

Identifying Key Demographics for the Use of Heroin and Analysis of High Risk Areas in the City of La Crosse, Wisconsin

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Abstract

This research focused on using Geographic Information Systems (GIS) to assess the ability of demographic variables to predict census block groups at risk for heroin use. The study area for the research is the city of La Crosse, Wisconsin. This area was chosen because of the recent dramatic increase in heroin use and deaths caused by heroin overdose, which has led to the creation of a heroin task force in La Crosse County. Demographic data associated with heroin users self-reported through the 2012 National Health Survey were reviewed and used to develop a predictive model of heroin use in La Crosse, WI. Location and demographics associated with actual heroin related arrests from 2014 were compared to the predictive model using statistical tests and visual representations. A Pearson correlation statistic was used to determine which demographic variables correlate with locations of heroin use based on collected demographic data from the 2012 National Health Survey. Five demographic categories were chosen based on previous literature on the subject: age, gender, employment status, education, and race. Step-wise regression was used to determine which demographic factors were the strongest predictors of heroin activity determined through arrests. Statistical analyses revealed age, gender, and employment status were the main contributing factors.

Introduction

Heroin Use at the National Level

According to the U.S. Department of Justice, heroin use is increasing among young people in many suburban and rural areas (Kane-Willis, Schmitz, Bazan, Narloch, and Wallace, 2011). Over a ten year period, the practice of injecting drugs increased among heroin using teens by 94 percent, with about 70 percent of teen heroin users currently using the injection method to administer the drug (Kane-Willis *et al.*). Injection drug use among 20-year-olds entering treatment for heroin increased by 110 percent; more than 75 percent reported injection as the preferred method of drug use (Kane-Willis *et al.*).

It is important to analyze and review these national heroin statistics at the local level in order to determine if similar trends exist.

Heroin Use in La Crosse, WI

Heroin use represents a leading health risk behavior to the residents living in the city of La Crosse and surrounding communities, with sometimes deadly consequences. Three years prior to this study, heroin was almost a non-existent problem in the small and safe community of just over 50,000 people neighboring the Mississippi River. It has now become one of the city's most pressing concerns with 17 overdose deaths documented within the past three years (Figure 1). Hundreds more

in the region received medical attention due to the use of pre-hospital naloxone administered by emergency medical service providers working with Tri - State Ambulance (Figure 2) (Bliss and Helf, 2014).

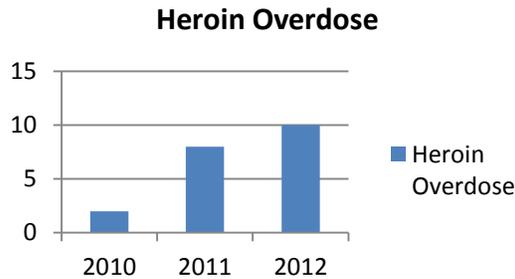


Figure 1. Represents the number of heroin overdoses from 2010 to 2012 (Bliss and Helf, 2014).

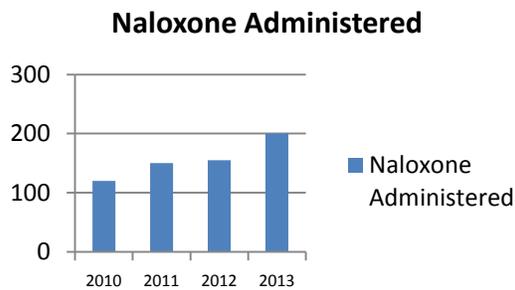


Figure 2. The number of Naloxone injections administered by emergency medical service providers in the greater La Crosse area from 2010 to 2013 (Bliss and Helf, 2014).

The heroin problem in La Crosse County has become so severe over recent years that a heroin task force was established to help combat the problem. One way to reduce the issues caused by heroin is to find areas of high concentration of abuse and increase police presence. This study will also help the city determine priority areas of concern, not only for the purpose of arrests, but also to help spread education, and apply medical assistance.

As it relates to drug use, the normalization thesis describes recreational drug use as moving away from a marginal

sub-cultural status toward the mainstream of youth culture. This suggests a cultural shift in drug related behaviors and attitudes for both users and non-users as it becomes more culturally and socially acceptable (Shaw, Egan, and Gillespie, 2007).

Demographics and Factors Influencing General Drug Use

Prior studies show the five major contributing factors for heroin abuse include age, gender, employment status, education, and race. Other studies suggest family structure and domestic abuse can be predictors of future drug abuse, but data for these variables are much harder to obtain at a census level. The following information provides a base as to why the chosen demographic variables are important; these facts all come from previous studies.

Four studies found age was both a forecaster of cannabis use and the overall amount of drug use (Young, Corley, Stallings, Rhee, Crowley, and Hewitt, 2002; Beckett, Heap, McArdle, Gilvarry, Christian, Bloor, Crome, and Frischer, 2004; Ljubotina, Galic, and Jukic, 2004; Howard and Jenson, 1999). According to the Kane-Willis *et al.* (2011) the average age of first use of heroin was 18.4.

Gender was a substantial forecaster of drug use in four studies with males being slightly higher, 52% (Hofler, Lieb, Perkonigg, Schuster, Holger, and Hans-Ulrich, 1999; Johnson, Schntz, Anthony, and Ensminger, 1995; von Sydow, Lieb, Pfister, Hofler, and Wittchen, 2002; Young *et al.*, 2002). Ilomaki, Hakko, Timonen, Lappalainen, Makikyro, and Rasanen (2004) and did not find a substantial association between gender and amount of drug use.

Active illicit drug use varied by employment status in 2012. Amongst

adults aged 18 or older, the rate of active illicit drug use was greater for those who were unemployed (18.1 percent) than for those who were employed full-time (8.9 percent) and those employed part-time (12.5 percent) (Bose, Chromy, Aldworth, Hedden, Kott, Gfroerer, and Liao, 2012).

Surveys show illicit drug use in 2012 varied by the educational status of adults aged 18 or older. The rate of active illicit drug use was significantly lower among college graduates (6.6 percent) than those with some college education (10.2 percent), high school graduates who did not attend college (9.8 percent), and those who had not graduated from high school (11.1 percent) (Bose *et al.*, 2012).

In 2012, amongst individuals aged 12 or older, the rate of active illicit drug use was 3.7 percent among Asians, 7.8 percent among Native Hawaiians or Other Pacific Islanders, 8.3 percent among Hispanics, 9.2 percent among whites, 11.3 percent among African Americans, 12.7 percent among American Indians or Alaska Natives, and 14.8 percent among multi-racial individuals (Bose *et al.*, 2012).

Data

Data gathering consisted of a three part process. The first was to gather the most current demographic data at the census block group level for the city of La Crosse, WI; second, gather voluntary data on heroin use from the National Health Survey that was current and coincided with the most recent demographic data; third, collect actual arrest data at the local level to include key demographics for the most recent calendar year.

Data Collection

Census Data

Census Bureau data was collected from the American Community Survey 5 year estimate for the years 2008 – 2012, which was the most current data set available at the time of the study. The data was further queried to represent the 52 census block groups which cover the city of La Crosse, WI.

There are five key demographics that are considered contributing factors of heroin/opiate abuse based on the results of the 2012 National Health Survey (Bose *et al.*, 2012): age, gender, employment status, education level, and race. Data for each of these factors were included at the census block group level.

National Health Survey Data

Data for the five key demographics were extracted from the National Health Survey demographic dataset. Over 4 million individuals who completed the 2012 National Health Survey had admitted to using heroin at least one time since 2011. Another 669,000 individuals had admitted to trying heroin in 2012. This study and statistical analysis is based on the 335,000 users who admitted in the survey to be current users of heroin. The following categories were derived for analysis based on the availability of data in both the National Health Survey and the U.S. Census block group data.

1. Age: Age was classified into five categories (18 – 20, 21 – 25, 26 – 29, 30 – 34, 35 and older).
2. Gender: Gender was divided into male and female users based on the type of drug used, i.e., heroin, marijuana, etc.
3. Employment: Employment status was reduced to either working or not working (employed and unemployed).

4. Education: Education was divided into three categories: no high school diploma, high school diploma, and college graduate.
5. Race: Race included five categories and did not take into consideration mixed race: Native American, African American, Caucasian, Hispanic, and Asian.

Arrest Data

Data on the number of heroin arrests was manually collected over the twelve month period beginning in January 2014 and ending December 2014. La Crosse County court records were obtained from the county's website and filtered for heroin under the category of reason for arrest. The court documents were then screened to make sure the arrest occurred within the city of La Crosse. If the arrest fell within La Crosse, the address, gender, and age of the offender were recorded for mapping purposes. Race, though collected for the demographic study, was discarded for the actual arrest study because it was determined to not be a contributing factor based on multiple studies and was not necessarily relevant for locating potential arrest hot spots.

Methods

Discussions in this section include the selection process for demographic data and computation of point values assigned to each demographic variable.

Computation of Point Values

In order to estimate areas in the study area with greater probability of heroin users per demographic area, an equation was developed to apply weights to each of the demographic inputs. The percentage of reported heroin users in each demographic category according to the National Health

Survey were converted to decimals and multiplied by the national user rate of .001. For example, age 18 – 20 had a 24% user rate based on the National Health Survey, which was then converted to .00024 points for each person in a census block group in that age range. If there are 100 people in a census block groups between ages 18 – 20, that census block group would receive .024 points.

- 1) Age: the calculated points for: (18 – 20) = .00024, (21 – 25) = .0002, (26 – 29) = .00015, (30 – 34) = .00013, (35 +) = .00009.
- 2) Gender: the percentage points for: male heroin users = .00012 and female heroin users = .00007.
- 3) Employment: the percentage points for: employed = .00009 and unemployed = .00018.
- 4) Education: the percentage points for: no high school diploma = .00011, high school diploma = .0001, and college graduate = .00007.
- 5) Race: the percentage points for: Native American = .00013, African American = .00011, Caucasian = .00009, Hispanic = .00008, and Asian = .00004.

Once calculations were complete for all of demographic categories, points were totaled for each census block group and mapped using five categories separated by Jenk's Natural Breaks (Esri, 2015). Highest point total areas were predicted to have the most heroin users based on the national statistics.

Analysis and Results

Both statistical and spatial analyses were utilized to model findings of this research. Spatial analysis results show where hot spots of heroin use in La Crosse should be

based on the national averages and also where the hot spots are actually located based on arrest information. Statistical analysis was used to validate which variables were most significant in predicting heroin use demographics. A comparative analysis of the number of heroin users La Crosse should have based on the national statistics was conducted assuming heroin use was equally distributed across populations.

Statistical Analysis

According to Bose *et al.* (2012), the five most common determining factors for illicit drug abuse, including heroin, include: (a) age, (b) gender, (c) education, (d) employment, and (e) race (Bose *et al.*). To determine which of these factors held the most statistical weight in the study area of La Crosse, a Pearson correlation analysis was conducted.

It is important to note all 19 inputs are statistically significant. The Y value for the Pearson Correlation is derived directly from the 19 variables. The reason for the analysis is to determine which of the 19 input variables were most significantly correlated with overall predicted heroin use. Any input variables show little significance could be looked at further to determine if they could be removed from future studies and focus on variables of only high significance.

The Pearson correlation requires two inputs X and Y, where the X value is compared to the Y value to determine how much the X value contributed. The Y value was the same for each demographic category where Y = the total calculated value of heroin use prediction in a census block group to determine likely areas of heroin use. The X value was substituted with each of the following demographic categories: working male, working female, not working male, not working female, no

high school diploma male, no high school diploma f, high school diploma male, high school diploma female, bachelor's degree male, bachelor's degree female, Caucasian, African American, Native American, Asian, Hispanic, population male, population female, and age.

According to the Pearson correlation, the highest contributing factors were Caucasians (.9154) (Figure 3) in the race category. Since the population of La Crosse is over 95% Caucasian, this could be considered an outlier.

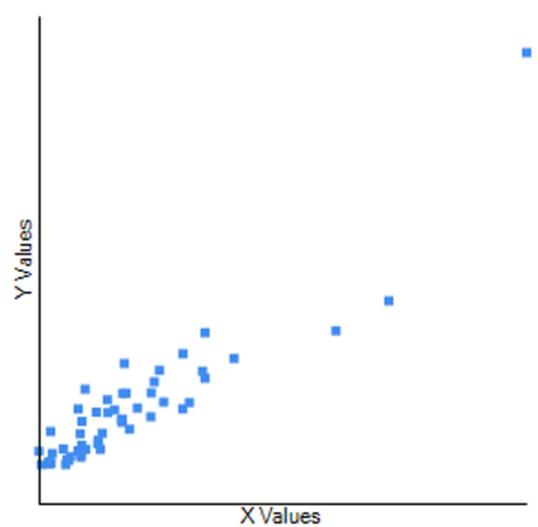


Figure 3. This graph shows the linear correlation between Caucasians (X) and the total points for predicted heroin use (Y).

The next significant identifier was working males (.9401) (Figure 4). Previous studies concluded females were slightly more likely to be heroin users; however, results from La Crosse arrests suggest male users are slightly more prevalent in La Crosse, confirming the working male statistics.

Females both working (Figure 5) and not working (Figure 6) had Pearson correlation scores of .7706, slightly behind the males, again this confirms the statistics as the percentage of male to female users

arrested in La Crosse in 2014 was 52% compared to 48%.

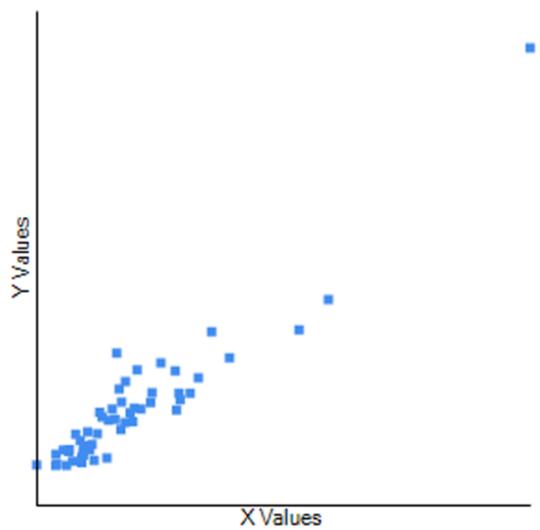


Figure 4. This graph shows the linear correlation between Working Males (X) and the total points for predicted heroin use (Y).

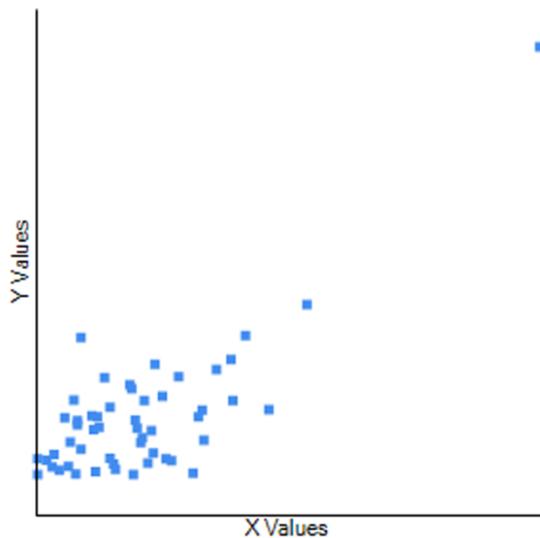


Figure 5. This graph shows the linear correlation between working females (X) and the total points for predicted heroin use (Y).

Research into national statistics and demographics yielded two completely different results. One study based on national arrest records found the main offenders are white females in their late

20's (Duhaime-Ross, 2014). Conversely, the national health survey conducted in 2012 concludes that Native American males between the ages of 18 – 20 are more likely to use heroin (Bose *et al.*, 2012).

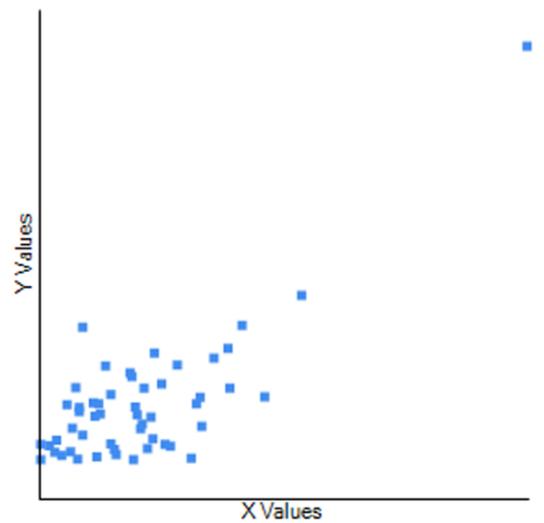


Figure 6. This graph shows the linear correlation between not working females (X) and the total points for predicted heroin use (Y).

Demographic Predictors of Heroin Arrests

Thirty-three heroin arrests were identified for the City of La Crosse in 2014. Based on the gender and age available in the arrest records, white males with an average age of 28 are the most likely to use heroin. A stepwise regression was also used to verify the data. The same 19 demographic variables from the Pearson correlation were used as the inputs. According to the output of that analysis, areas with the heroin arrests were predicted by males who had only graduated from high school and were also Native American (Table 1).

The difference between male and female users is negligible based on results from the 2012 National Health Survey. La Crosse male to female arrests was 17 to 16 – essentially 50/50.

Table 1. Stepwise regression based on La Crosse arrests. Where models represent the following categories: 1) Predictors: (Constant), Male High School Graduate; 2) Predictors: (Constant), Male High School Graduate, Native American; 3) Predictors: (Constant), Male High School Graduate, Native American, Hispanic; 4) Predictors: (Constant), Male High School Graduate, Native American, Hispanic, No HS Diploma Female.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.50	.25	.24	.800	.255	17.1	1	5	.000
	5 ^a	5	1	18		57	1	0	
2	.60	.37	.34	.742	.116	9.02	1	4	.004
	9 ^b	1	6	80		3	1	9	
3	.64	.42	.38	.719	.050	4.15	1	4	.047
	9 ^c	1	5	95		9	1	8	
4	.68	.46	.42	.697	.046	4.10	1	4	.049
	4 ^d	8	3	77		0	1	7	

Equal Distribution Prediction

The final statistical analysis was a simple comparative analysis based on an equal distribution of the national self-reported heroin users and national heroin arrests, meaning the number of users for a given city would be based solely on population size. According to the Federal Bureau of Investigation, in 2012 there were 1,552,432 drug arrests, 16.5% of which were heroin related for a total of 94,087 heroin arrests in 2012 (Federal Bureau of Investigation, 2012). In 2012 there were 335,000 users who had admitted using heroin by either survey or medical related data collection. With a U.S. population of 313,000,000 in 2012, an average of .001 heroin users per capita was determined. Assuming trends are consistent in the study area, and with a population of

51,647, there would be approximately 52 expected users in the study area. Since 28% of the national users were arrested, the expected number of heroin arrests would be 15 per year in the study area. This also assumes trends are consistent. However, the number of heroin arrests in the study area in 2014 was 33 (Figure 8) – more than double the national average.

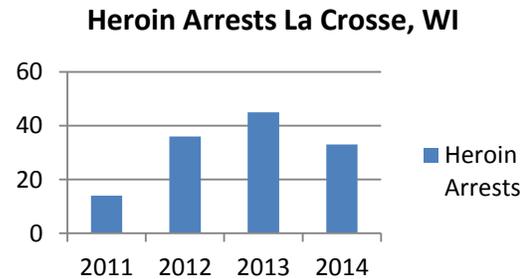


Figure 8. The number of heroin arrests in the La Crosse County for the years 2011, 2012, and 2013. The year 2014 shows arrests within the city of La Crosse (Bliss and Helf, 2014).

Spatial Analysis

Spatial analysis is important for targeted education and increased policing. Visualization is paramount in studying emerging patterns in the arrests of heroin use/possession. Figure 9 shows an emerging pattern where most of the arrests occur centrally throughout the city. However, after running a cluster and outlier analysis, no significant clustering was found.

The area in black towards the bottom of the map is the census block group with the highest number of arrests for heroin in 2014. The average age for this census block group is 43.4; 95.6% of the residents are Caucasian. The majority of the population in the area has a high school diploma as their highest level of education. The unemployment rate for this census block group is 10.5%, and the male to female ratio is 2:1.

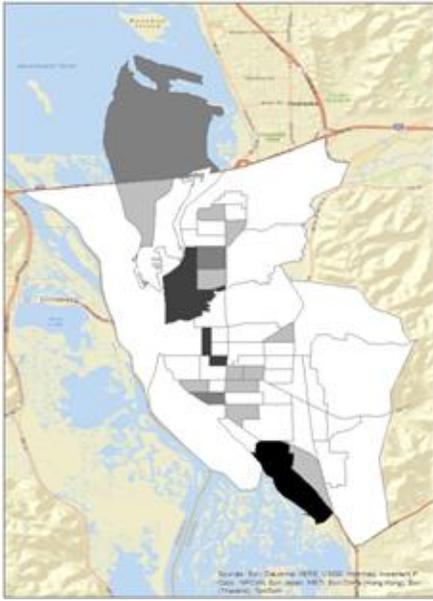


Figure 9. A visual display of the La Crosse census block groups. White areas are census block groups that have 0 reported arrests for 2014. Black areas are the highest with 4 arrests in 2014. The scale is from white to black ranging from 0, 1, 2, 3, or 4 arrests.

The census block group with the most arrests had a high unemployment rate (highest point value for the employment demographic), most of the census block groups only have a high school diploma (the second highest point value for the education demographic), and the majority of the census block group is Caucasian (the third highest point value for the race demographic). Compared to La Crosse arrest data, which suggested Caucasian males in their late 20's are most likely offenders, the actual arrest data appears to coincide fairly well with the demographic data.

One key factor not mentioned in any of the studies was population size. The census block group with the highest number of arrests in La Crosse also had the second highest number of residents. The census block group with the highest

population coincides with the University of Wisconsin – La Crosse campus.

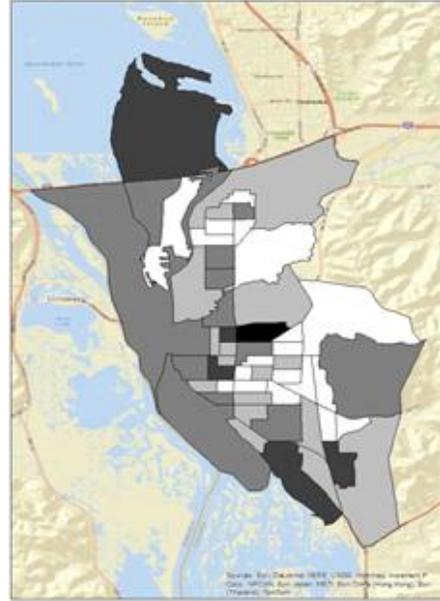


Figure 10. A visual display of the La Crosse census blocks groups. White areas show the lowest possible scores for expected heroin use based on the five demographic categories. Black areas represent the areas with the most points for expected heroin use and the rest are scaled accordingly light to dark.

The area in Figure 10 with the highest result for predicted drug use does not meet the national or La Crosse expected drug use demographics. This area has a high population of educated students in their early 20's. The contributing factor to its high predicted heroin use is that it has the highest concentration of people in any of the 52 census blocks. This area is considered an outlier because the population is significantly larger than any other census block group in the study; in fact, it is nearly twice as large. The University of Wisconsin La Crosse census block group was the only block group in the highest predicted heroin use category. Since the result is highly based on population alone, the highest predicted heroin use class was removed. The final

analysis compares only four categories of predicted heroin use (high, moderate-high, moderate, and low).

When comparing the two maps closely, the census block group with the highest number of arrests (four) was also an area with the highest calculated value of heroin use prediction coinciding with the national demographics for heroin users. Two census block groups had three arrests each. These two block groups coincided with the moderate (second lowest) calculated value for suspected heroin use. Three census block groups had two arrests each; one block coincided with high predicted heroin use class, and two blocks coincided with moderate-high (second highest) calculated value for suspected heroin use.

Eleven census block groups had one arrest each. Two of the eleven blocks coincided with the moderate-high calculated value for suspected heroin use, five blocks coincide with the moderate amount of points for suspected heroin use, and four blocks coincide with the lowest calculated value for suspected heroin use. Four total arrests occurred in the high level of suspected heroin use areas, six total arrests occurred in the moderate-high level of suspected heroin user areas, eleven total arrests occurred in the moderate level of suspected heroin user areas, and four total arrests occurred in the low level of suspected heroin user areas. Figure 11 reflects actual arrests; statistically they are only 28% of the actual users.

Discussion

Heroin has one of the highest dependence liability profiles of any licit or illicit drug. Only nicotine ranks higher (Kane-Willis *et al.*, 2011). Estimates suggest the number of heroin dependent persons is about 0.3

percent of the U.S. population (Darke, 2011).

Comparative Analysis

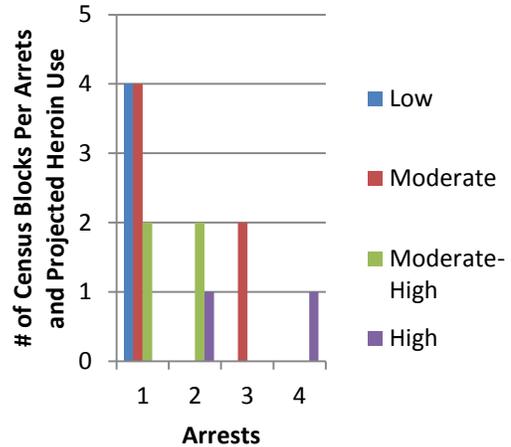


Figure 11. Graphic display of actual arrests compared with how many census block groups had arrests in the study area and their level of calculated suspected heroin use.

Darke's (2011) estimate already suggests an error in the data; numbers gathered at the national level suggested 0.1 percent of the population are current heroin users. One of the most difficult aspects of this research is a person either needs to be arrested or admit to using heroin voluntarily to be counted in the national statistic. Since the heroin task force for La Crosse County was just recently established in 2014, data specific to La Crosse is almost non-existent during time of this study. This research is intended to address some of those information lapses and provide an example methodology for collecting and analyzing future heroin statistics for La Crosse.

Suggestions for Future Research

Missing data necessary for a complete study is simple: demographics for heroin users at a more localized level. A much more in depth project could have been

completed if access to drug convictions, medical admittances for heroin, and actual home addresses for convicted heroin users was available. This data would have provided a much more accurate picture of the areas of La Crosse which are of the highest concern for heroin abuse. The data used for this study was based on simple police reports which give the address nearest where the arrest occurred, the age of the suspect, gender and sometimes race. These reports, though effective, are not 100% accurate. The other issue is most national data is derived from surveys in which illicit drug user's volunteered information. This is not fully accurate data because 100% of participants may not share valid data and is based on a sample, not an entire population.

Hope for the future is cooperation between the author or another geospatial analyst and the heroin task force of La Crosse to compile a much more accurate representation for the city which can be used to help inform citizens and also help the police make arrests and curb heroin use and reduce criminal drug-related offenses.

Conclusion

The key conclusion to draw from this research is that national averages are just that – averages. Even when applied to smaller study areas like states or even counties, the data will continue to change. There are different factors dependent on location.

The arrest numbers for La Crosse were well above the national average. Why? That answer was not determined from this study because it is a highly complex question with multiple answers. One key factor that was evident almost immediately was that the number of students living near or on college

campuses affected the results, because the population density is much higher than in other areas of the city.

Overall, data from the national study appeared to coincide with the La Crosse specific data. With more information from local law enforcement and hospitals, the accuracy would be significantly increased and would significantly help both the public and police in quelling the heroin epidemic.

Seddon (2006) argued social acceptance is a key driving force in which drugs kids and young adults find acceptable. Casual conversation with other citizens of La Crosse have led to the same conclusion. Heroin is a much larger problem now because it has become more socially acceptable. How does this happen? Lack of knowledge is a key driving force and that is why further research needs to be done in La Crosse. More research leads to more people being educated about the dangers of heroin addiction and will hopefully raise awareness and subsequently cull heroin use.

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