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Reaching for the Stars: Exploring the Connection Between Light Pollution and Mental Health in the United States

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Abstract

Because of the COVID-19 pandemic, the importance of good mental health is becoming more and more relevant. Outdoor therapies have been used as treatments for mental health for years, so the researchers investigated if stargazing has the potential to have the same benefits. Rather than surveying people on how often they stargaze, the researchers used light pollution data as a metric for the ability of a region to stargaze. The light pollution data was gathered from the Visible Infrared Imaging Radiometer Suite (VIIRS) and the mental health data was collected from a survey conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA). All fifty states were stratified based on light pollution and ten were chosen for analysis. From these states, the number of people with mental illness, number of people who received mental illness treatment, and number of attempted suicides were all considered. Linear regression was performed for these three metrics against light pollution. Overall, the correlation coefficient is too low to confidently establish correlation. Further research and different methods are required to determine the existence of a correlation.

Keywords: light pollution, mental health, stargazing

Introduction

Humans have studied astronomy and watched the stars for thousands of years, across many cultures and civilizations. Early humans told stories about the stars, spotted objects and animals among them, and even viewed space as a power over their existence. This activity is defined as stargazing, or the act or practice of observing the stars. Throughout the centuries, humans have continued to stargaze, even with the development of technology and advancement in society; however, light pollution makes it difficult for many to do so. For the purpose of this study, the researchers will consider the ability to stargaze, which will be measured by light pollution levels.

Light pollution is caused by artificial light that raises the luminance of the night sky, which creates an artificial glowing (Falchi et al., 2016). Around 83% of the total world population and 99% of the United States and European population live in areas that are affected by light pollution (Falchi et al., 2016). Light pollution has been an issue for years because of its negative effects on both the environment and human health. Because of light pollution's ability to disrupt a person's circadian rhythm, areas with more light pollution are correlated with higher rates of depression, insomnia, suicidal behaviors, and other health conditions (Falchi et al., 2019; Min, Min, 2018).

Moreover, the importance of good mental health is becoming more and more relevant. With the arrival of the COVID-19 pandemic, millions of people have isolated themselves from their loved ones, not gone into work, and avoided public spaces for long periods of time. These actions can become a catalyst for mental illnesses such as depression, stress disorders, irritability, insomnia, anxiety, and more (Usher, Bhullar, Jackson, 2020). Because the amount of people suffering from poor mental health is on the rise, there is an increasing need for therapies that can reduce these symptoms.

As a possible solution, outdoor therapies could help reduce mental illnesses and improve wellbeing (Sachs, Rakow, Shepley et al., 2020). Outdoor therapies can include almost any activity in an outdoor environment, and they can help improve attention span, memory, anxiety, sleep, and perceived quality of life (Buckley, Brough, Westaway, 2018). Although there is data correlating time spent outdoors and improved mental health, there is no data that specifically incorporates stargazing. Because of the evidence suggesting that outdoor therapies can improve mental health, the ability to stargaze could potentially have the same effect.

While there is evidence that spending time in nature is positively correlated with mental health, there is little research that correlates time spent stargazing and mental health. Because of the correlation between quality mental health and exposure to nature, the researchers seek a correlation between the amount of light pollution in the sky and mental health in ten different regions in the United States. By analyzing data and conducting a correlational study, the researchers intend to determine if stargazing has the potential to be an effective way to improve mental health.

Methods

The researchers wanted to understand more about the impact of light pollution on mental health within the United States. For this, two types of data were gathered: light pollution and mental health data. This data was originally collected for 10 different states/areas. These areas were chosen through stratification of the states based on levels of light pollution. From these strata, random selection produced the following list: Massachusetts, Washington D.C., New Jersey, California, Nevada, Alaska, Montana, South Dakota, Utah, and Missouri. Upon visual analysis of the preliminary data, Washington D.C. was replaced with Florida. Washington D.C. was too small and urbanized compared to the other states and was an extreme outlier. A correlational study was used for this study, and no ethical considerations were required for this study due to a lack of direct experimentation.

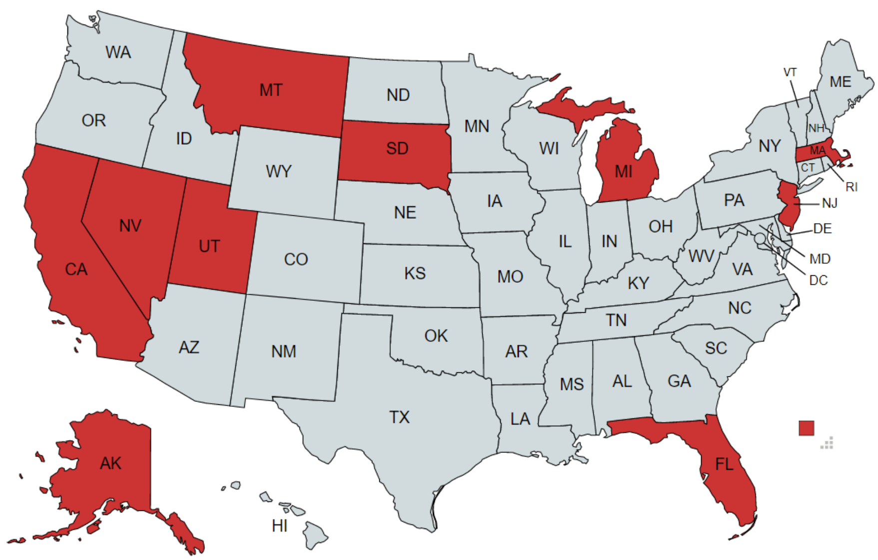

Figure 1. Pictorial representation of states chosen for analysis (Mapchart, 2021)

The light pollution data was collected using an interactive mapping software called VIIRS (Visible Infrared Imaging Radiometer Suite), an instrument on the Suomi NPP satellite that accurately collects infrared imagery (Stare, 2021). The light pollution data was accessed using this interactive map that gives 2019 VIIRS data on specific regions of land. The researchers outlined each region and collected the data given by this software. The mental health data was collected from the Substance Abuse and Mental Health Services Administration, or SAMHSA, as they created many extrapolated data tables based on the 2018 and 2019 National Survey on Drug Use and Health. The mental health data encompassed the following factors: the number of people per capita with any mental illness, number of people per capita who attempted suicide, and number of people per capita who received mental health assistance (SAMHSA, 2021). These factors were used because of their ability to effectively quantify mental health for the purpose of this study. For each state, the light pollution data was statistically analyzed with the mental health data using linear regression to evaluate the potential correlation. The results for the ten regions were compared in order to determine the extent and impact of light pollution within the United States.

Results

The raw data can be seen in Table 1 below.

Table 1. Raw light pollution and mental health data

State	Mean Light Pollution (Radiance)	Percentage of population with any mental illness	Percentage of population receiving mental health assistance	Percentage of population that attempted suicide in 2019
Montana	0.054	16	13.5	0.47
Alaska	0.1059	15.4	12.3	0.27
South Dakota	0.1279	13.3	11.6	0.57
Nevada	0.3283	16.6	10.6	0.49
Utah	0.3583	18.6	13.6	0.66
Missouri	0.8987	17.2	13.5	0.55
California	1.2654	14.8	9.96	0.37
Florida	2.5569	13.5	9.48	0.39
Massachusetts	3.0282	16.8	16.7	0.29
New Jersey	6.8021	12.6	10.4	0.37

The results of the data analysis can be seen in Figures 1, 2, 3, and 4. The trendline equation was calculated using Excel's linear regression software. As can be seen from Figure 1, the correlation between the percentage of the population with any mental illness and the mean light pollution of that area is negative, with an R^2 value of 0.2595. The slope of the trendline is -0.4623, implying that for every one radiance increase in a given area, the populations' percentage of people with mental illnesses is expected to be 0.4623 percentage points lower.

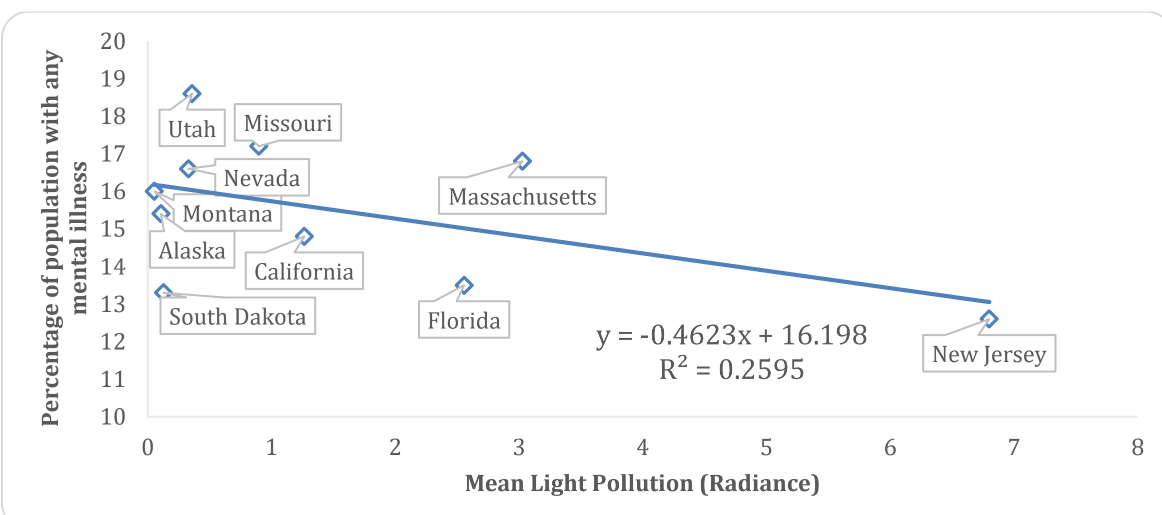

Figure 1. Linear regression of mental illness versus light pollution

The correlation coefficient of this data is only 0.5094, which is much lower than what it should be if there was truly a correlation. Additionally, upon visual analysis, the points seem rather randomly scattered. In fact, when excluding New Jersey due to its significant difference in radiance from the rest of the sample, the trendline becomes nearly horizontal.

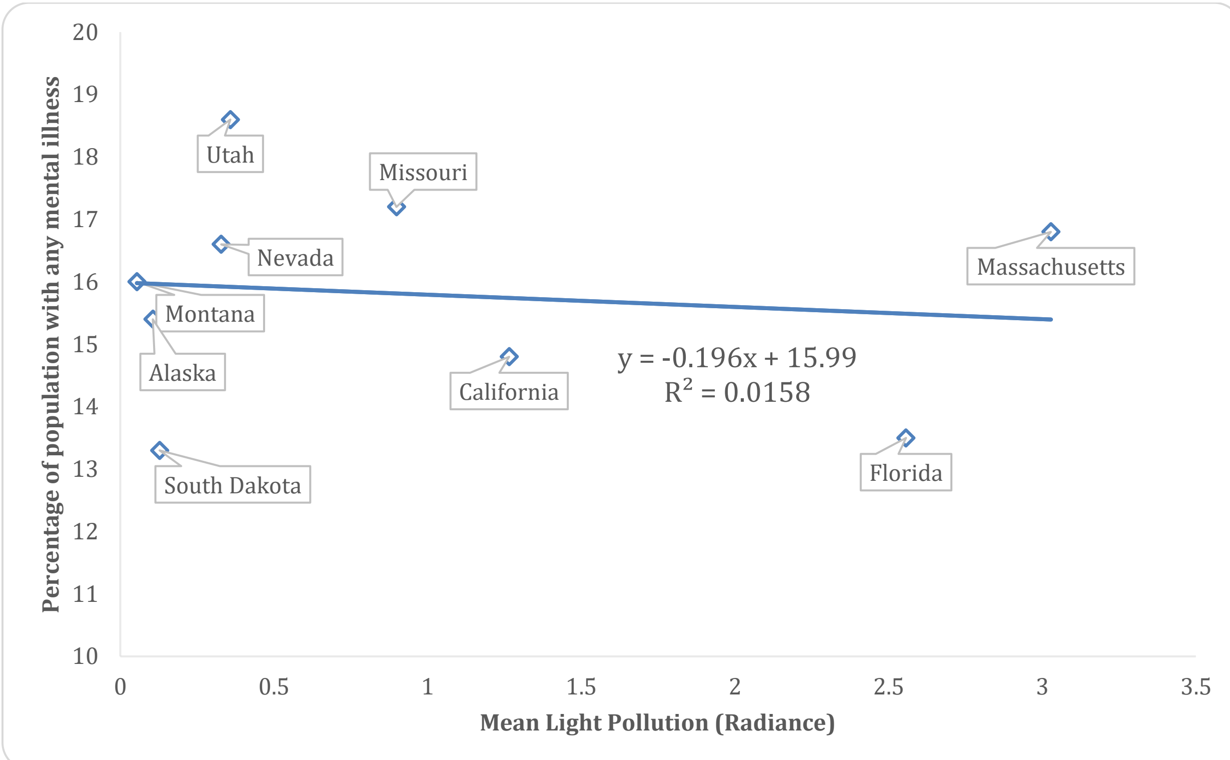

Figure 2. Linear regression of mental illness versus light pollution, excluding New Jersey

With a correlation coefficient of only 0.1257, this distribution is nearly random. However, whether or not New Jersey is included, there is still no evidence to suggest any correlation between the percentage of the population with mental illness and the light pollution in a state.

Figures 3 and 4 show a similar trend. The trendline of Figure 3 has a negative slope (-0.1652) and a very low R^2 value (0.0251), with a correlation coefficient of only 0.1584. For Figure 4, the slope is closer to 0 (-0.0246) and the R^2 is about the same (0.1705). The correlation coefficient for this data is 0.4129. These values are far too low to provide support for a correlation between the two variables.

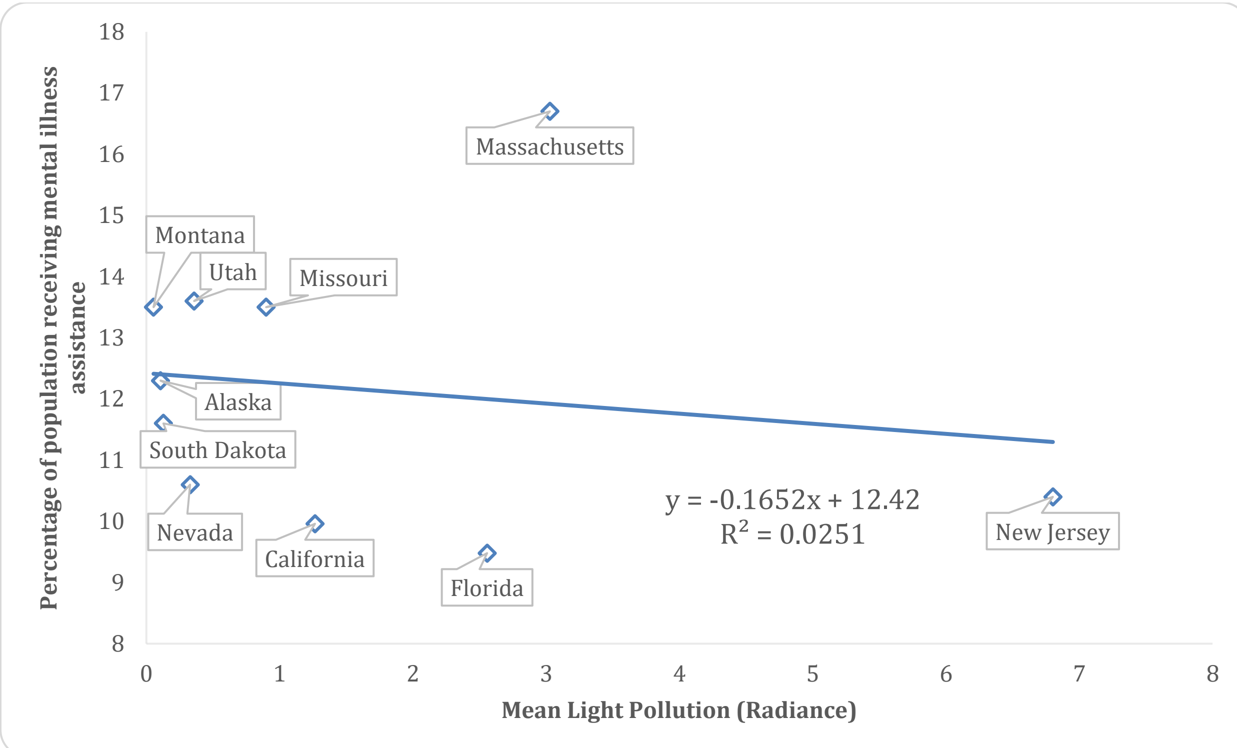

Figure 3. Linear regression of mental illness assistance versus light pollution

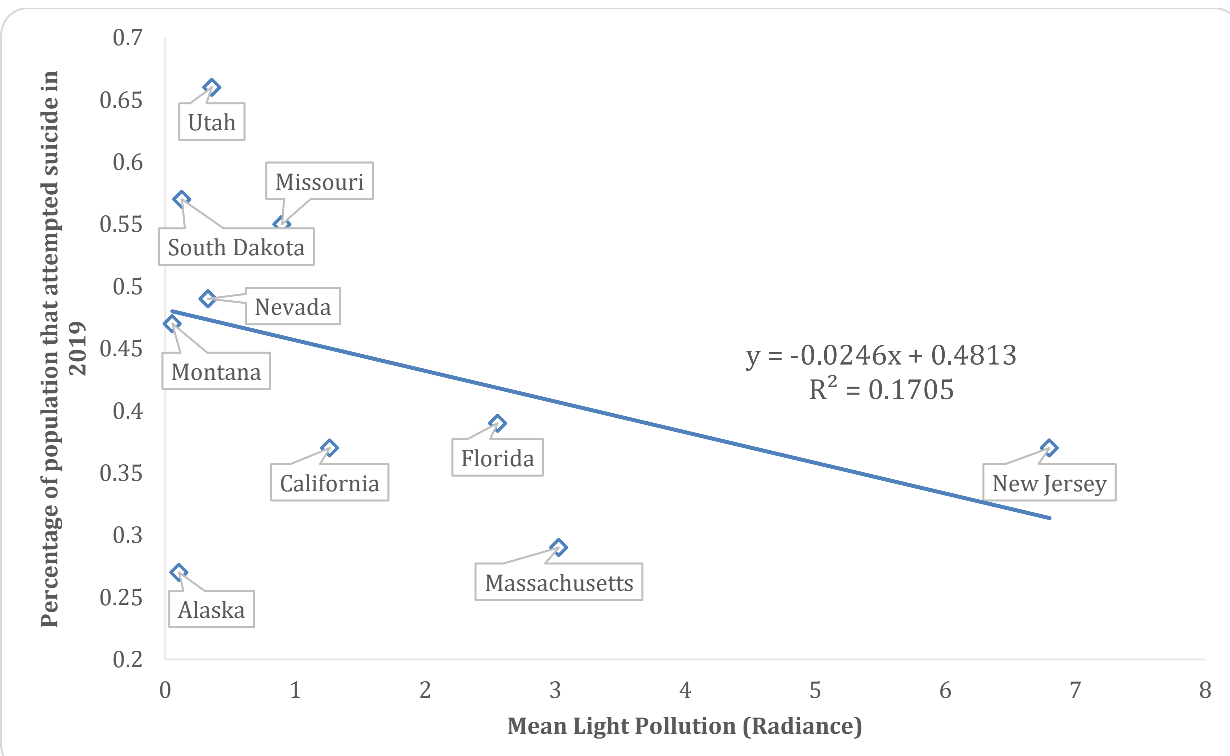

Figure 4. Linear regression of attempted suicide versus light pollution

Discussion

Although the data did not support the initial hypothesis that stargazing could improve mental health, there is still much to consider from this research. Prior research shows that artificial light can negatively affect humans' circadian rhythm, which in turn affects mental health (International Dark Sky Association). The fact that there was no significant correlation found implies one of two things; either the analysis was not thorough enough, or the idea that artificial light affects mental health is not entirely true.

There are a few sources for potential error in the method of data collection. For one, due to the lack of mental health data on individual cities, this research was forced to focus on states. This forced us to have to average the radiance across the entire state. While this is fine for sparsely populated states, the mean of the states with major urban cities were not as accurate. For example, most of California has a low level of light pollution. However, the few major cities it has significantly increases its overall mean. This discrepancy can be seen using the standard deviations of the radiance, as shown in Table 2. Another limitation for the mental health data is that the data is extrapolated, so the data may not show a true representation of the population. In addition, the only method the researchers could find to access the VIIRS database for a given area was to use an interactive map and draw a border around the area in question. However, the software that runs the map would not allow the drawn borders to be too big or too complex. This means that large states like Alaska had to be broken up into multiple pieces, and bends in state borders were occasionally not drawn accurately. Some of this inaccuracy can be seen simply by comparing the area drawn to the actual area for each state, shown in Table 3.

Table 2. Average radiance of all states

State	Radiance (Mean ± Std. Dev.)
Alaska	0.1059 ± 1.515
California	1.2654 ±7.7475
Florida	2.5569 ± 9.1664
Massachusetts	3.0282 ± 8.5367
Missouri	0.8987 ± 5.3308
Montana	0.0540 ± 1.9762
Nevada	0.3283 ± 7.1342
New Jersey	6.8021 ± 14.0297
South Dakota	0.1279 ± 2.6610
Utah	0.3583 ± 4.5619

Table 3. Difference in measured and actual area of states

State	Measured Area (km^2)	Actual Area (km^2)	Difference in Areas (km^2)
Alaska	2045702	1,717,854	-327848
California	468447	432970	-35477
Florida	200540	170,304	-30236
Massachusetts	31609	27336	-4273
Missouri	181183	180,533	-650
Montana	380473	380,838	365
Nevada	290658	286,351	-4307
New Jersey	22840	22588	-252
South Dakota	199606	199,742	136
Utah	220262	219,887	-375

Conclusion

The researchers concluded that at a statewide level, the data between stargazing and mental health doesn’t suggest a correlation; however, future studies could further research that gap. One suggestion for future research could be to focus on smaller geographical areas. Due to our constraint of secondhand data, this is not something which could be accomplished. Also, future studies could use survey methods to directly measure the population that actively stargazes rather than light pollution in general. All of these recommendations can and should be implemented in future studies on this topic.

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