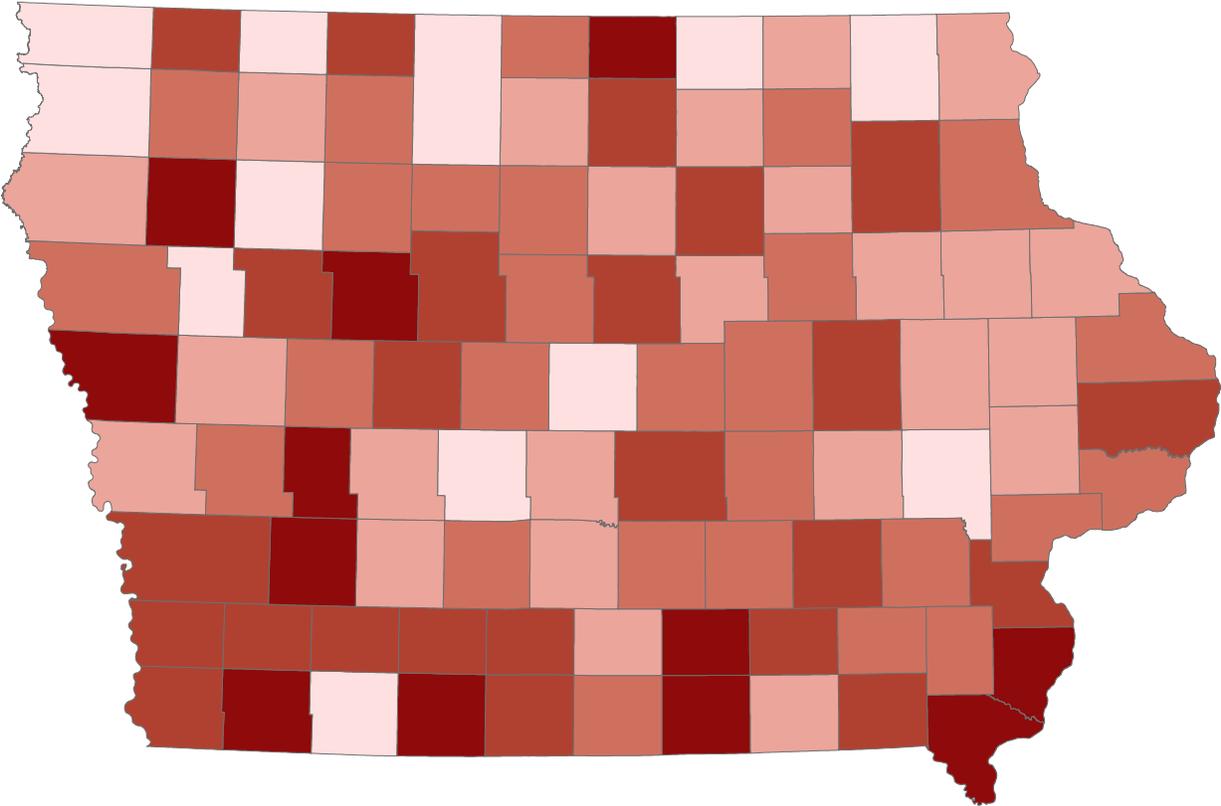
Premature Deaths/100K

- 217 – 290
- 291 – 357
- 358 – 422
- 423 – 497
- 498 – 621

Jenks Natural Breaks Classification

Appendix K – Substance Use – Adults Who Smoke (Percent)

Percent of adults who smoke

- 0.12 – 0.13
- 0.14
- 0.15
- 0.16
- 0.17 – 0.18

Jenks Natural Breaks Classification

HIV due to IDU/100K

- 0.0
- 0.1 – 0.7
- 0.8 – 7.0
- 7.1 – 9.8
- 9.9 – 14.2
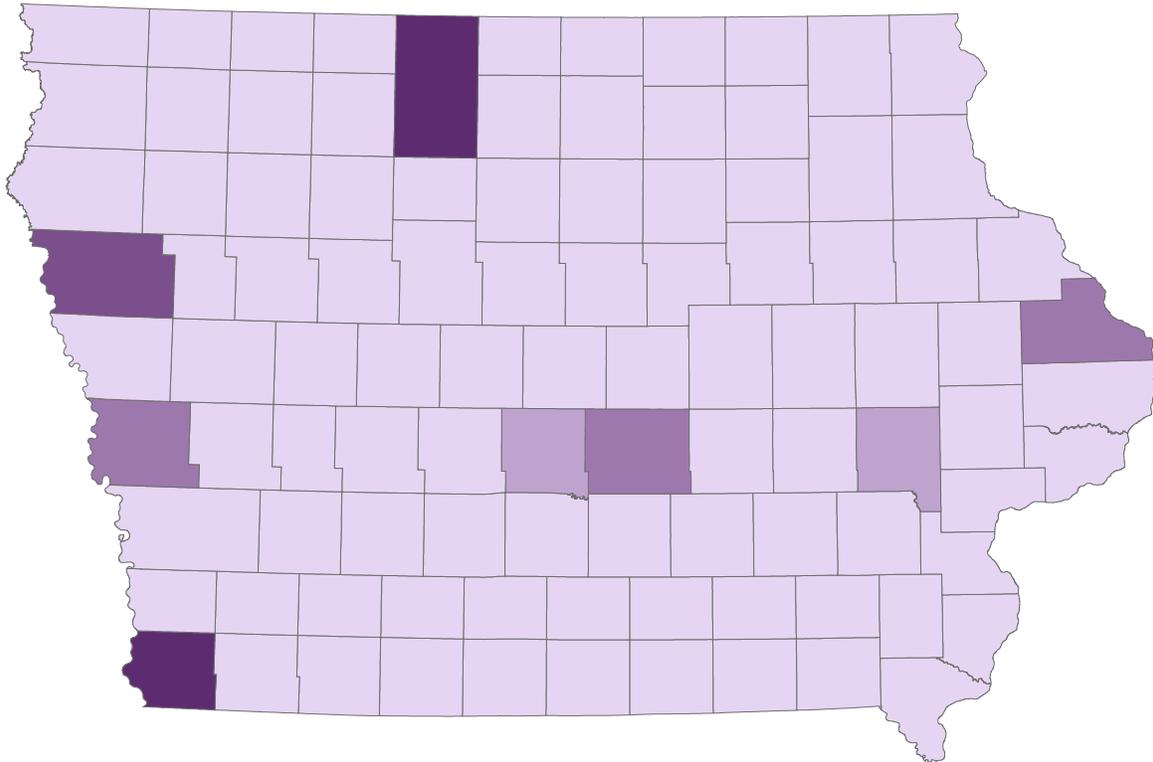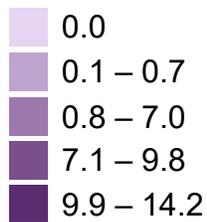
Jenks Natural Breaks Classification

Appendix M – Health Outcomes – Syphilis Diagnoses (Rates)
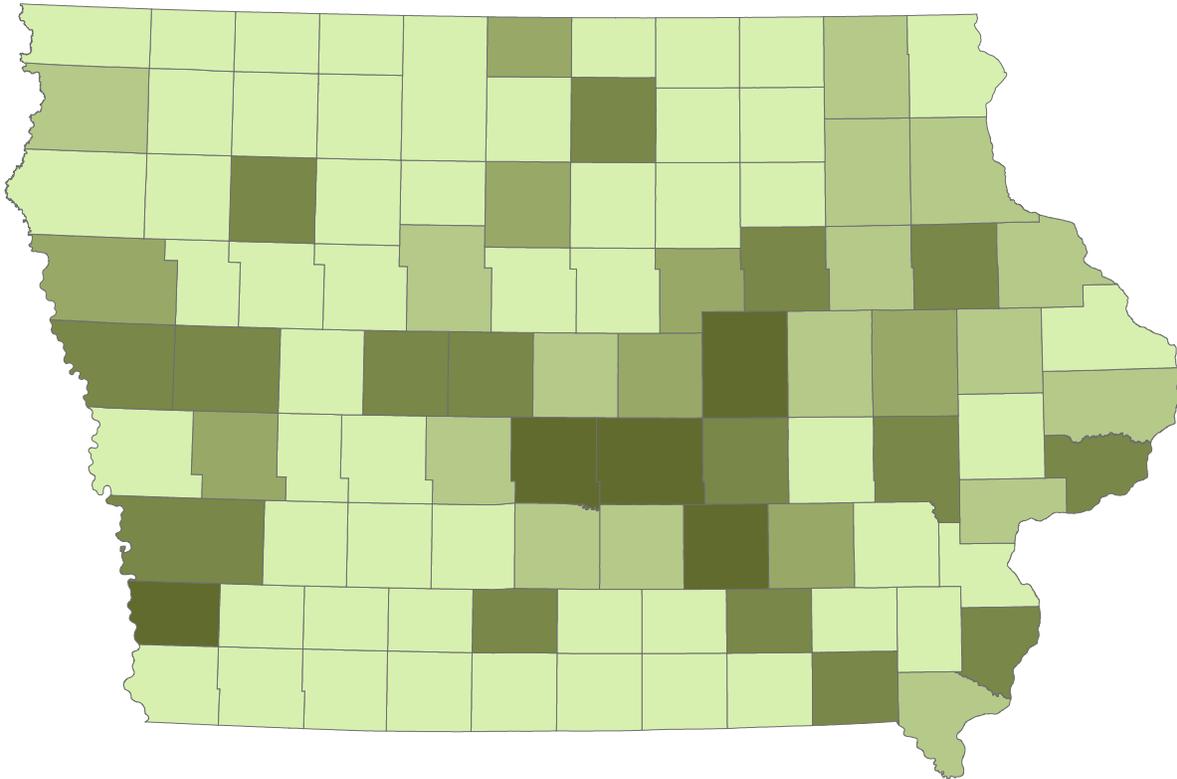
Syphilis cases/100K

- 0.0
- 0.1 – 5.6
- 5.7 – 9.8
- 9.9 – 15.1
- 15.2 – 24.5

Jenks Natural Breaks Classification

Nonfatal overdose, All/100K

- 0 – 24
- 25 – 44
- 44 – 71
- 72 – 107
- 108 – 144

Jenks Natural Breaks Classification

Appendix O – Substance Use –Nonfatal Overdoses, Psychotropics (Rates)
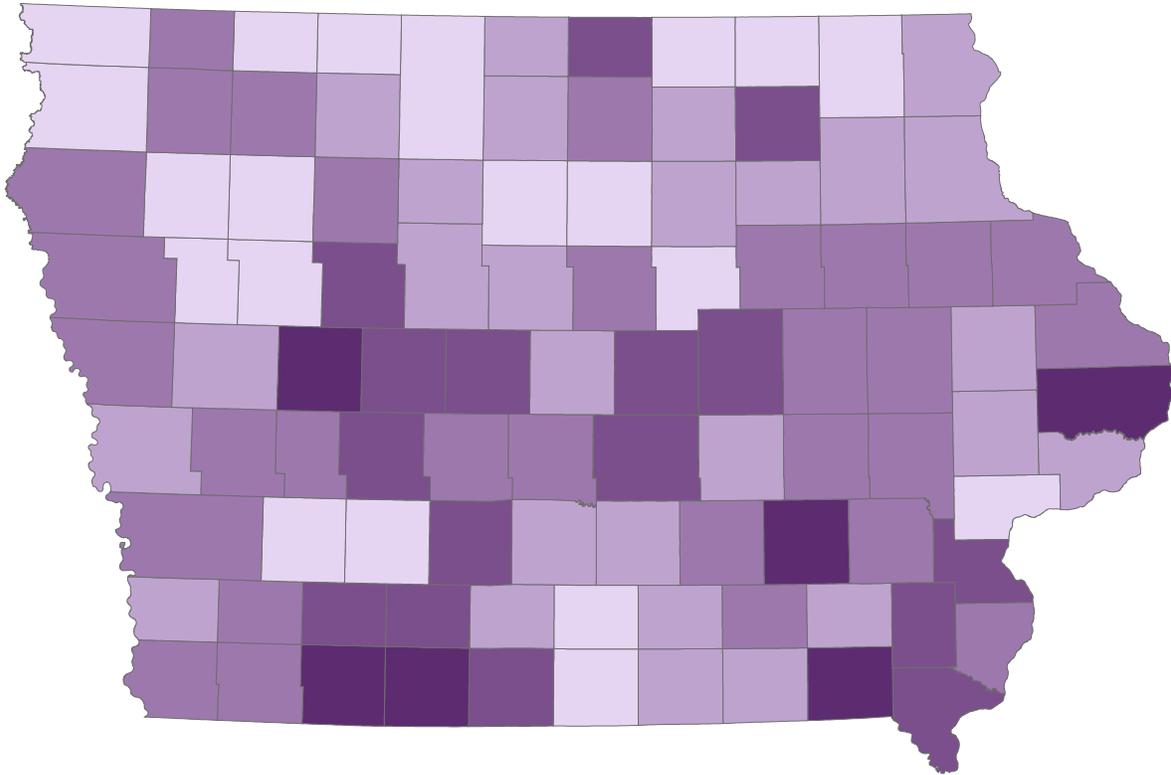
Nonfatal overdose, psychotropic/100K

- 0 – 5
- 6 – 13
- 14 – 23
- 24 – 40
- 41 – 78
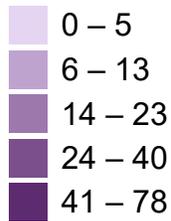
Jenks Natural Breaks Classification

Appendix P –Admission to Substance Use Treatment for Injection Drug Use (Rates)
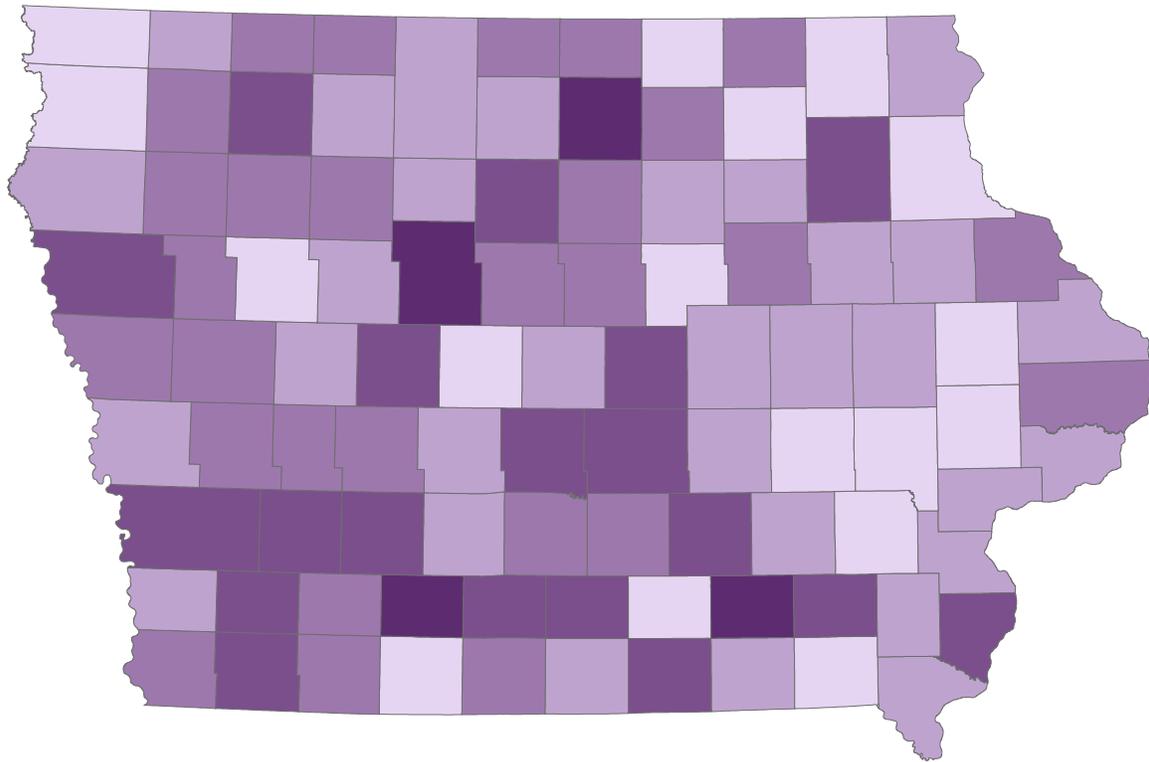
IDU treatment Admission/100K

- 20 – 100
- 101 – 174
- 175 – 271
- 272 – 424
- 425 – 653

Jenks Natural Breaks Classification

Appendix Q – Demographic – Vacant Housing Units (Rates)

Vacant Housing Units/100K

- 34,488 – 38,563
- 38,564 – 40,456
- 40,457 – 42,373
- 42,374 – 44,186
- 44,187 – 46,979
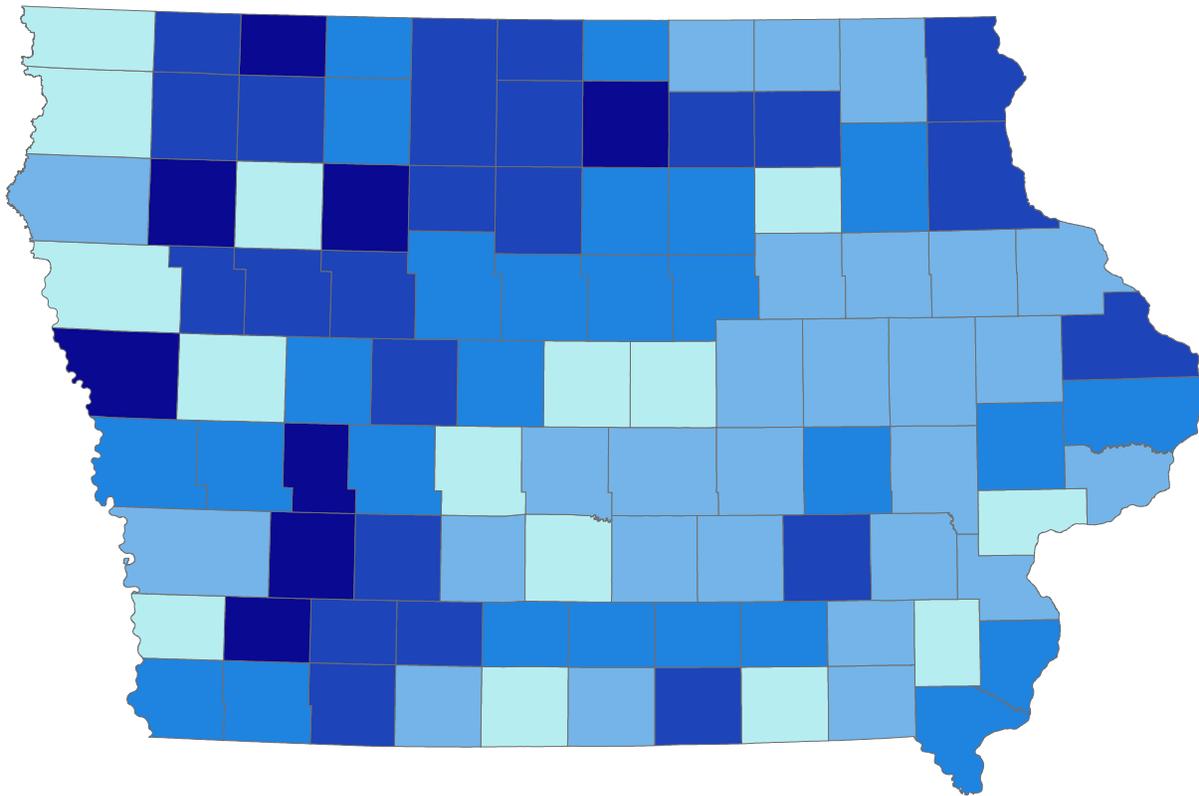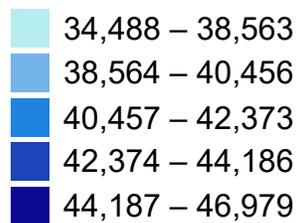
Jenks Natural Breaks Classification

Appendix R – Demographic – Percent of Persons without Health Insurance
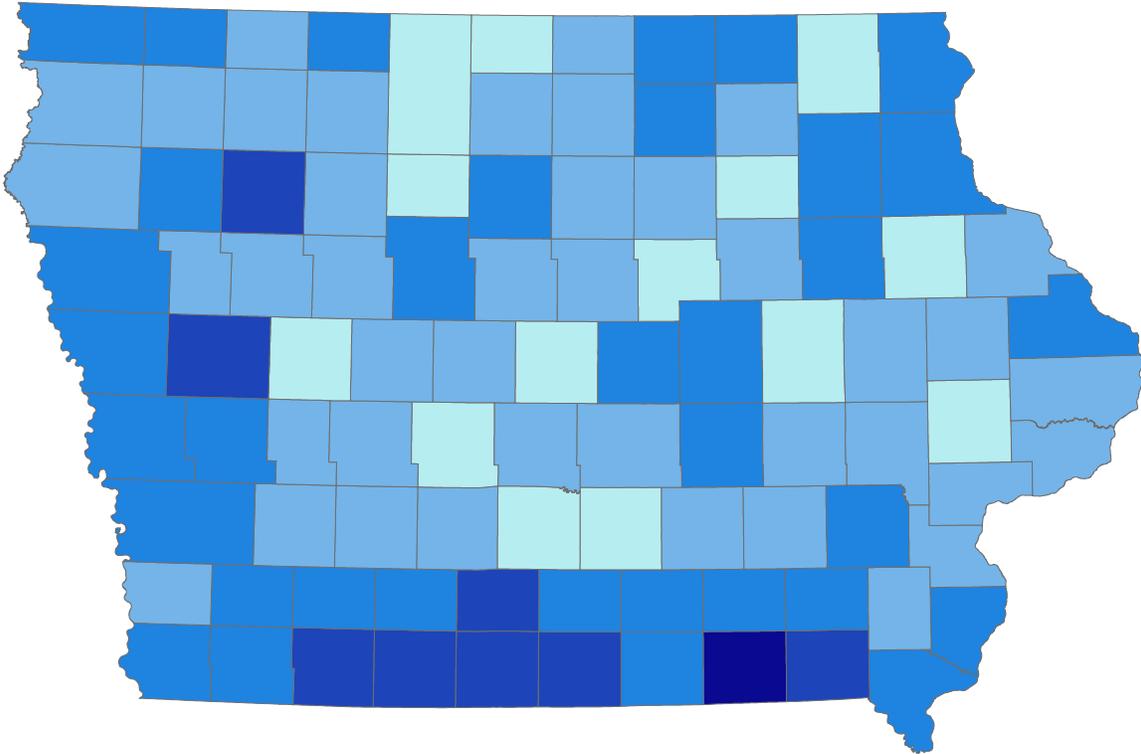
Percent Uninsured

- 3.3 – 4.5
- 4.6 – 6.7
- 6.8 – 9.4
- 9.5 – 15.2
- 15.3 – 24.5

Jenks Natural Breaks Classification

Appendix S – Health Outcomes – STD Diagnoses (Rates of Chlamydia, Gonorrhea, & Syphilis)

STD cases/100K

- 46 – 156
- 157 – 253
- 254 – 353
- 354 – 557
- 558 – 914

Jenks Natural Breaks Classification

Appendix T – Percent of Population Living in Poverty

**Percent of Population
in Poverty**

- 5.7 – 8.2
- 8.2 – 11
- 11 – 14.2
- 14.2 – 17.9
- 17.9 – 22.3
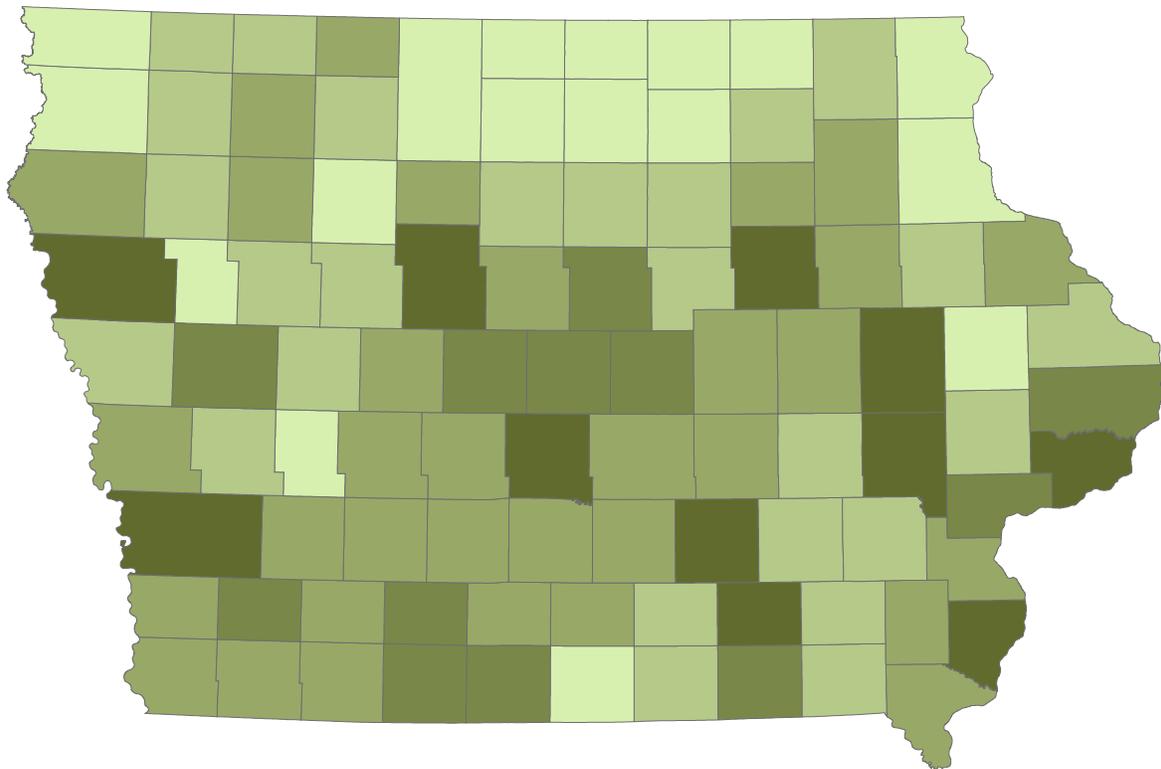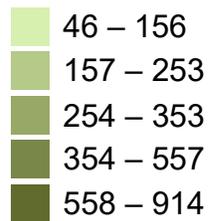
Jenks Natural Breaks Classification

Appendix U – Morphine Milligram Equivalents (MME) Prescribed

MME / 100K

- 11200000 – 27200000
- 27300000 – 41600000
- 41700000 – 57000000
- 57100000 – 83300000
- 83400000 – 116000000

Jenks Natural Breaks Classification

Opioid Deaths/100K

- 0 – 2.5
- 2.5 – 7
- 7 – 12.5
- 12.5 – 24.4
- 24.4 – 39.7

Jenks Natural Breaks Classification