CASA007
Quantitative Methods Assessment
Written Assignment
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1. Research Question

Opioids, both prescription and illicit, have been the cause of drug overdoses in increasing numbers across the United Kingdom since the 1990s (Deaths related to drug poisoning in England and Wales: 2019 registrations - Office for National Statistics, no date). These increasing opioid overdose numbers are not a phenomenon unique to the United Kingdom. America is in a self-declared opioid epidemic. In 2019, over 60,000 Americans died of drug overdoses involving fentanyl, heroin, prescription or other opioids (Katz, Goodnough and Sanger-Katz, 2020). In the same year in the United Kingdom, opioids were involved in just over 2,100 drug poisonings or approximately 50% of all drug poisonings across the country (Deaths related to drug poisoning in England and Wales: 2019 registrations - Office for National Statistics, no date). These are not insignificant numbers, and each one is a potentially preventable tragedy in its own right. This paper will answer the question: what factors in English local authorities have the most substantial relationship with opioid overdose deaths?

2. Literature Review

Opioids have a long history of use in the United Kingdom. Since at least 1924, the government has understood that opioids can cause severe problems related to addiction, and since at least 1960, there has been research done to understand the link between opioid use and increasing criminality (Mott, 1980). Many studies have shown that increased opioid use leads to increased petty acquisitive crime like theft, but the relationship's causality is often harder to determine (Hammersley et al., 1989). While the causality is not understood, it is clear that as users move from moderate to heavy opioid use, the likelihood of their criminality increases as their addiction becomes more difficult to fund.

Another item that is becoming increasingly clear is the cause of the sharp increase in opioid use since the 1990s - an increase in the prescription of opioids for pain relief (Basler, no date). While this is a more marked trend in the United States than in the United Kingdom, both were following a rising trajectory through the majority of the 1990s and the 2000s, with the UK reaching the US' 1999 prescription "tipping point" in 2010 (Weisberg et al., 2014).

As the epidemic continues to worsen in the US, there has been a concerted effort to model or predict overdoses to better help those dealing with chronic addiction (Weisberg et al., 2014). Standard variables used to predict overdoses have included criminal justice statistics, medical information and demographic information like median household income ('AI can predict opioid overdoses from crime and socioeconomic data', 2019). While the UK and the US report and track measures differently regarding opioid statistics, there is enough similarity to reproduce a

version of these studies in the UK at a local authority level to understand which factors have the most substantial relationship with UK overdoses.

3. Data

This paper's data was retrieved from three websites: Office for National Statistics, UK Parliament House of Commons Library and Gov UK. Table 1 below outlines the variables used.

Variable	Description	Source
Crime Rate Indicator	Sum of the 2017 crime rates per 1,000 population: Robbery, Theft offences, Burglary, Non-domestic burglary, Vehicle offences, Theft from the person, bicycle theft, Shoplifting and All other theft offences	Office for National Statistics - Crime in England and Wales Statistical bulletins
Disposable Income Indicator	2016 Gross Disposable Household Income per Head	Office for National Statistics - Regional gross disposable household income by local authority (Regional gross disposable household income by local authority
Drug Death Rate Indicator	Sum of the age-standardised rates of drug poisoning and drug misuse deaths for 2016 to 2018	Office for National Statistics - Deaths related to drug poisoning in England and Wales: 2019 registrations
Rough Sleeping Indicator	2017 Rough Sleeping Rate per 1,000 households	UK Parliament House of Commons Library - Local Authority Homelessness Statistics (England)
Opiate User Indicator	2016-2017 prevalence estimates for rate of opiate use per thousand of the population	Gov UK - Opiate and crack cocaine use: prevalence estimates by local area

Table 1. Variable Description and Sources

These variables were chosen as they reflected most closely the variables used in models seen in the literature review. The variables are also tracked at the local authority level, which is the study's focus level.

Two thousand seventeen data is used as this was the most recent estimate from Gov UK on opiate and crack cocaine users. The 2017 timeframe informed the decision to use data from a similar timeframe for the other datasets. The data was then cleaned in Excel and Python and merged into a DataFrame for analysis using the local authority name as the basis for the merge. Once merged, local authorities with missing variables were removed from the analysis. Once the data had been cleaned, 102 local authorities were remaining for analysis. A decision was made to keep outliers in the data as it was deemed that the model would not understand the opioid scenario across the UK without them.

To first understand the data, a histogram plot was made of the drug poisoning and drug misuse deaths. As seen in figure 1 below, the data is slightly skewed and does not follow a normal distribution. Similar plots were done for each variable, and they all followed as similar positive skew.

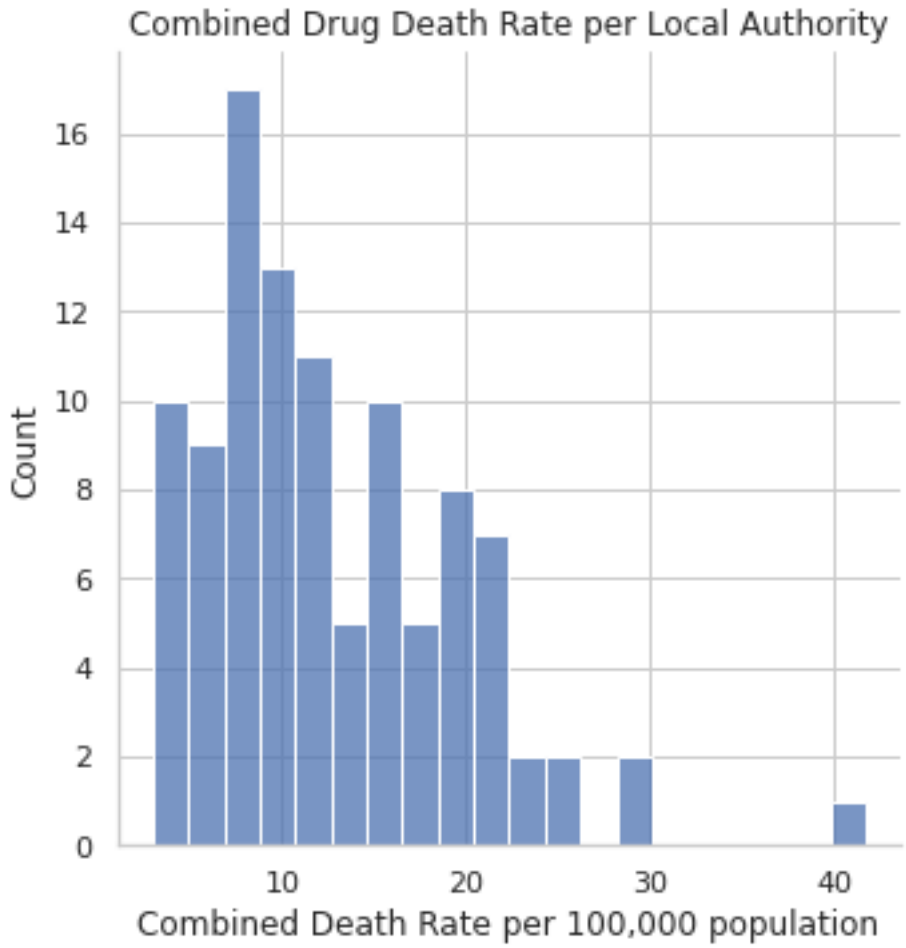

Figure 1. Histogram of Combined Death Rate

The next step for the data was to complete the descriptive statistics for each opioid variable. The descriptive statistics are shown below in table 2.

Variable	Count	Mean	Median	Standard Deviation	Minimum	Maximum
Crime Rate Indicator	102	78.13	75.30	30.75	35.10	273.69
Disposable Income Indicator (£)	102	20,026	18,249	7,542	12,232	62,600
Drug Death Rate Indicator	102	12.68	10.85	6.89	3.00	41.70
Rough Sleeping Indicator	102	0.2512	0.1450	0.3037	0.0000	1.890
Opiate User Indicator	102	8.36	7.90	3.45	2.99	21.95

Table 2. Descriptive Statistics for Opioid Variables

4. Methodology

Multiple regression will be run using the drug death rate indicator as the response variable. The regression will be done under the assumption that the regression meets the four required LINE assumptions.

i. Log Data Transformation

As evidenced by figure 1, there is a positive skew to the response variable, not normally distributed. Similar plots for the other variables, not shown in this paper, show similar skews. To run a successful regression and improve the linearity, the data for all variables will be log-transformed (9.3 - Log-transforming Both the Predictor and Response | STAT 501, no date).

Please note that to deal with values that were 0 in the Rough Sleepers indicator and the Drug Death Rate indicator, a constant of 1 was added to each value in order to allow the log transformation.

ii. Multicollinearity Checks

Before running the multiple regression, a check was run to check for multicollinearity between our logged variables. A correlation matrix was completed using a threshold of 0.8 as the mark to remove any highly correlated variables. Figure 2 below outlines the findings.

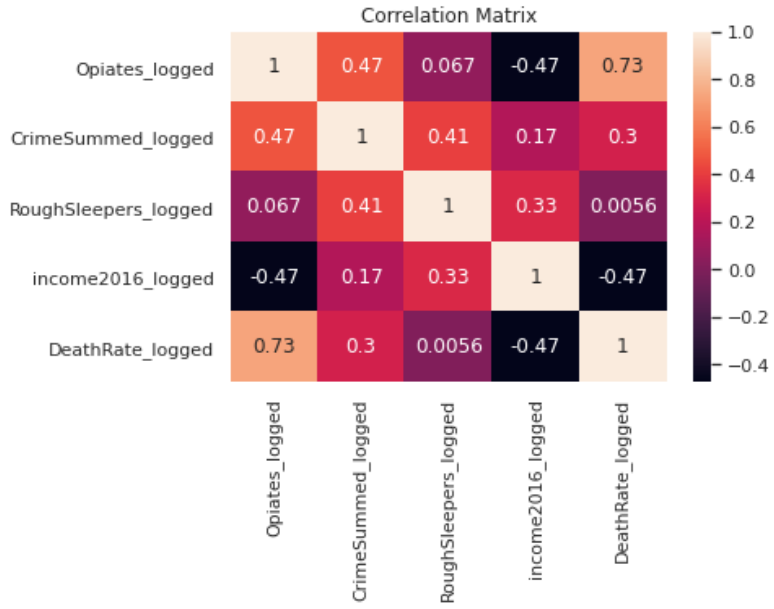

Figure 2. Correlation Matrix

No variables reached the 0.8 thresholds, so a decision was made to keep all variables for the regression. Although interestingly, the correlation between the logged death rate and the logged opiates user is by far the highest at 0.73. However, as it does not go above the 0.8 score, and it will be kept for the regression.

A Variance Inflation Factor (VIF) test, using the logged Drug Death Rate variable as the response variable, was then completed to confirm no multicollinearity. For this test, a VIF threshold of 5 was chosen. Table 3 shows the results below.

Variable	VIF
Logged Crime Rate Indicator	1.88
Logged Disposable Income Indicator (£)	1.82
Logged Rough Sleeping Indicator	1.31
Logged Opiate User Indicator	2.14

Table 3. VIF Test Result

The results of this test reconfirmed that there is no issue of multicollinearity with our variables. The next step is to run the multiple regression and analyse the results.

5. Presentation of Results

Table 4 below highlights the results from the multiple regression.

Regression Statistic	Value
R-Squared	0.561
Adjusted R-Squared	0.543

Variable	Coefficient	P-Value	Standard Error	t-Stat
Intercept	3.89	0.014	1.56	2.49
Logged Crime Rate Indicator	0.031	0.83	0.14	0.22
Logged Disposable Income Indicator	-0.33	0.043	0.16	-2.05
Logged Rough Sleeping Indicator	0.042	0.84	0.20	0.21
Logged Opiate User Indicator	0.83	4.25e-09	0.13	6.46

Table 4. Multiple Regression Results

Figure 3 below highlights the residuals for the four predictor variables. Based on these plots, the logged variables appear to conform to the four LINE assumptions. However, the outliers are apparent in some of the plots, especially in the crime rate, income and rough sleepers plots which would have an effect on the results.

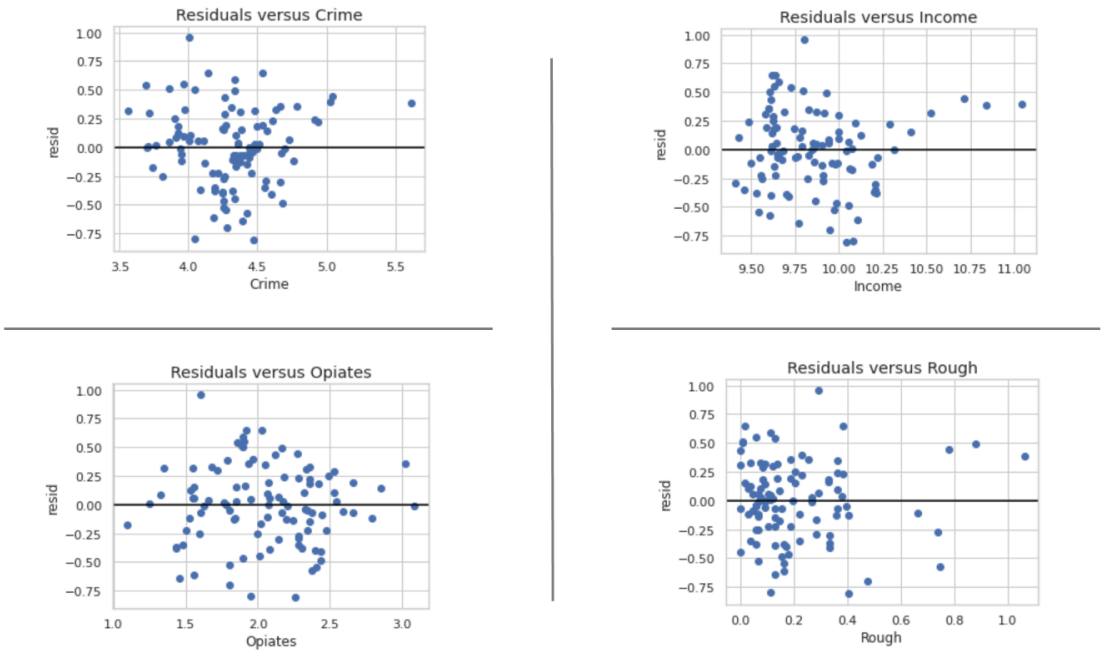

Figure 3. Residual Plots for Predictor Variables

6. Discussion of Results

The model accounts for 54.3% of the variance in opioid deaths based on the adjusted R-Squared value. The logged rough sleeping indicator and the logged crime rate have very high p-values, both above 0.8, which means that they are not highly correlated to the death rate. More interesting, however, are the low p-values of logged disposable income, 0.043, and the logged opiate user indicator, 4.25e-09.

The low p-value for the logged opiate user indicator makes logical sense, as the number of opiate users increases the likelihood of drug deaths increases as well. Disposable income is negatively correlated to the drug death rate; as people in local authorities have higher disposable income, drug overdose deaths become less frequent.

While this regression cannot point to the causality in these relationships, it does show that if local authorities want to decrease the number of drug deaths in their jurisdictions, they should prioritise policies that decrease the number of opioid users. Combined with the literature, this likely means working with healthcare providers to ensure that opioids are prescribed in a health conscious manner and not overprescribed, leading to higher chances of addiction (Greener, no date). Disposable income is likely more difficult to influence as a local authority. However, a successful policy would focus on those most vulnerable and in higher levels of poverty as it clear that higher levels of poverty, or lack of disposable income, leads to higher levels of drug overdoses.

This model would likely be improved by adding data related to opioid prescriptions per local authority, as evidenced by similar US models. It may also have been improved by removing outliers and by looking into the types of crimes added to the

crime rate variable in greater detail to determine if there are any most commonly associated with opioid users.

However, looking back to the research question, it appears that a higher number of drug users and higher levels of deprivation in local authorities correlate to a higher frequency of drug-related deaths.

7. Conclusion

There does not appear to be a silver bullet for local authorities when it comes to decreasing the rate of drug-related deaths. However, the route to bringing down the numbers seems obvious, decreasing drug user numbers. In reality, as evidenced by the increasing problems in both the US and the UK, this is easier said than done.

Dealing with addiction is tricky, nuanced and many tactics can be prove to be controversial. Drug use is related to unwanted social behaviours like crime but more likely reflects pre-existing inequalities in society and harms those already most vulnerable. Based on this study, local authorities should begin to work with opioid users in their areas to help them find solutions to stop them from using. Local authorities should prioritise preventative drug policies on those who are most impoverished as it appears they are the highest risk group when it comes to drug-related deaths.

References

9.3 - Log-transforming Both the Predictor and Response | STAT 501 (no date) PennState: Statistics Online Courses. Available at: https://online.stat.psu.edu/stat501/lesson/9/9.3 (Accessed: 17 January 2021).

'2019_03_estimates_of_the_prevalence_of_opiate_use_andor_crack_cocaine_use_201617_sweep_13_.pdf' (no date). Available at: https://www.ljmu.ac.uk/~/media/phi-reports/pdf/2019_03_estimates_of_the_prevalence_of_opiate_use_andor_crack_cocaine_use_201617_sweep_13_.pdf (Accessed: 14 January 2021).

'AI can predict opioid overdoses from crime and socioeconomic data' (2019) VentureBeat, 14 May. Available at: https://venturebeat.com/2019/05/14/ai-can-predict-opioid-overdoses-from-crime-and-socioeconomic-data/ (Accessed: 15 January 2021).

Barton, C. and Dempsey, N. (2021) 'Local Authority Homelessness Statistics (England)'. Available at: https://commonslibrary.parliament.uk/research-briefings/cbp-7586/ (Accessed: 14 January 2021).

Basler, M. H. (no date) Could we see a prescription opioid epidemic in the UK? | EndNote Click. Available at: https://kopernio.com/viewer?doi=10.1136%2Fbmj.j790&token=WzMwMDAwNjQsIjEwLjExMzYvYm1qLmo3OTAiXQ.jsDlZBDm79XGddGKhPnyHqDiXD4 (Accessed: 16 January 2021).

Crime in England and Wales Statistical bulletins - Office for National Statistics (no date). Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/bulletins/crimeinenglandandwales/previousReleases (Accessed: 17 January 2021).

Current UK data on opioid misuse | Faculty of Pain Medicine (no date). Available at: https://fpm.ac.uk/opioids-aware-clinical-use-opioids/current-uk-data-opioid-misuse (Accessed: 15 January 2021).

Deaths related to drug poisoning in England and Wales: 2019 registrations - Office for National Statistics (no date). Available at: https://www.ons.gov.uk/releases/deathsrelatedtodrugpoisoninginenglandandwales2019registrations (Accessed: 16 January 2021).

Drug misuse in England and Wales - Appendix table - Office for National Statistics (no date). Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/datasets/drugmisuseinenglandandwalesappendixtable (Accessed: 14 January 2021).

Gostin-2017-Reframing-the-opioid-epidemic-as-a-.pdf (no date). Available at: https://kopernio.com/viewer?doi=10.1001/jama.2017.13358&route=7 (Accessed: 16

January 2021).

Greener, M. (no date) Will the UK face an opioid abuse epidemic? | EndNote Click. Available at: https://kopernio.com/viewer?doi=10.1002%2Fpsb.1604&token=WzMwMDAwNjQsIjEwLjEwMDIvcHNiLjE2MDQiXQ.MA_RNnJoyfuI8KAK3YGR-UPyZ6E (Accessed: 18 January 2021).

Hammersley, R. et al. (1989) 'The Relationship Between Crime and Opioid Use*', British Journal of Addiction, 84(9), pp. 1029–1043. doi: https://doi.org/10.1111/j.1360-0443.1989.tb00786.x.

Katz, J., Goodnough, A. and Sanger-Katz, M. (2020) 'In Shadow of Pandemic, U.S. Drug Overdose Deaths Resurge to Record', The New York Times, 15 July. Available at: https://www.nytimes.com/interactive/2020/07/15/upshot/drug-overdose-deaths.html (Accessed: 16 January 2021).

Mott, J. (1980) 'Opiate Use and Crime in the United Kingdom', Contemporary Drug Problems, 9(4), pp. 437–452. Available at: https://heinonline.org/HOL/P?h=hein.journals/condp9&i=450 (Accessed: 15 January 2021).

Opiate and crack cocaine use: prevalence estimates by local area (no date) GOV.UK. Available at: https://www.gov.uk/government/publications/opiate-and-crack-cocaine-use-prevalence-estimates-for-local-populations (Accessed: 17 January 2021).

Pierce, M. et al. (2015) 'Quantifying crime associated with drug use among a large cohort of sanctioned offenders in England and Wales', Drug and Alcohol Dependence, 155, pp. 52–59. doi: 10.1016/j.drugalcdep.2015.08.018.

Predictive Modeling of Opioid Overdose Using Linked Statewide Medical and Criminal Justice Data | Psychiatry | JAMA Psychiatry | JAMA Network (no date). Available at: https://jamanetwork.com/journals/jamapsychiatry/article-abstract/2767722 (Accessed: 16 January 2021).

Public Health Institute reports (no date). Available at: http://www.ljmu.ac.uk/research/centres-and-institutes/public-health-institute/phi-reports (Accessed: 14 January 2021).

Recorded crime data by Community Safety Partnership area - Office for National Statistics (no date). Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/crimeandjustice/datasets/recordedcrimedatabycommunitysafetypartnershiparea/current (Accessed: 14 January 2021).

Regional gross disposable household income by local authority - Office for National Statistics (no date). Available at: https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/datasets/regionalgrossdisposablehouseholdincomegdhibylocalauthorityintheuk (Accessed: 14 January 2021).

Weisberg, D. F. et al. (2014) ‘Prescription opioid misuse in the United States and the United Kingdom: Cautionary lessons’, International Journal of Drug Policy, 25(6), pp. 1124–1130. doi: 10.1016/j.drugpo.2014.07.009.

Yamamoto, A. et al. (2019) ‘Association between homelessness and opioid overdose and opioid-related hospital admissions/emergency department visits’, Social Science & Medicine, 242, p. 112585. doi: 10.1016/j.socscimed.2019.112585.