Examining the Relationship Between Multihousing Rental Factors, Crime, and Police Calls for Service in the City of Burnsville, Minnesota

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Abstract

Apartment and townhome complexes, also known as multihousing, represent an interesting challenge for law enforcement. The high concentration of people in one area provide ample criminal opportunities and targets, but also a higher level of community guardianship, which has been shown in previous studies to deter criminals. This study describes factors pertaining to specific multihousing complexes in Burnsville, Minnesota, such as average rent, use of security cameras, walkability scores, and low income housing acceptance, and explores the relationship between these factors and the amount of crime and police calls for service to those complexes, using data from the Burnsville Police Department. Pearson's Correlation and Point-Biserial Correlation are used to identify relationships between variables on a one-to-one basis, and then ArcGIS tools for Ordinary Least Squares and Exploratory Regression are used to further understand multivariate relationships in the data. Ultimately, no passing multivariate models were found in this study to effectively describe the crimes or police calls. Acceptance of low income housing vouchers at a complex was found to have a significant relationship with more than one dependent variable, though the sample size for the dataset was small, so further research on the topic on a wider scale is suggested.

Introduction

This project focuses on rental apartment and townhome complexes (also known as multihousing) in Burnsville, Minnesota, and the crime and police calls that occur at these complexes. Variables pertaining to the infrastructure and rental practices of each complex were examined to see if a relationship exists between a combination of housing factors and the amount of crime or police calls for service that each one has experienced in the last 3.5 years.

Several previous studies have explored relationships with crime prevalence using Pearson's Correlation, Ordinary Least Squares (OLS), and Esri's Exploratory Regression tools (Eckerson, 2013; Florhaug, 2018; Riley, 2017). This study aims to use a similar methodology to assess multihousing factors and crime.

Background

The Social Disorganization Theory of criminology describes three main elements that lead to crime prevalence through social disorganization of a community. These elements are low income, ethnic heterogeneity, and residential mobility

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(He, Paez, Liu, and Jiang, 2015). Residential mobility refers to people moving homes, and therefore not creating long-lasting bonds between neighbors to reinforce the sense of community. This is often an issue in rental apartments and townhomes, such as the ones in this study.

The routine activity theory of criminology also touches on an interesting dichotomy of multihousing complexes, pointing out that these communities have a higher concentration of criminals, as well as potential crime targets, due to the close proximity of residents to one another. At the same time, these complexes are also home to more pro-social tenants watching over the area as capable guardians, which has previously been shown to deter criminals in high-concentration areas (Cahill and Mulligan, 2007).

Study Area

Burnsville, Minnesota is a suburb south of Minneapolis (Figure 1) and has an estimated population of 61,290. The city occupies 25 square miles and is within Dakota County. The Burnsville Police Department has 75 sworn officers and receives just under 50,000 calls for service per year (Burnsville Police, 2018).

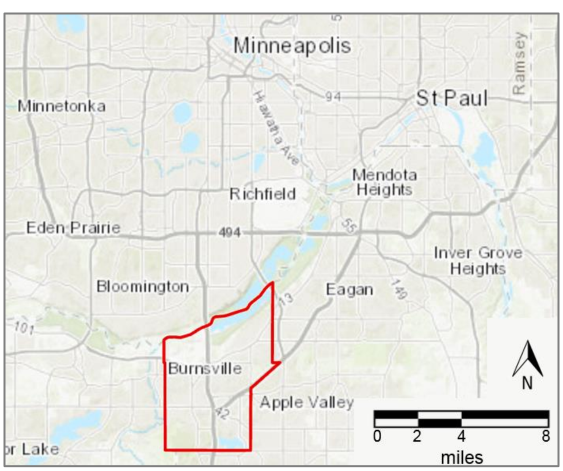


Figure 1. Location of study area (Burnsville, MN), within the Minneapolis and St. Paul metro area.

According to the U.S. Census Bureau, 83.6% of Burnsville residents are living in the same house they lived in one year ago. The median rent in Burnsville is $1,111, and 64% of residences are owner-occupied (U.S. Census, 2018).

The estimated median household income of Burnsville was $67,397 in 2017, there are 9.3% of people living in poverty, and 73.8% of residents are white. Compared to Dakota County as a whole, Burnsville has more diversity, more rental housing, lower average income, and higher poverty (U.S. Census, 2018). Section 8 housing assistance vouchers are available through the Public Housing Authority to residents who make less than 50% of the median income of the local area, which in Burnsville would be a household income under $33,700 (U.S. Department of Housing and Urban Development, 2019).

Methods

Apartment/Townhome Data

Data was collected from the Burnsville Police Community Resource Office on 53 apartment and townhome complexes, including complex name, building addresses, number of units, type of complex (apartment or townhome), and whether security cameras were installed. A map of the multihousing complexes in this study can be seen in Figure 2.

Additional information was collected online using apartment search websites, including average rent for a 2-bedroom unit, and whether Section 8 (low income) housing vouchers were accepted, as well as Walk Score and Transit Score. Walk Score and Transit Score are patented measures of walkability and access to public transit, respectively, which were developed by private company Walk Score, and are available online for any address using their proprietary search tool (Walk Score, 2019b). All of the attributes were combined into a spreadsheet, herein referred to as the Multihousing Data Sheet.

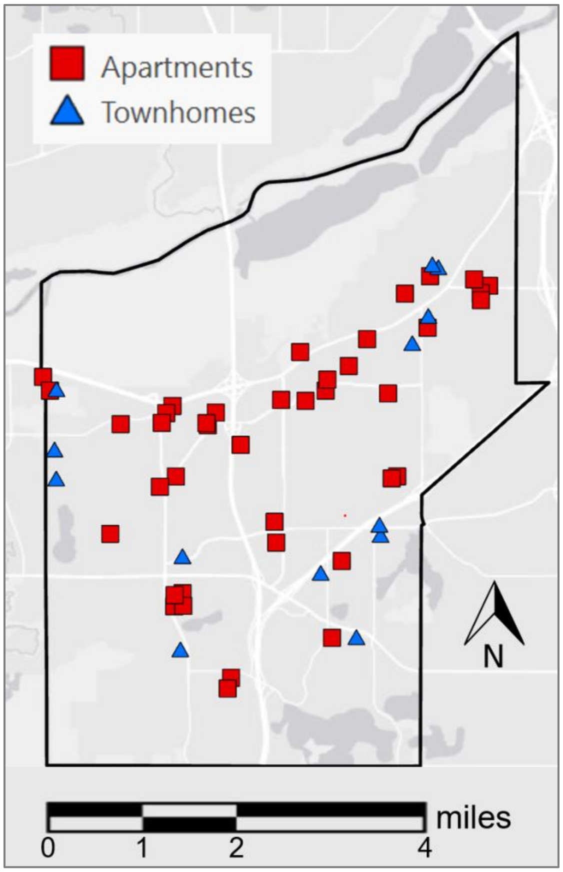


Figure 2. Locations of Burnsville multihousing complexes analyzed in this study.

Police Calls for Service Data

Housing complexes in this study were analyzed using the following metrics: total police calls for service, dispatched calls for service, Part I crimes, Part II crimes, and total crimes.

The police calls for service data were retrieved from Burnsville Police Department's ProPhoenix record management system (RMS). Multihousing addresses are coded in the system, so a query was run for all calls to these addresses for the timeframe of January 1, 2016 to June 30, 2019, and a spreadsheet was exported that included date/time, call type, and address, among other fields.

Dispatched calls are defined as calls for service where a 911 dispatcher assigns a call to an officer because someone has requested help, as opposed to those where the officer proactively creates a call. For the purposes of this study, dispatched calls are defined as all calls that do not fall into one of the following categories, as these categories are typically officer-generated: Background/ Prints/Gun Permits, Community Policing, Details - Traffic/Tobacco, Extra Patrol, Follow Up, Probation Checks, Test/Void, Traffic Stop, Utility Callouts, Warrant Service.

Crime Data

Part I crimes are defined by the Federal Bureau of Investigation's (FBI) Uniform Crime Report and specifically include homicide, rape, robbery, aggravated assault, burglary, theft, vehicle theft, and arson (FBI, 2012). Crimes not in this list are considered Part II crimes. They are less serious in nature and include things like fraud, drugs, and vandalism (FBI, 2012). A report of all Burnsville crimes in the same date range as above, along with their addresses and crime codes, was also generated using the ProPhoenix RMS.

Data on calls and cases were retrieved based on address, and a lookup table was used to join individual addresses to the apartment/townhome complex they are a part of, so analysis could be run per complex, rather than per building.

Total calls, dispatched calls, Part I crimes, Part II crimes, and total crimes were all totaled per complex, and then also divided by the number of units per housing complex to produce per-unit variables, before being added to the Multihousing Data Sheet described above.

Data Limitations

Burnsville has over 100 multihousing complexes, but only a subset was used for this study. In order to compare similar resident profiles and reduce confounding variables, only full-rental apartment and townhouse complexes were considered, not owner-occupied or partially owner-occupied buildings. Workforce housing, senior living, and assisted living homes were also excluded. Mobile homes are also sometimes considered multihousing, due to the close proximity of residents to one another, however these were also excluded from this study.

Only 45 of the 53 complexes were included in the analysis of average monthly rent, as the others did not have comparable data available. This study used rent collected for a 2-bedroom unit, and some complexes did not have any 2-bedroom units in the building. There were also complexes that catered to low-income residents and structured rent on a sliding scale based on the tenant's income. These were also excluded since they were not a direct comparison to others in the market.

This study was initially going to include whether a complex runs background checks on applicants, as well as whether they make applicants sign an agreement to not engage in criminal activity, and if these variables have any relationship with the crime and police metrics discussed above. The use of tenant background checks at time of application has become a contentious topic in the Minneapolis metro area as of late, with advocates citing discrimination against tenants who are low-income or have prior criminal histories (Evans, 2019). However, upon data collection, it was learned that the City of Burnsville has an ordinance in place that requires management to conduct criminal background checks on all applicants, as well as have a crime-free agreement on file (City of Burnsville, 2019). Since these variables are the same for all complexes, they were not examined in the study.

Software, Statistical Tests, and Use of Variables

Descriptive statistics were calculated for each variable using Microsoft Excel. Excel was also used to create boxplots, histograms, scatterplots, and correlation coefficients. A selection of scatterplots can be found in Appendix A.

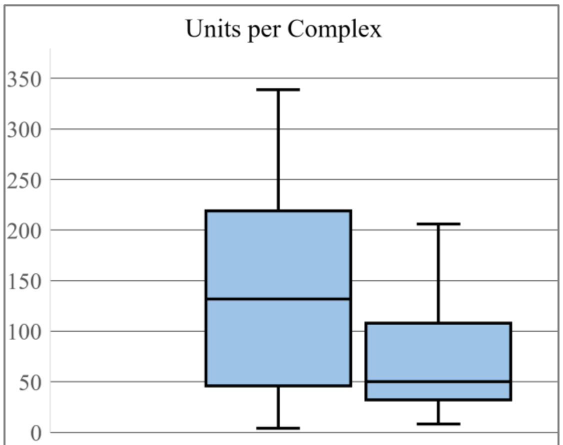
ArcGIS Pro was used for mapping and more advanced statistical analysis, including Ordinary Least Squares (OLS) and Exploratory Regression.

In all statistical tests, the housing variables (number of units, complex type, Section 8 housing vouchers, security cameras, Walk Score, Transit Score, and average rent) were used as the independent variables. Law enforcement variables (total calls, total calls per unit, dispatched calls, dispatched calls per unit, Part I crimes, Part I crimes per unit, Part II crimes, Part II crimes per unit, total crimes, and total crimes per unit) were used as the dependent variables.

Results

Descriptive Statistics

The multihousing complexes analyzed included 40 apartment complexes (6,225 total units) and 13 townhome complexes (966 total units). Figure 3 shows the minimum, maximum, mean, median, and standard deviation of the number of units per complex, broken out by complex type (apartment or townhome). Apartments had a much larger spread than townhomes did in this regard, with the largest apartment complex (400 units) having nearly double the units of the largest townhome complex (206 units). This was not a normally distributed dataset, as there were a large number of complexes with few units.



	Apartments	Townhomes
Min	4	8
Max	400	206
Mean	155.6	74.3
Median	144	50
SD	114.8	65.5

Figure 3. Box and whisker plots for both apartment and townhome complexes in this study, showing the descriptive statistics of each in terms of number of units per complex

Of the 53 complexes studied, only 7 of them, or 13.2% of the complexes, accept Section 8 housing vouchers. This represents 507 units, or 7.1% of all multihousing units in this study. The proportion of units being smaller than the proportion of complexes suggests complexes that do accept Section 8 are smaller than average.

Of the 53 complexes studied, 27 or about half of them have security cameras installed. However, even though only 27 complexes have cameras installed, this represents 4,985 or 69.3% of all units. This suggests that many of the larger complexes are equipped with cameras, since the proportion of units is higher than the proportion of complexes.

Walk Score is a measure of walkability, describing the proximity to amenities and infrastructure for a given location (Walk Score, 2019b). On a scale of 0 to 100, the complexes in this study have a median Walk Score of 48. The lowest score is a 4, which is held by a townhome complex that is located 1.5 miles from the nearest gas station or restaurant. The highest score is a 73, which is the largest complex in the study, located on a corner with a gas station and several shops and restaurants.

Transit Score is calculated by combining the total "usefulness values" of nearby public transportation routes, including distance to the nearest stop, frequency of the route, and type of route (Walk Score, 2019a). The median Transit Score for the complexes in this study was 28 out of 100. The minimum was 7, and the maximum was 39. The American Community Survey estimates that 80% of Burnsville residents drive alone to work in their own cars, and public transit is not very popular (Data USA, 2019). Burnsville does have a transit station, with multiple bus routes to the major metro area arteries, but complexes that are not near the transit station have little to no public transportation access nearby.

The median rent for a 2-bedroom unit in one of the study complexes was $1,308. Table 1 displays the descriptive statistics for 2-bedroom unit rents in the study complexes.

Table 1. Descriptive statistics of 2-bedroom rent prices for the complexes in this study, broken out by complex type (apartments or townhomes).

	Total n = 45	**Apt n = 36**	**Town n = 9**
Min	$795	$795	$921
Max	$1,840	$1,840	$1,525
Mean	$1,323	$1,327	$1,307
Median	$1,308	$1,301	$1,308
SD	$213	$217	$206

There was a larger range of rent values (higher highs and lower lows) for apartments compared to townhomes, but the mean, median, and standard deviations of each subset were very close, meaning the average rent was not significantly affected by the complex type. The rent values were also normally distributed, as depicted by the histogram in Figure 4.

Descriptive statistics of the police calls for service data and the crime data can be found in Tables 2 and 3. In both the calls and the crimes, there were a wide range of values. Some complexes had almost no crime or police calls, while others had over 1 crime per unit during the study timeframe.

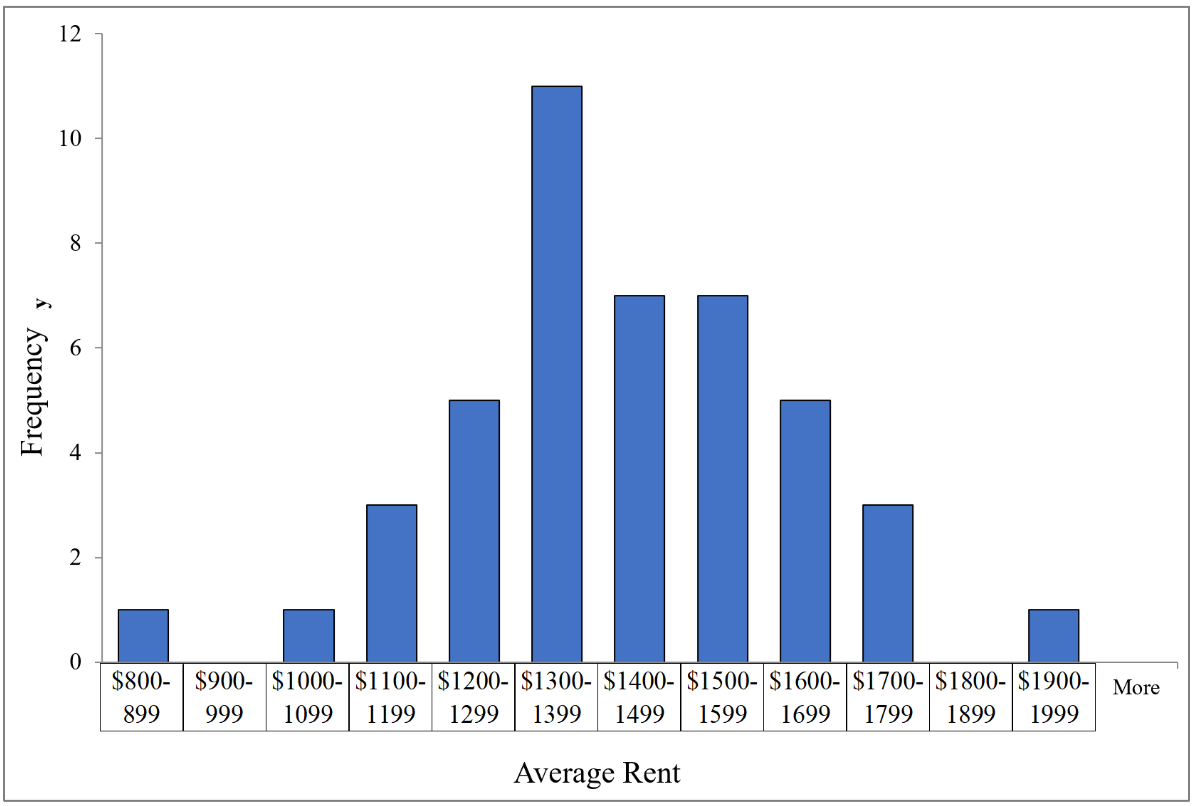


Figure 4. Histogram of average 2-bedroom rent prices for the complexes in this study.

Table 2. Descriptive statistics for total and dispatched police calls for service at the complexes in this study

	Total Calls	**Total Calls Per Unit**	**Dispatched Calls**	**Dispatched Calls Per Unit**
Min	5	0.6	5	0.5
Max	1670	12.2	1527	11.1
Range	1665	11.6	1522	10.6
Median	317	3.5	292	3.05
Mean	480.9	3.78	430.5	3.35
SD	441.9	2.28	397.9	2.00

Table 3. Descriptive statistics for Part I, Part II, and total crimes at the complexes in this study.

	Part I Crimes	**Part I Crimes Per Unit**	**Part II Crimes**	**Part II Crimes Per Unit**	**Total Crimes**	**Total Crimes Per Unit**
Min	1	0.02	1	0.05	2	0.08
Max	83	0.78	110	0.73	192	1.22
Range	82	0.76	109	0.68	190	1.14
Median	15	0.14	22.5	0.23	35.5	0.375
Mean	21.5	0.17	30.6	0.26	52.2	0.43
SD	20.8	0.12	26.2	0.16	45.2	0.25

Every metric in these tables had a higher mean than median, which suggests the distributions of these metrics are right-skewed, and there were individual complexes with high amounts of police or crime activity that were outliers and skewed the data. In fact, among the variables that describe entire complexes (rather than per unit), the mean was an average of 45% higher than the median. However, a large part of this skewness had to do with the size of the complexes. When the number of units per complex was factored in, the average mean was only 13% higher than the median, meaning that there were far fewer outliers in the crimes and calls per unit data.

Correlation

Pearson's Correlation

Pearson's Correlation is a test for determining whether a linear relationship exists between two interval- or ratio-level variables, as well as the strength and direction of the relationship (LeBlanc and Cox, 2017). The equation for Pearson's Correlation is as follows (LeBlanc and Cox, 2017):

$$r = \frac{n\sum(x_i y_i) - \sum x_i \times \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2} \times \sqrt{n\sum y_i^2 - (\sum y_i)^2}}$$

Pearson coefficients are on a scale from -1 to 1, with -1 representing a strong negative correlation, and 1 representing a strong positive correlation.

The Pearson test was used to determine whether any relationships exist between the number of units, Walk Score, Transit Score, or average rent individually, and any dependent variable. The correlation coefficients for each pair of variables are in Figures 5 and 6. A full matrix of all variables in the study can be found in Appendix B.

	Total Calls	Total Calls/ Unit	Dispatched Calls	Dispatched Calls / Unit
# of Units	0.85	-0.16	0.86	-0.15
Walk Score	0.04	-0.10	0.03	-0.10
Transit Score	0.13	-0.06	0.13	-0.05
Avg 2BR Rent	0.44	-0.01	0.44	0.00

Figure 5. Pearson Coefficient values describing relationships between the independent variables (left) and calls for service dependent variables (top) in this study.

	Part I Crimes	Part I Crimes Per Unit	Part II Crimes	Part II Crimes Per Unit	Total Crimes	Total Crimes Per Unit
# of Units	0.83	-0.16	0.79	-0.31	0.84	-0.28
Walk Score	0.05	-0.04	0.04	-0.13	0.05	-0.10
Transit Score	0.08	-0.09	0.09	-0.17	0.09	-0.15
Avg 2BR Rent	0.44	-0.11	0.38	-0.11	0.42	-0.12

Figure 6. Pearson Coefficient values describing relationships between the independent variables (left) and crime dependent variables (top) in this study.

In the tables above, the only correlations above a 0.8, which represent a very strong correlation, were between the number of units in a complex and the number of police calls and crimes at that complex. This is logical, as a building with more units is likely to have more law enforcement needs.

However, in looking at the number of units compared to the calls and crimes per unit, there are negative correlation coefficients, meaning that the more units there are in a complex, the number of calls and crimes per unit tends to go down. It is also important to note that the correlations for per-unit variables were all weak correlations, with coefficients between 0 and -0.3. This means that, when multiplied by themselves to get the Coefficient of Determination, no more than 10% of the variation in calls or crimes per unit was explained by the number of units per complex.

None of the correlation coefficients for the other independent variables (Walk Score, Transit Score, or average rent) were above the 0.5 threshold, meaning that no other strong correlations existed between these and the dependent variables.

Point-Biserial Correlation

Point-Biserial Correlation is used to find whether a relationship exists between a continuous variable and a binary variable. The formula is the same as that of the Pearson's Correlation test, but it uses 0 and 1 as the two options for the binary variable (LeBlanc and Cox, 2017). In this study, three of the independent variables were binary in nature, and those were whether a complex was made up of apartments or townhomes, whether the complex had security cameras installed, and whether the complex accepted Section 8 housing vouchers.

For the binary values of the Complex Type variable, apartments were represented by 0, while townhomes were represented by 1. For both the camera and Section 8 variables, "No" values were represented by 0, and "Yes" values were represented by 1. The correlation coefficients for these variables are in Figures 7 and 8.

	Total Calls	Total Calls Per Unit	Dispatched Calls	Dispatched Calls Per Unit
Complex Type	-0.28	0.23	-0.28	0.20
Cameras Installed	0.47	-0.11	0.46	-0.12
Section 8 Housing	-0.08	0.38	-0.09	0.35

Figure 7. Point Biserial Correlation Coefficient values describing relationships between the independent variables (left) and calls for service dependent variables (top) in this study.

	Part I Crimes	Part I Crimes Per Unit	Part II Crimes	Part II Crimes Per Unit	Total Crimes	Total Crimes Per Unit
Complex Type	-0.31	0.07	-0.24	0.35	-0.28	0.26
Cameras Installed	0.44	-0.04	0.46	-0.15	0.47	-0.12
Section 8 Housing	-0.16	0.18	0.03	0.59	-0.06	0.47

Figure 8. Point Biserial Correlation Coefficient values describing relationships between the independent variables (left) and crime variables (top) in this study.

For the complex type variable, since 0 represented apartments and 1 represented townhomes, a negative correlation to calls or cases meant that there were higher values for the dependent variables in the apartment dataset compared to townhomes, and a positive correlation represented that the dependent variables were higher for townhomes than they were apartments. Using this, the data showed that all of the crimes and calls for service were higher in apartments than townhomes, but when divided per unit, they were all higher in townhomes than apartments. It is important to note, however, that these relationships were all weak correlations, with the highest correlation coefficient being 0.35 (Part II crimes per unit).

For the camera variable, since 0 represented no cameras, and 1 represented cameras installed, a negative correlation to calls or cases meant that there were higher values for the dependent variables for the complexes without cameras, whereas a positive correlation meant that the dependent variables are higher for the complexes with cameras. Using this, the data showed that crimes and calls for service were all higher in complexes with cameras than complexes without cameras, but the inverse was true when the calls and crimes were divided per unit. However, the strength of the relationships between cameras and the total number of crimes and calls (not per unit) were much higher, with coefficients between 0.44 and 0.47, compared to those divided by unit of -0.15 to -0.04.

In both of these binary variables, however, it is important to keep in mind that the number of units per complex could have been a confounding variable. As noted above, number of units was the only independent variable with a strong positive correlation to total calls and cases, meaning that more calls and crimes took place in complexes with more units.

In relating this to complex type, apartments had more than twice as many units, on average, than townhome complexes did, and complexes with cameras had more than twice as many units, on average, compared to complexes without cameras. These differences likely had an influence on the variation between these groups. This possibility led to the testing of multivariate models further in this study.

For the Section 8 housing variable, since 0 represented no vouchers, and 1 represented vouchers accepted, a negative correlation to crimes or calls for service meant that there were higher values for the dependent variables for the complexes that do not take vouchers, whereas a positive correlation meant that the dependent variables were higher for the complexes that do take vouchers. Using this, data showed complexes that do take Section 8 housing had more calls and crimes per unit than complexes that do not take Section 8, but complexes that do not take Section 8 had more calls and crimes overall. There was one exception to this, which was Part II crimes. Those are the less severe crimes as classified by the FBI, and include things like drugs, alcohol, and fraud. Part II crimes are the only dependent variable that were higher both overall and per unit in the complexes that do take Section 8. The correlation coefficient between Section 8 and Part II crimes per unit was also 0.59, the highest coefficient of anything tested in this study, aside from number of units per complex.

Exploratory Regression

In order to develop and evaluate regression models using more than one independent variable, the Exploratory Regression tool in ArcGIS Pro was used. Exploratory Regression runs trials using all possible combinations of the independent variables to come up with models it then tests using the following diagnostic criteria to identify the best fit (Esri, 2019a):

1. Minimum acceptable Adjusted R^2 value *(0.5 default used in this study - measures the percentage of dependent variable variation explained by the model)*
2. Maximum coefficient p-value cutoff *(0.05 default used in this*

study - measures confidence level of statistical significance of correlation coefficients)

3. Maximum Variance Inflation Factor (VIF) value cutoff *(7.5 default used in this study - measures redundancy between variables)*
4. Minimum acceptable Jarque Bera p-value *(0.1 default used in this study - measures whether residuals are normally distributed or if model is biased)*
5. Minimum acceptable Spatial Autocorrelation p-value *(0.1 default used in this study - measures whether key variables are missing by checking if residuals are clustered)*

The Exploratory Regression tool was run using the following as potential independent variables: number of units, type of complex (apartment or townhome), Section 8 housing accepted, security cameras installed, Walk Score, Transit Score, and average rent.

The tool was run for each of the following dependent variables: total calls per unit, dispatched calls per unit, Part I crimes per unit, Part II crimes per unit, and total crimes per unit. The per-unit metrics were chosen for analysis rather than the overall counts, as complex size was shown to be a significant factor in earlier tests.

For total calls per unit, all models using between 1 and 5 independent variables were generated, and no models passed all of the diagnostic tests. In reviewing the Global Summary section of the report, it shows that none of the models had an Adjusted R^2 over 0.5, meaning that none of the models explained at least half of the variation in the dependent variable (total calls per unit). Similar outcomes were shown for dispatched calls per unit, Part I crimes per unit, Part II crimes per unit, and total crimes per unit. No passing models were discovered for any of these dependent variables.

The Summary of Multicollinearity (VIF values) in each of the Exploratory Regression reports also showed that there were no redundant variables within the set of independent variables tested. This was interesting, as it was hypothesized the Walk Score and Transit Score would be somewhat redundant, due to their both representing proximity to infrastructure, but the tests apparently consider them different enough to both be valuable.

Although none of the models were strong enough to generalize or create predictions from, the variable regarding whether Section 8 housing vouchers are accepted at a complex was consistently shown to be statistically significant in a positive direction, meaning that the complexes that do take Section 8 vouchers had significantly higher levels of police calls for service. This variable was significant 100% of the time during testing of both total and dispatched calls for service (Figure 9). It was also statistically significant when evaluating models related to Part II (less severe) and total crime activity. This is in line with the results from the Point-Biserial Correlation testing, which also showed Section 8 housing to have a correlation to the dependent variables.

Summary of Variable Significance

Variable	% Significant	% Negative	% Positive
ACCEPTS8	100.00	0.00	100.00
UNITS	0.00	87.72	12.28
CAMERAS	0.00	92.98	7.02
WALKSCORE	0.00	100.00	0.00
TRANSITSCORE	0.00	40.35	59.65
AVG2BR	0.00	12.28	87.72
TYPEBIN	0.00	45.61	54.39

Figure 9. Significance of individual variables in the exploratory regression report for total calls per unit.

Section 8 was not significant,

however, when evaluating models related to Part I (more severe) crime activity. There was still a positive correlation 100% of the time, but the results were not statistically significant.

The number of units in a complex was also shown to be statistically significant 10.5% of the time during testing of models related to Part II crimes per unit. It was significant in a negative correlation to the crime, meaning that the more units a complex had, the lower the Part II crime activity it experienced. This supports the theory of more capable guardians reducing crime. Other than Section 8 housing and the number of units in a complex, none of the variables were shown to be significant during the Exploratory Regression tests.

Ordinary Least Squares (OLS) Regression

The Ordinary Least Squares (OLS) Regression tool was used in ArcGIS Pro to confirm that none of the regression models would be suitable for explaining the variation in the crime and police calls for service data. OLS regression was run on the same dependent variables listed in the Exploratory Regression section, and all seven independent variables. No additional models were successfully produced using OLS. The output of the OLS tool is slightly different from the Exploratory Regression tool, providing additional detail on the statistical significance of each individual diagnostic test. The Koenker Statistic significance was of particular interest as a precursor to Geographically Weighted Regression analysis.

Geographically Weighted Regression

In reviewing the results from Exploratory Regression and OLS tools, the Koenker (BP) Statistic describes whether the relationship between variables is non-stationary, meaning the strength of the relationship could change based on geographic location. For example, Eckerson (2013) conducted a study on the relationships between tree canopy and crime in Minneapolis, and tree canopy was found to be a significant factor in crime levels in some neighborhoods but not others. Geographically Weighted Regression (GWR) is a tool in ArcGIS that is used to test this concept on specific models. It is generally used when the Koenker test is statistically significant in the model diagnostics (Esri, 2019c).

In this study, only one of the OLS models produced a statistically significant Koenker test result, and that was the model using all 7 independent variables in describing Part II crimes per Unit. However, in order for GWR to be effective in analyzing a model, the model must be properly specified according to the other diagnostic tests, and ideally there would be several hundred data points to evaluate (Esri, 2019b). Because neither of these criteria are the case for the Part II crimes per Unit model, GWR was not used to analyze it further.

***t*-Test**

To further confirm the significance of Section 8 housing acceptance on crime, a *t*-test was attempted to determine if there was a statistically significant difference between mean Part II crimes per unit in complexes that do accept Section 8 and those that do not.

The default *t*-test used in many statistical programs is known as the Student's *t*-test, but this test has several assumptions that must be true of the data, including a homogeneity of variance and a normal distribution (Delacre, Lakens, and

Leys, 2017). An *F*-test was conducted on the Section 8 test groups, using Part II crimes per unit as the values, and it was determined that the variance between the groups was suitable for use in the Student's *t*-test. However, histograms of the two groups revealed that they are not normally distributed. Complexes that do not allow Section 8 have a right-skewed distribution, and complexes that do accept Section 8 have a small sample size that makes it difficult to display much of a shape (Figure 10). Therefore, the Student's *t*-test is not appropriate for this dataset.

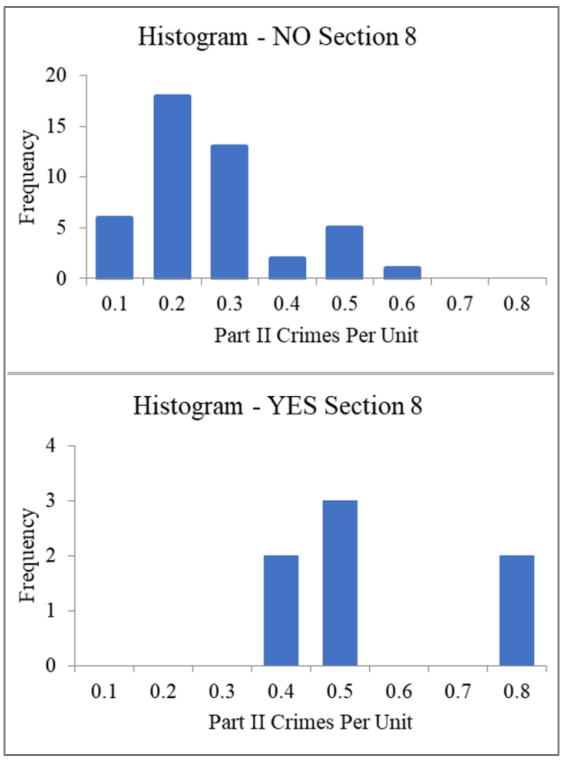


Figure 10. Distribution histograms of Part II crimes per unit for each test group – complexes that do not accept Section 8, and those that do.

Alternative tests exist, such as the Welch's *t*-test, which is more suitable for datasets with unequal sample sizes or variance between the test groups, but non-normal distributions with small sample sizes also pose a problem for the Welch's *t*-test (Delacre *et al.*, 2017).

It has been shown, however, that distribution normality becomes less important in *t*-tests as sample size grows (Lumley, Diehr, Emerson, and Chen, 2002). Therefore, this relationship between Section 8 housing and Part II crime could be more accurately analyzed in the future using a larger multihousing complex dataset.

Discussion

Statistical analysis did not produce any significant multivariate models that successfully describe or predict variation in the dependent variables. The number of units in a complex was confirmed as having a relationship with the overall amount of crime and police calls in a complex, but when activity was further analyzed on a per-unit basis, these relationships were no longer present.

Potential Sources of Error

There are possible data quality issues in any study. The calls for service and crime data were pulled from the ProPhoenix RMS, based on a list of locations classified as multihousing addresses in the system. It is possible that there are errors in that list, either omissions or extraneous addresses that should not be there. There is also a standardization process that all crimes and calls go through to ensure accuracy, but it is possible that a typographic error in a call or case led to it being included or not included in the multihousing data pull based on that error. Precautions were taken to reduce error once the data was exported into spreadsheets and tables as well, but there is also always a chance that values were inadvertently altered during the course of analysis.

Another consideration is that crime

often goes unreported. This study obviously only analyzed crimes that were reported, and has no way of accounting for unreported crime. It is also important to note that the crime data is only gathered by the FBI in a manner where only one crime classification is collected for each incident, ignoring lesser crimes in the same incident. For example, if a sexual assault and a theft occurred during the same incident, only the sexual assault would be counted by the FBI. This study counted crimes in the same way. Additional insights could potentially be generated if these incidents were broken out into individual criminal charges.

Seeing as none of the models developed accounted for even half of the variation in the dependent variables, there are clearly variables that are outstanding. Measures were taken to narrow down the complexes used in this study to a dataset that were comparable to one another, but there could be additional variables related to infrastructure, rental practices, or geographic location that influence the crime and calls for service.

Opportunities for Future Research

Complexes that accept Section 8 housing vouchers were shown to have significantly higher amounts of Part II crimes per unit in this study. However, due to the small number of complexes in this category, outliers and model bias were a factor in exploring this particular metric further, so additional study into this topic is recommended on a larger scale.

The results of Section 8 housing vouchers being linked to higher Part II crime would be worth investigating further from a criminology standpoint as well. Section 8 vouchers are for low income tenants, and Social Disorganization Theory has stated that low income is one of the main factors that influence crime prevalence of a given area (He *et al.*, 2015). Therefore, it could be interesting to further explore the specific types of Part II crimes being committed, and analyze each one with respect to Section 8 or low income status. Because Part II crimes are such a wide category, ranging from fraud to drugs to prostitution, this would help to identify specific crime types that are influenced most by this relationship. Census data on crime and income levels could also be used to expand this analysis.

Another opportunity for further study would be geospatially analyzing hotspots and cold spots of crime or calls with respect to concentration of the complexes themselves. This study was statistical in nature, and since none of the models were properly specified, geographic weighted regression and other geospatial tests were not run on the data.

Conclusion

Although no properly specified model was found to explain the crime and police calls in Burnsville multihousing complexes, this research can nevertheless provide guidance for future research on this topic. Tools such as exploratory regression, OLS, and GWR can be used to continue quantitative assessment on the factors that may influence crime in Burnsville and beyond, arming law enforcement officers with actionable information to help make communities safer.

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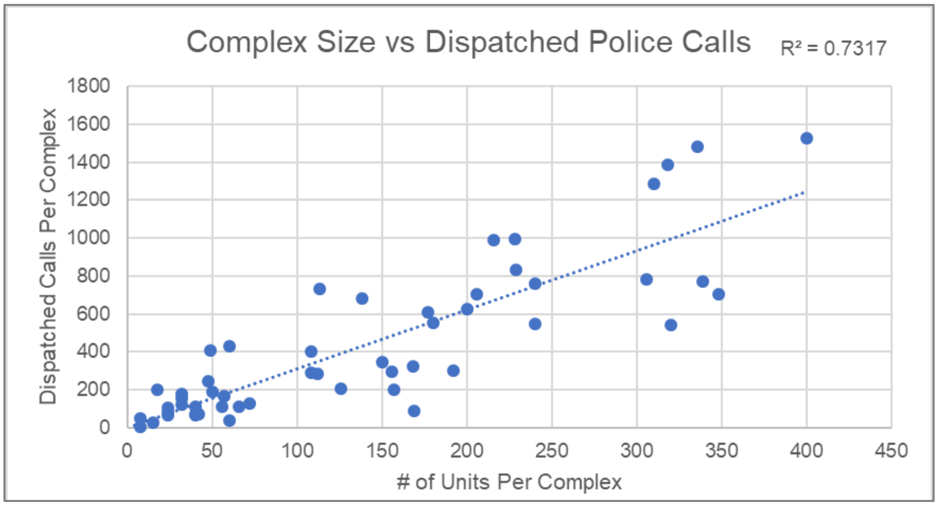
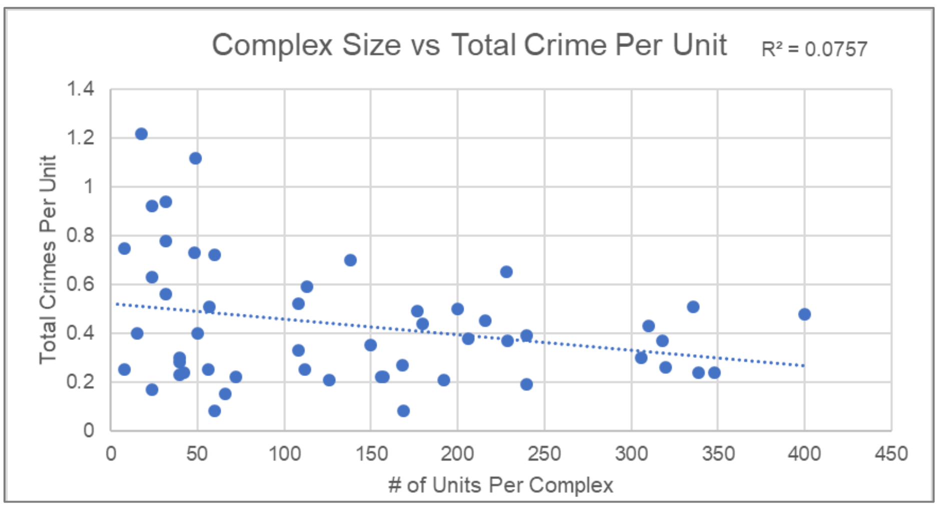
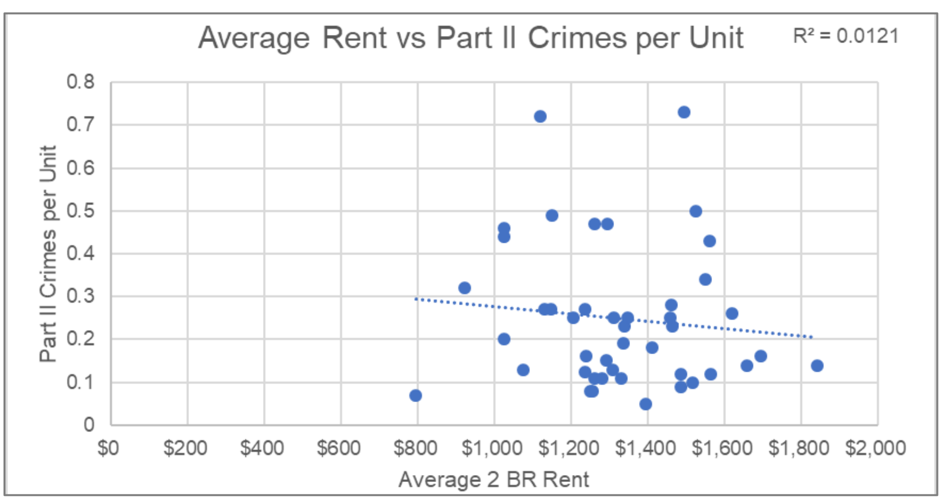
Appendix A. Scatterplot charts for selected dependent/independent variable pairs.



Graph representing number of units per complex and dispatched calls for service.



Graph representing number of units per complex and total crimes per unit.



Graph representing average rent for a 2-bedroom unit and Part II crimes per unit.

Appendix B. Correlation coefficients (Pearson's and Point-Biserial) for all variables in this study.

	# Units	Type	Accept S8	Cameras	Walk Score	Transit Score	Avg 2BR Rent	Total Calls	Total Calls per Unit	Dispatched Calls	Dispatched Calls per Unit	Part 1 Crimes	Part 1 Crimes per Unit	Part 2 Crimes	Part 2 Crimes per Unit	Total Crimes	Total Crimes per Unit
# Units	1.000																
Type	-0.321	1.000															
Accept S8	-0.226	0.425	1.000														
Cameras	0.458	-0.406	-0.063	1.000													
Walk Score	0.114	-0.081	0.223	0.116	1.000												
Transit Score	0.087	-0.181	0.069	0.281	0.506	1.000											
Avg 2BR Rent	0.508	-0.039	-0.087	0.109	0.007	0.206	1.000										
Total Calls	0.850	-0.280	-0.077	0.468	0.035	0.132	0.442	1.000									
Total Calls per Unit	-0.165	0.227	0.382	-0.109	-0.101	-0.065	-0.005	0.211	1.000								
Dispatched Calls	0.855	-0.284	-0.092	0.462	0.035	0.128	0.445	0.999	0.203	1.000							
Dispatched Calls per Unit	-0.146	0.202	0.350	-0.118	-0.097	-0.051	0.004	0.227	0.997	0.220	1.000						
Part 1 Crimes	0.835	-0.311	-0.158	0.436	0.053	0.079	0.437	0.896	0.116	0.899	0.133	1.000					
Part 1 Crimes per Unit	-0.164	0.074	0.182	-0.042	-0.041	-0.087	-0.112	0.080	0.793	0.078	0.791	0.190	1.000				
Part 2 Crimes	0.794	-0.240	0.028	0.461	0.042	0.092	0.384	0.955	0.226	0.953	0.238	0.849	0.074	1.000			
Part 2 Crimes per Unit	-0.309	0.354	0.593	-0.154	-0.126	-0.170	-0.110	0.043	0.800	0.033	0.784	-0.047	0.551	0.174	1.000		
Total Crimes	0.844	-0.282	-0.057	0.468	0.049	0.090	0.423	0.966	0.184	0.966	0.199	0.952	0.130	0.970	0.079	1.000	
Total Crimes per Unit	-0.275	0.262	0.473	-0.120	-0.099	-0.151	-0.118	0.068	0.901	0.060	0.891	0.065	0.844	0.148	0.913	0.116	1.000