Sunlight and Mental Health: The Broader Effects of Sunlight Exposure

Lawrence Daniels

CEPC 0911

August 12, 2020

Abstract

Key terms: Sunlight exposure, mental health, phototherapy, light therapy, and Rhode Island.

This paper attempts to confirm correlation between the hours of sunlight in a region and the quality of the mental health of the inhabitants of that region. While phototherapy and sunlight exposure have been studied and prescribed to treat specific conditions, they have yet to be observed on a population-wide scale. This potential association was explored by analyzing data from the 2018 BRFSS (Behavioral Risk Factor Surveillance System) survey and weather data for Providence, Rhode Island. The BRFSS data showing the quality of mental health of the participant (MENTHLTH, or the number of poor mental health days in the past month) was then averaged and divided into months to be compared to the monthly sunlight hours in Providence, RI using a Pearson's test. This test found there to be no significant correlation between the hours of sunlight in Providence and the averaged mental health for participants in that region. Despite this, we believe that this topic requires more exhaustive research to come to a meaningful conclusion, especially if exact weather data and a larger sample size (instead of many participants simplified into a few data points) could be used.

1. Introduction

While sunlight exposure and light therapy are shown to be effective treatments for seasonal affective disorder (*Light therapy* 2017), and--more recently--bipolar depression, it is still unknown to what degree sunlight exposure affects mental health on a larger scale. In this research, we plan to observe the effects of sunlight exposure on a population-wide scale, expecting to see the reported benefits of sunlight exposure or phototherapy--from reduced hospitalization to reduced symptoms of depression--in periods with more sunlight (Benedetti et al. 2001; van Hout et al. 2020). Additionally, many previous trials focused on very specific groups for testing, whether cardiac patients in Eisenberg et al. (2020) or Cystic Fibrosis patients in Kopp et al. (2016). Even many of those studies which did not focus on very particular disorders did so with phototherapy instead of sunlight exposure, largely because of its relative controllability in a trial (Deltito et al. 1991). Unlike many of these previous research papers and studies, we plan to observe

sunlight's effect on mental health more broadly. With this in mind, we ask the following question: Is there a positive linear correlation between the hours of sunlight in a month and the reported quality of mental health participants in that month?

2. Methods

2.1 Data Collection

The data used in this paper were collected from the BRFSS (Behavioral Risk Factor Surveillance System) 2018 survey and usclimatedata.com which reports weather data from a variety of national sources. The particular data used from the BRFSS survey are the interview month, the state of the respondent (to narrow down the data to Rhode Island), and the number of bad mental health days in the past month of the respondent. The data from usclimatedata.com are the average monthly hours of sunshine in Providence, Rhode Island calculated from 1981-2010 (optimally, we would have used the daily hours of sunshine in 2018).

2.2 Data Cleaning

Extraneous data were removed by subsetting the data table in R to only include participants who responded that they are in Rhode Island and had an appropriate (1-31) number of days of poor mental health in the past month (values above 31 were used in the BRFSS survey to indicate whether the question was asked, ignored, or the like, but were removed as to not influence the data). The climate data are simply 12 points and were manually checked and entered. Additionally, the mental health data were grouped into months to compare easily with the sunlight data, but originally contained 1821 points for Rhode Island alone.

2.3 Testing and Assumptions

While there are a variety of tests that could have been used, the one chosen for this particular research question--one that tests for a linear correlation--was a Pearson product-moment correlation test. In this case, because our dependent variable is poor mental health days, we would be anticipating a negative correlation between sunlight hours and poor mental health days due to other studies finding that sunlight therapy and phototherapy reduce the length of hospitalization and act as an antidepressant for certain disorders (Benedetti et al. 2001; Yamada et al. 1995).

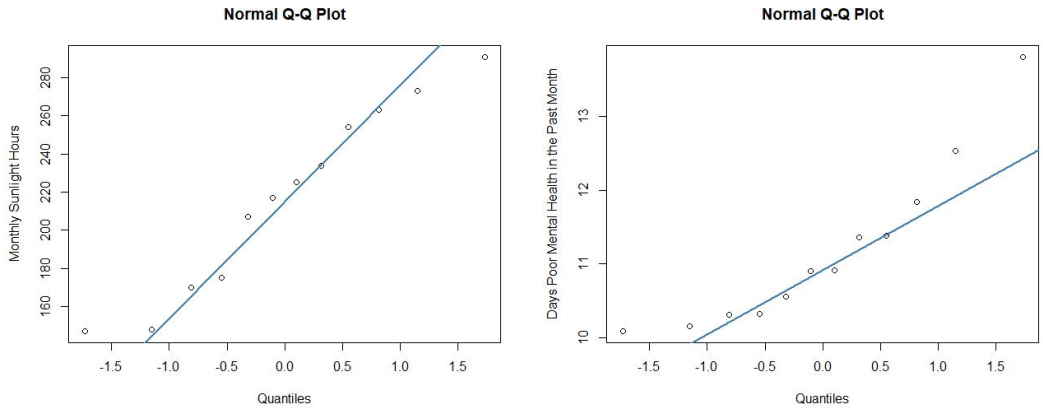
The assumptions of a Pearson's correlation test are continuous variables, paired variables (the variables you are testing are from the same observation/representative of 1 data point), absence of outliers (this will skew the results somewhat), linearity (the data, when graphed, should be vaguely linear), and normally distributed variables. While the data meet some of the assumptions (continuous and normally distributed as seen in a Q-Q plots), it is questionable as to whether they meet the others. In graphing the data, it is clear that the mean days of poor mental health for December is an outlier (a value of 13.81 compared to the mean of 11.18 and the standard deviation of 1.11). We continue the test knowing that the result may be slightly skewed. Finally, the data, as will be clear in the graphs, is not linear.

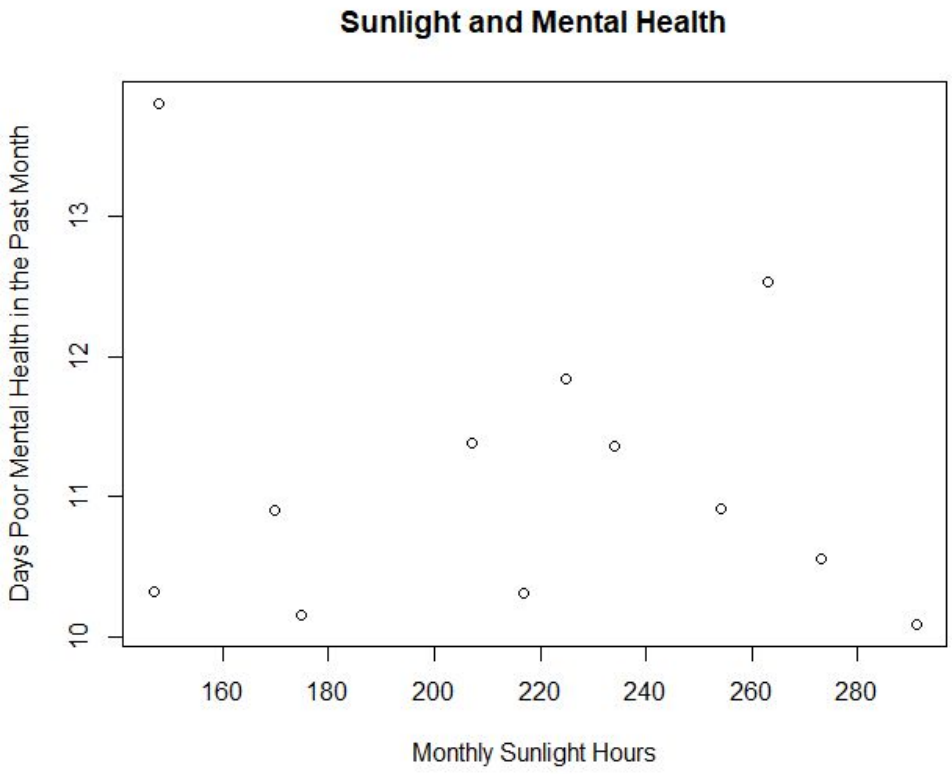
2.4 Performing the Pearson's R Test

The alternative hypothesis is that there is a significant negative correlation between the hours of sunlight in Rhode Island in a month and the mean days of poor mental health in that month. The null hypothesis is that there is no significant correlation between the hours of sunlight in a month and the mean days of poor mental health in that month (in Rhode Island). The significance level was set at $\alpha = .05$.

3. Results

These are the quantile-quantile plots to show the distribution of the variables:





Before interpreting the results, it is important to remember that this test attempts to find the true correlation between the variables. The Pearson's product-moment correlation test resulted with the following values: t = -0.67091, df = 10, p-value = 0.5175, 95 percent confidence interval = {-0.6982724, 0.4158978}, and a sample cor -0.2075405. Simply, the p-value is greater than .05 (the α), meaning that there is no significant correlation and we fail to reject the null hypothesis. In fact, in analyzing the graph above we could have possibly come to this conclusion. The graph above does not seem to follow any clear linear correlation, and the Pearson's test simply confirms that belief.

4. Conclusion

We fail to reject the null hypothesis because of a p-value > .05. Despite this result, as it only pertains to a macro-scale observation of sunlight in mental health, more research can and should be done in sunlight exposure and phototherapy as a treatment for specific illnesses, even if those treatments do not seem to have an effect on a state-wide level. Moreso, this paper only examines the linear relationship between these variables (sunlight hours and

mental health) and another relationship could emerge in a larger or more exhaustive data set. While the original data from the BRFSS survey were numerous, they were simplified (to n = 12) and averaged to fit the limitations of the sunlight data in the region. Once more, the sunlight data for Providence, Rhode Island were only the average sunlight hours for each month. These were not the exact sunlight hours for 2018, but locating those numbers could add more reliability to these results instead of relying on the idea that the sunlight hours per month in 2018 must be somewhere near the normal. One last important drawback is the nature of these large-scale non-controlled studies. In general, attempting to observe correlations at this large of a scale is not necessarily meaningful by itself. If we did find a correlation between sunlight hours and mental health, that does not necessarily mean that there is a direct relationship between the two. For example, more sunlight hours could lead to a hotter climate which may have some effect on mental health. Similarly, hotter temperatures may lead more people to go outside and be physically active, which could again have an impact on the results of our test. There could also be a variety of socio-economic factors, from job security to community safety, that may vary from location to location and season to season and could affect our test. In essence, it is important to take any results from these trials, especially limited or non-controlled/normalized ones with caution, and not take them at face value. In future studies of this kind, we hope that some of these confounding variables can be accounted for in either study design or numerical analysis.

As for future exploration of this topic, there are several different directions available. Already, there are already many papers on phototherapy or sunlight exposure in relation to seasonal affective disorder or bipolar disorder, but there is certainly still more room for research both in that field and in relating sunlight exposure/phototherapy to more general depression or lifestyle changes. In addition, this project--as detailed above--is not perfect and this general idea, a large-scale analysis of sunlight exposure on mental health, could be performed with more resources and experience for more meaningful and conclusive results. Specifically, it may be beneficial to observe sunlight data and mental health statistics over many different regions in order to have a variety of relationships to observe.

References

Benedetti, F., Colombo, C., Barbini, B., Campori, E., Smeraldi, E., 2001. Morning sunlight reduces length of hospitalization in bipolar depression. Journal of Affective Disorders 62, 221–223. https://doi.org/10.1016/S0165-0327(00)00149-X

Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2018. https://www.cdc.gov/brfss/annual_data/annual_2018.html

Climate Providence - Rhode Island [WWW Document], n.d. [WWW Document]. URL https://www.usclimatedata.com/climate/rhode-island/united-states/3209 (accessed 8.11.20).

Deltito, J.A., Moline, M., Pollak, C., Martin, L.Y., Maremmani, I., 1991. Effects of phototherapy on non-seasonal unipolar and bipolar depressive spectrum disorders. Journal of Affective Disorders 23, 231–237. https://doi.org/10.1016/0165-0327(91)90105-2

Eisenberg, M.J., Habib, B., Alcaraz, M., Thombs, B.D., Filion, K.B., 2020. Bright light therapy for depressive symptoms in hospitalized cardiac patients: A randomized controlled pilot trial. PLoS ONE 15, e0230839. https://doi.org/10.1371/journal.pone.0230839

Kopp, B.T., Hayes, D., Ghera, P., Patel, A., Kirkby, S., Kowatch, R.A., Splaingard, M., 2016. Pilot trial of light therapy for depression in hospitalized patients with cystic fibrosis. Journal of Affective Disorders 189, 164–168. https://doi.org/10.1016/j.jad.2015.08.056

Light therapy [WWW Document], 2017. [WWW Document]. URL https://www.mayoclinic.org/tests-procedures/light-therapy/about/pac-20384604 (accessed 8.11.20).

van Hout, L.J.E., Rops, L.E.P., Simons, C.J.P., 2020. Treating winter depressive episodes in bipolar disorder: an open trial of light therapy. Int J Bipolar Disord 8, 17. https://doi.org/10.1186/s40345-020-00182-5

Yamada, N., Martin-Iverson, M.T., Daimon, K., Tsujimoto, T., Takahashi, S., 1995. Clinical and chronobiological effects of light therapy on nonseasonal affective disorders. Biological Psychiatry 37, 866–873. https://doi.org/10.1016/0006-3223(94)00221-N