A Statistical Analysis on Park Relationships with Socioeconomic Factors in the City of Modesto

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**Abstract:**

Parks serve as a safe place for people from all walks of life to spend time recreationally. Parks are a good thing to have in cities, but many studies have found that lower-income groups and minorities are at a disadvantage when it comes to access, equity, and quality of parks. This study focuses on socioeconomic conditions and how they correlate with data from other parks to find patterns between groups of census tracts in Modesto. The main independent variables in this study are location, per capita income, population, and racial data. These are compared to amenities, number of parks, and park access to reveal patterns about them. The data was collected through existing sources, such as the Healthy Places Index and the City of Modesto's park database. This study will explore the discrepancy in race and socioeconomic data in relation to park amenities, number of parks, and park access in four regions of Modesto. I hypothesize that per capita income and the number of parks, amenities, and access are correlated positively while percent minority groups and the dependent variables are inversely related. However, the study found that park access was relatively equal between all income groups, the number of parks was similar between population and the ratio of amenities per park was also not influenced much by income or race. That said, this study is simply the beginning of a more complex analysis of parks that is sure to come in the future.

**Literature Review**

Multiple studies display how an increase in social status or wealth has given way to better park facilities in the surrounding region. A study by David Scott, mentions that poorer Americans' leisure time is taken by other things since they do not have easy access to recreation centers close to them due to economic conditions. This displays that income and access to recreation can have an association. Therefore, Scott determines that lower income can be associated with lower park access. (David Scott et al. 2013, pg 6)[2]

One study in Kansas City, Missouri displays that low-income census tracts have more parks, but worsened quality whereas middle and high-income tracts have a variety of parks, in terms of types of amenities offered, and are all well maintained. This has had a profound effect on the people of a neighborhood since parks provide a place of physical activity and fitness for the people that use them. This study used a method of auditing to obtain data on the quality of parks. This means that this study went out to each park and collected data on each piece of equipment present as well as noting other things such as litter. The quality of parks varied between low and high-income areas, and so did the amenities offered at each park. This study also measured quality concerns per income distribution in census tract by taking six negative attributes such as graffiti or litter and seven positive attributes, like art or educational features and summing them to determine the average of the two per park, which is why the ratio is always under 1. The higher the ratio, the more quality concerns. The low-income areas had 0.75, the medium was 0.50, and the high was 0.42. The quality concerns varied by 0.33 concerns and the amenities at each group of parks (aggregated by income level) varied by 0.91. This means that high-income areas averaged about one more amenity than low-income areas.

Despite the quality concerns, the park availability was determined to be higher in the lower-income areas since the population was denser in those regions and more people lived closer to parks. This was determined through density calculations between census tract area, number of parks, and population of people. (Katherine B. Vaughan et. al 2013)[3]

Adding to park access figure, another study from Christine A Vaughan et al in Pittsburgh, Pennsylvania surveys people on their use of parks. It was found that 82.4% of people had visited a park at least once in their neighborhood before while 46.2% had visited in the past month. The alarming concern the study found is that 8.5% of people were unaware of the closest park to them. (Vaughan, Christine A et al 2018). Such a high percentage of people not knowing their closest park indicates that Pittsburgh is not doing a good job of encouraging regular use of park facilities. They concluded that by offering more incentives like park amenities, (playground, basketball courts, water fountains, etc.) lower-income folks would visit their nearest park more often. This is because the study looked into parks with high amenities vs parks with little amenities and found that the ones with higher amenities are being used more in relatively the same area. With this association, they concluded that more amenities would help increase park visits. (Vaughan, Christine A et al 2018)[4]

In 2008, Abercrombie et al in the state of Maryland found that mixed-race neighborhoods had the highest access to parks, despite the variety of income levels. Conversely, they found that low and middle-income areas (groups of people and households in neighborhoods) in primarily caucasian neighborhoods, as well as wealthy groups that lived in low-income neighborhoods, had the lowest access to parks in the region. In this study, park access was determined through a calculation of park size and people per park. In addition, they studied the ratio between the number and size of parks and compared it to the number of people in a census tract. This was used to confirm or deny the self-reported access and see if there was a correlation between the calculations and the survey. This study used census tract data to come up with its conclusions. It portrays a relationship between the income of a setting of the surrounding parks. (Abercrombie et al. 2008)[1]

In the studies above, the data was collected for a town or state, similarly, this study focuses just on Modesto, California. By limiting this study to just a city, it was much easier to gather data and process it more accurately. To improve the sample size of this data, collection and analysis between multiple states would better showcase the conclusions that both groups presented since it would ensure proper use of replication. The studies above do display a correlation between the socio-economic factors of regions and the access to and quality of parks available in that area, which is opposite to what this study found. To further add to this study between these variables, I would like to add my perspective on the city of Modesto and its community to gain a more diverse outlook on these studies as well as find other correlations that might occur.

**Introduction to the City of Modesto**

The City of Modesto is a diverse, medium-sized city in the middle of Stanislaus County in the valley of California. Modesto offers 76 parks and recreation centers (Laurie Smith, Director of Parks, Recreation, and Neighborhoods) across its landscape and some are much more well-supported than others. (Tuolumne River Trust)[7].  Parks go hand in hand with serving the community of a city. Many citizens use parks for various activities such as walking, biking, meditation, sports, running, etc. A person's relationship with a park is determined by the activities they like to perform, which is why park equity is so important in Modesto. The study will be using 2010 census tracts as a measure of aggregating spatial data.  The Census tract is the number associated with the census data of the specific region used for the location of parks and the surrounding area's socioeconomic data. This is the central type of geographic locator that I will be using to identify parks. Tracts are drawn based on population and geography proportional to land area.  (Geographic Products Branch U.S. Census Bureau)[8].

In order to better aggregate by stratifying the census tracts based on predicted differences in region, Modesto was split into four sections for the study. The groups consisted of similar populations and sizes, based on direction. By stratifying the data, the study was better able to determine key factors and trends in Modesto based on location since it was easier to compare the groups of census tracts rather than each tract. Each map was created by assigning each census tract into one of four groupings based on the cardinal direction. This was done since each group was predicted to report different data for the factors being tested. The East and West groups were split based on the number of people from the Healthy Places Index and based on the geographic location. Then, after each tract was assigned a group the area and population of the group were used as a second measure to confirm the validity of each group so that it is similar in size and population. (2018, Healthy Places Index Map 3.0)[5]

**North**
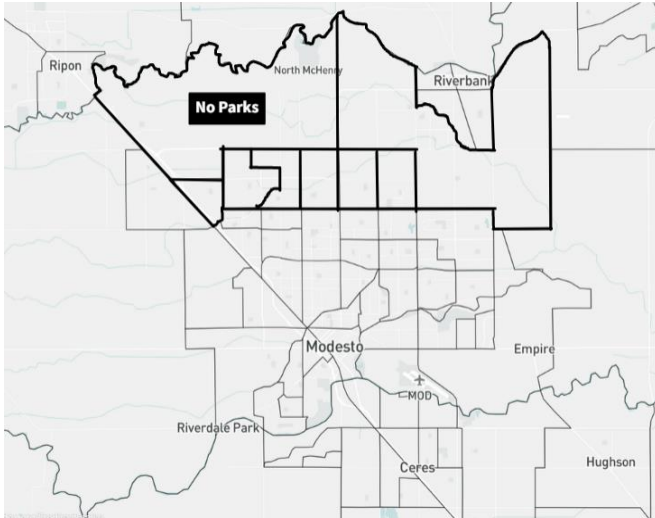
**West**
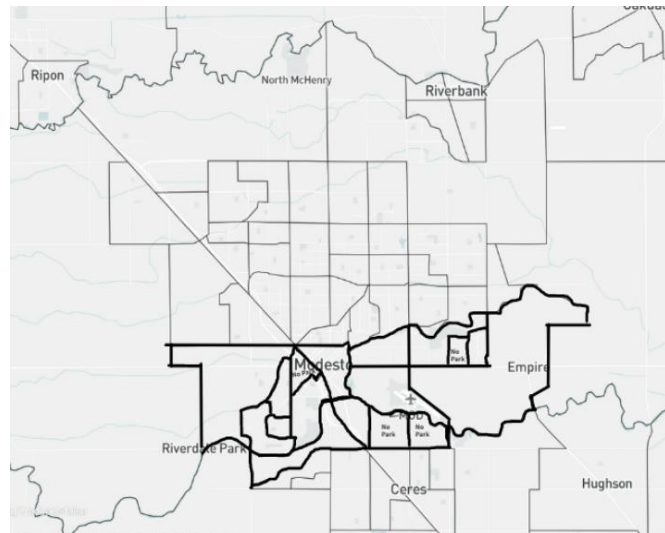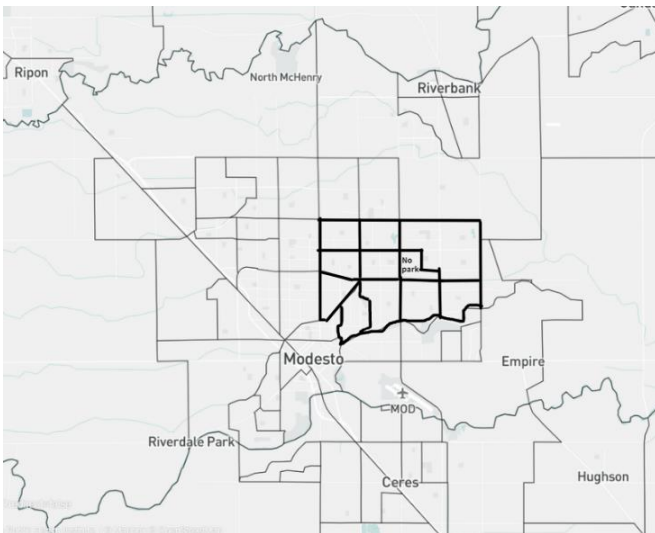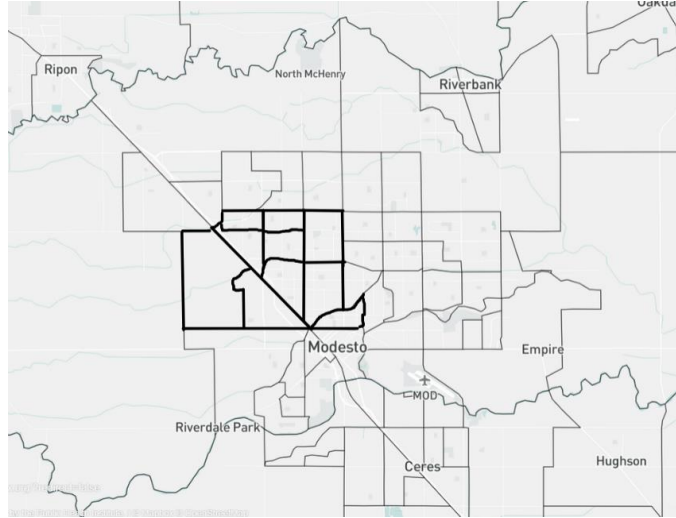


**East**

**South**

How exactly does this affect parks in the area? The study of Modesto will capitalize on previous studies' methodology and variables. With that being said, these complex variables will have further explanations to better understand how they work individually. Later, the variables will be connected and displayed their worth in groups.

The central independent variables in the study are income per capita, race, and the location of each group. The income per capita is calculated by dividing the total income of an area by the number of people that live in that area. It is essentially an average for the amount of

money made in a Census Tract. When taking a look at the HPI Map, the economic status of census tracts in Modesto is unevenly distributed across the city, with the South having a much lower per capita income than the rest of the regions. (2010, Healthy Places Index)[5] For this study, the race identifiers used were: White, Black, Asian, and Hispanic. These races were used to find an association between data variables such as income or access to parks. This race data is collected through the U.S. Census and is self-reported; the options available were white, Black, Asian, American-Indian, Asian-Indian, etc. Before this question of race, there is a question that asks if you are Hispanic, Latino, or of Spanish Origin (U.S. Census Bureau, Population Estimates Program)[10]. This question is separate from the other question about race but is still used with other races to compare three distributions. If a person marks they are Hispanic, the Healthy Places Index uses their race as Hispanic, and does not try to use the latter question of race to identify them. The census does two groupings, those who are Hispanic or of Spanish Origin, and those who are not. If they marked that they are Hispanic, then the second question on race is simply counted towards that race. For example, if they mark Hispanic and Black, they are grouped with "Hispanic, Black."(2021, Pew Research Center)[9]. The HPI index used in this study simply just takes Hispanic into account. Thus, if you marked "Hispanic, Black" you would be counted as Hispanic.

| | North | South | West | East |
|---|---|---|---|---|
| **Population** | 44,646 | 87,832 | 50,023 | 72,407 |
| **Parks Per 1000 People** | 0.16 | 0.28 | 0.36 | 0.15 |

The key dependent variables in the study are park access, parks per tract, parks per 1000 people, and amenities per park. The access to park percentage is defined as the percentage of people who live within 0.5 miles of a park in 2017. It was based on the census tract of the 2010 census and the data was collected by the California Department of Public Health (2018, Healthy Places Index). This measure is used to determine the number of people who could visit a park easily, not the number of people who would. The number of parks per 1000 people and the parks per tract were also used in this study to determine how many parks each group had. To calculate this number, each park in the group was totaled and divided by every 1000 people in the group. For example, if a group had ten parks and 10000 people, the ratio would be 1. The parks per tract was calculated by taking all the parks in the group and dividing them by the number of tracts that make up the group. The amenities per park was also used to determine the relative amount each group had. This was done by taking the total amenities in each group and dividing it by the total number of parks in each group. For this

study, an amenity was anything that was built on the park to increase the park's quality. These can include playgrounds, benches, fields, etc. (Laurie Smith, Director of Parks, Recreation, and Neighborhoods)[6]

Throughout the years' many groups have come to aid Modesto's park situation to provide equity to all parks in Modesto, especially the underfunded ones. The central group responsible for this is the local government of Modesto. In addition to this, a group called the Tuolumne River Trust has been established in order to maintain and improve parks over time. This group is a part of a larger branch that runs throughout the state called "All Children Thrive". This association has distinguished multiple cities to host events, provide feedback, and gain youth support for multiple cities in California, including Modesto (2022, All Children Thrive California). In this research paper, I strive to add to the knowledge ACT Modesto already has as well as establish a new line of reasoning for associations found through data collection. Specifically, the data found in racial minority neighborhoods can serve to improve certain parks to improve equity and equality between all regions of Modesto.
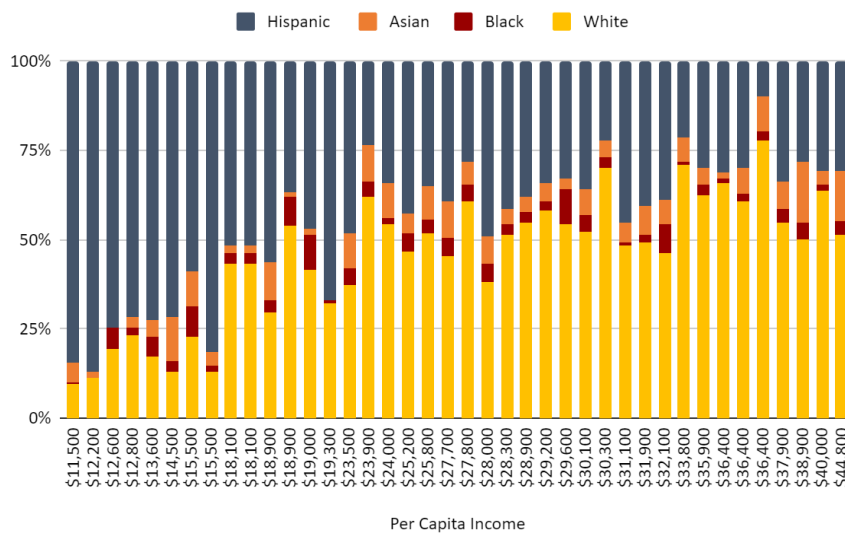


The X-axis on the stacked bar plot is each census tract sorted by income. The bar on the left is the lowest income census tract and the bar on the right is the highest. The percent white population displays a positive trend whereas the colored peoples scatter plot is more of a constant or negative trend. Specifically, the Hispanic scatter plot shows a negative association between the per capita income. This would mean that as the Hispanic population increases, the per capita income of the tract tends to decrease. As for the Asian and Black populations, there seems to be much less of a correlation between their populations and the per capita income of each tract. This can further portray that minority populations are more consistently living in low-income areas compared to their white counterparts. What does this mean for park equality? Lower-income areas are thought to have fewer facilities and equipment than high-income areas. On top of this, the quality of the equipment may be worse than in high-income areas as well, as similarly mentioned in the Kansas City, Missouri study.

I hypothesize that lower-income areas in Modesto will have a similar number of parks as other areas, but its amenities and park access will be lower than moderate or high-income areas. It can showcase that park equity does not apply to both low and high-income areas as high-income areas may differ in the number of amenities per park offered as well as the number of parks offered. Splitting Modesto into regions, the difference in income is seen to differentiate between regions, especially the south.
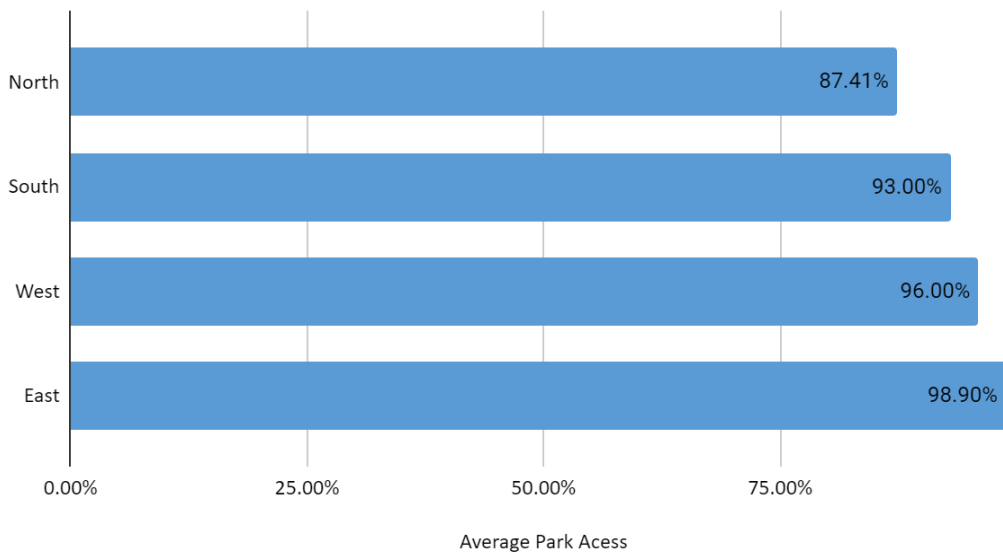
## Evidence

Based on the data gathered, park access has been relatively the same for each of the four regions. Parks per tract and parks per 1000 people seem to differ between regions, with the North side of Modesto having the lowest ratio for both. Despite this, the differences are minimal. Similarly, the amenities per park are similar between all four regions despite the rather large income and race disparities between all regions.

|  | North | South | West | East |
|---|---|---|---|---|
| **Total Parks** | 8 | 25 | 18 | 17 |
| **Total Ameneties** | 23 | 62 | 58 | 59 |
| **Average Per Capita Income** | $32,514 | $17,654 | $27,510 | $30,690 |
| **Parks per Tract** | 1.14 | 1.79 | 1.80 | 1.54 |

## Park Access

Park access between the four regions of Modesto was not very spread out compared to the other variables. Some areas have higher park access than other regions. This being said, the park access for all of the regions was quite high with three of the regions being at over 90%. Again, the pattern of the East and West sides of Modesto having more parks per tract supports the idea of park access. This is also consistent with the North side of Modesto as well since the North had the least parks per tract. For each census tract in the north, the population ranges from 4,000 to 11,000 people, which is similar to the rest of Modesto. Despite this, the North has the least number of parks, driving the park access down for that region compared to other regions in Modesto. This is contrary to the hypothesis of higher income correlating positively with park access. The South region's income is much lower than the East and West, yet the park access is negligibly lower. Therefore, even though there is a trend between the three regions, it is not strongly related.

Average Park Acess vs. Location



Amalgamating the data from the table, it is evident that despite having the most income, the North has the lowest access to parks. Many parks in the Northern area are very spread out and there are much fewer of them than the rest. That being said, many other variables could be affecting the park access like the distribution of parks in an area. This is not the full picture of park access in Modesto. Another measure of this would be the number of parks per 1000 people, which can give insight into why park access is distributed the way it is.

## Number of Parks Relative to Population

### Parks Per 1000 People



Parks Per 1000 People
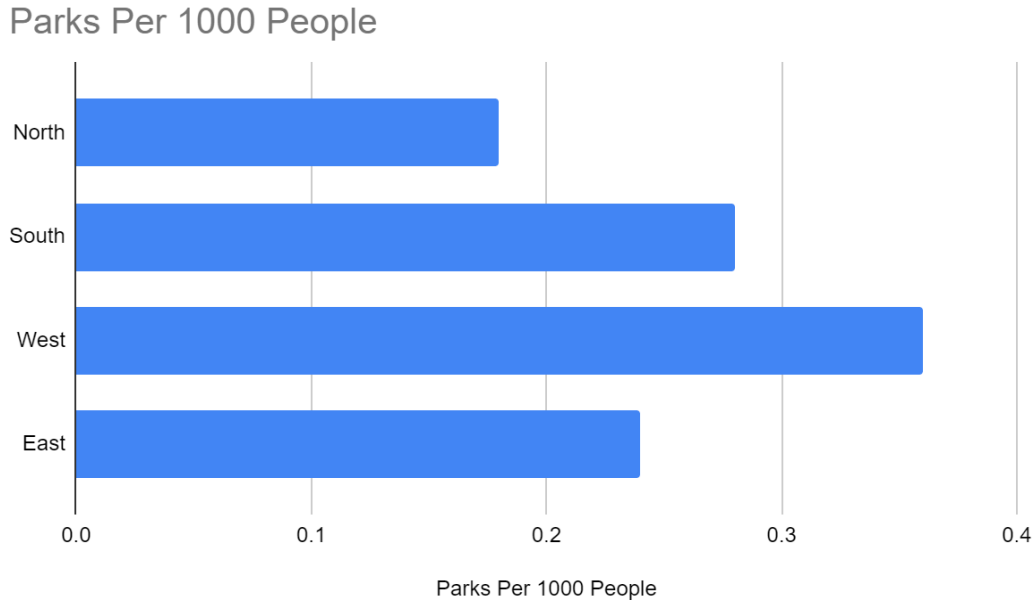
The most affluent area of Modesto, the North, has much fewer parks, most likely since this part of Modesto has many more private recreation centers such as country clubs to use. For example, many northern Modesto citizens use the Del Rio country club, located at the very top of Modesto. The West and Eastern portions of modesto are the middle ground of the study. They have a relatively similar per capita income and a similar number of parks and amenities. One independent variable that could have been causing a disparity between the number of parks in each region would be the population. Therefore, a Chi-Squared test was used to find statistical significance. The predicted number of parks was based on the population of each region. The predicted parks for the North was 13, for the South, West, and East it was 23, 13, and 19 respectively.

A test for statistical significance was used in relation to population to see if the relationship between relative population and number of parks in a region could be due to chance. The P-value for this test was 0.2376, meaning that the test was not statistically significant. This shows that the number of parks in a region could be due to random chance, meaning that the null hypothesis of parks in a region cannot be rejected. Although the results were not statistically significant, they can still be interpreted to comment on trends seen in the city of Modesto.

Despite having about the same area as the northern portion of Modesto, the southern portion of Modesto has many more parks compared to the North. The parks per 1000 people in South Modesto is 0.28 while the North, West, and East are 0.18, 0.36, and 0.24 respectively. A higher ratio would mean that there are more parks in an area and relatively fewer people. This displays West Modesto to have a very high ratio because of the number of parks in the area compared to a lower population than South and East Modesto. The North has the lowest since

not many people live on the North side of Modesto, and because the North does not have many parks.

**Number of Amenities Relative to Number of Parks**

| | North | South | West | East |
|---|---|---|---|---|
| **Ameneties per Park** | 2.88 | 2.48 | 3.22 | 3.47 |

 The amenities of the southern parks are much lower in number compared to the rest of the groups. The south has 2.48 amenities per park while the North has 2.88 and the West and East have over 3.  A chi-squared test was used to determine the statistical significance of the amenities per park in each area. The actual amenities per park were compared to the predicted number based on the income level, specifically using the reasoning that as income increases, amenities per park would increase. The P-Value was determined to be 0.27, which is not statistically significant. This means that the parks per track and the amenities per park could be due to chance, and not due to income levels. This chi-squared test was based on income, meaning that the income might not have had an effect on the number of amenities in a park. However, trends can still be said about the average amenities per park. The south still has a lower amount of amenities, but it may not be caused by the income of the area but perhaps another confounding variable such as funding.

 Overall, the information from the table and the stacked bar chart represents what the hypothesis of the study focused on. Despite having the lowest income, the southern portion of Modesto is still very good in terms of amenities per park since it is still within one amenity from the other regions. This shows that south Modesto is still a decent contender for the quantity of parks and amenities offered. Conversely, the income per capita is also very low compared to the other three regions, showcasing the disparity in class between the south. Ultimately, this evidence can give more insight into park equity in the future and serve as a basis for understanding socioeconomic relationships in Modesto.

**Shortcomings + Future Studies**
 This study has served as more of a basis for future studies rather than making a breakthrough in and of itself. The study focuses on trends that have been previously confirmed

in other cities to confirm them in Modesto. Since this study did not have access to park auditing or resident surveying, it is very hard to conclude more relationships between other factors such as opinions and differences in responses based on the four groups of Modesto. This led to me not being able to conclude for myself if income and the quality of parks have a direct correlation. In the future, if this study were to be modified, a team of people would audit every park to obtain data on the quality of parks. Surveys could also be utilized to obtain the people's opinions on parks and their neighborhoods. Ideally, future studies would be able to compare the self-reported information from surveying people and the object information gathered from auditing the parks.

## Conclusion

This study has been a review of factors that have led to differences in park access, people per park, and amenities per park. Park access has been relatively the same throughout the four regions despite economic differences.

In the end, this study can be used to aid future research on the equity of parks in Modesto as well as provide a good start to anyone that wants to learn more about the data behind the census tracts. The overall purpose of this study was to compare and contrast parks in certain regions in Modesto to showcase the radical differences between them. Overall, the study has been successful in comparing these census tracts based on racial and economic standpoints. Applying these comparisons to parks was where the central struggle of the study. Despite these shortcomings, a comparison was still able to be made between census tracts.

Overall, to improve the quality of all parks in Modesto, the community needs to be flexible and motivated for change. Policy changes can also be made to help the condition of these parks. Advocating for policy changes is already being made through All Children Thrive, mentioned earlier. The specific policy changes are still being worked out, but the main goal is to increase amenities and funding for parks to make them more equitable to the youth.

Parks have a lasting legacy on the youth and it is extremely important to protect them, especially today since many youth are spending less time outside. Many children are spending less time at parks every year and slowly parks and other outdoor centers of recreation are being forgotten. Parks are a haven for people of all ages and it is important to protect green space to create a better atmosphere for the people. Ultimately, this study is a portrayal of certain trends in Modesto more than it is of concluding about the equity of parks in Modesto. However, this research can be confirmed and added upon in future studies to display more on the equitability of parks in Modesto as well as provide environmental justice. Justice through policy-making serves as one of the best ways to create a wave of motivation for both the people and local leaders in the community to stand for equity and display a call to action.

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