Positive Correlation of Smoking Percentage and Mentally Unhealthy Days in Ohio 2016-2022

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Positive Correlation of Smoking Percentage and Mentally Unhealthy Days in Ohio 2016-2022

Kevin Williams, Matt Crudele
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Abstract

There is substantial research regarding the negative physical side effects of smoking, such as increased risk of developing hypertension or chronic obstructive pulmonary disease. Smoking rates are substantially higher among those with a pre-existing mental illness (such as schizophrenia or generalized anxiety disorder)\(^1\). Additionally, second-hand smoke exposure among non-smokers has been attributed to an increased risk of developing symptoms of poor mental health (such as anxiety or depression)\(^2,3\). It has also been shown that smoking cessation leads to improved mental health\(^4\). However, there is limited research regarding the negative effects of smoking on mental health, especially in the state of Ohio, across rural and urban counties, and in comparison to surrounding states. This study aims to clarify these relationships and help guide further research in the field.

This article will expose the relationships between these two variables that are ever-increasing in relevance and importance as well as provide direction for further research. County health rankings, a de-identified national database, was used to research these trends and associations. Data from 2022 was used when comparing the relationship between two variables. Data from 2016 and 2022 were used to track the short term changes. These years are especially interesting as they may highlight the changes from the COVID-19 pandemic. Spearman correlation, unpaired t-test, and ANOVA test were used to statistically analyze the data where appropriate.

Smoking percent and mentally unhealthy days in Ohio significantly increased from 2016 to 2022. There are significant differences in smoking percent among adults and mentally unhealthy between Ohio, Michigan, Kentucky and Indiana.
**Key Words:** Smoking, Smoking Cessation, Mental Health, Mentally Unhealthy Days, Ohio, Midwest, COVID-19, 2016, 2022

**Introduction**

The negative physical side effects of smoking are well known and health organizations have worked tirelessly using this knowledge to reduce smoking rates\(^4\). Smoking is one of the leading causes of death and can contribute to risks in countless diseases\(^2\). Along with smoking, mental health has become an issue of great importance. However, the relationship between smoking and poor mental health are less established. It is known that smoking habits are more common among those with diagnosed mental health issues\(^1\), but the relationship between smoking and frequency of mentally unhealthy days is less established. Furthermore, advocates would like to know if there is a difference between rural and urban areas with either of these variables?

Policies and budgets for health campaigns differ by state; this difference in programs can lead to differences in smoking and mental health rates\(^7\). How does Ohio compare in this regard to surrounding states? We know that the statistics around these metrics changed from 2016 to 2022, to indicate higher smoking rates and more frequent mentally unhealthy days\(^5\). Policies and budgets for health campaigns differ by state; this difference in programs can lead to differences in smoking and mental health rates\(^7\).

Poor mental health can be quantified for studies by the number of mentally unhealthy days an individual experiences in a month. This project examines the relationships between smoking rates and the number of reported mentally unhealthy days in the state of Ohio in the years 2016 and 2022. These metrics are compared by rural and urban counties as well as to neighboring midwestern states. This data, as well as other pieces of literature, will be used to
draw definitive associations between smoking and mental health and further guide the conversation regarding the direction of causality between the two.

The following paragraph is a list of the specific research questions we will be analyzing in this study. These questions compare time changes and urbanality in Ohio, as well as comparing Ohio to geographically close States.

**Research Questions**

RQ1. **What is the relationship between Mentally Unhealthy Days and smoking in Ohio in 2022?**

RQ2. **What is the difference in mentally unhealthy days of rural vs urban counties in Ohio in 2022?**

RQ3. **What is the difference in smoking rates in rural vs urban counties in Ohio in 2022?**

RQ4. **How did the number of Mentally Unhealthy Days in Ohio change from 2016 to 2022?**

RQ5. **How did smoking rates in Ohio change from 2016 to 2022?**

RQ6. **What are the differences in smoking rates in Ohio vs Michigan, vs Indiana, vs Kentucky in 2022?**

RQ7. **What is the difference in average number of mentally unhealthy days reported in Ohio vs Michigan, vs Indiana, vs Kentucky in 2022?**

**Methods**

**Context / Protocol**

Mentally unhealthy days (MUD) is the number of days in a typical month (standardized to 30 days) that a respondent felt that their mental health was not good. The definition of “not
good” is fluid, but may include more anxiety, depression, or manic behavior than usual. Smoking, in this study, is defined as the habitual use of tobacco smoke products (i.e. cigarettes).

For these two variables (mentally unhealthy days and smoking), we will look at their frequency in the states of Ohio, Indiana, Kentucky, and Michigan. We will explore how these variables have changed between 2016 and 2022.

We will also research the relationship between these two variables as they specifically relate to the state of Ohio. We will do this by looking at the frequency of smoking rates and the frequency of mentally unhealthy days in all Ohio counties as well as looking at these variables as they specifically pertain to rural and urban counties. Finally, we will investigate how these rates have changed from 2016 to 2022. We do not need to exclude any counties that are listed on county health rankings (except in RQ2 and RQ3 as explained in methods). All data from this specific section can be obtained from the County Health Rankings for Ohio. For defining rural versus urban counties in Ohio, we used the Ohio Department of Health who defined urban counties as those counties that are part of a metropolitan area.

Data Collection

Of Ohio’s 88 counties, all reported mentally unhealthy days and smoking rates for the years 2016 and 2022. This data was obtained from the County Health Rankings for Ohio. Of Indiana’s 92 counties, all reported mentally unhealthy days and smoking rates for the years 2016 and 2022. Of Kentucky’s 120 counties, all reported mentally unhealthy days and smoking rates for the years 2016 and 2022. Of Michigan’s 83 counties, all reported mentally unhealthy days and smoking rates for the years 2016 and 2022.
Of Ohio’s 88 counties, 16 are considered to be Urban, 22 are considered partially rural, and 50 are considered Rural per the Ohio Department of Health. For the rural vs urban comparisons (RQ2 and RQ3), the 22 counties that were considered partially rural were omitted.

In conclusion, all counties from all 5 states were included in this study. However, when it comes to investigating the relationships in rural vs. urban counties in Ohio, 22 counties were omitted.

**Data Analysis**

For our first question, we used a 2 sample independent T test to investigate the relationship between MUD and smoking in Ohio. For our second question, we used an unpaired t-test to investigate the relationship between MUD and smoking in rural vs. urban counties in Ohio. For our third question, we used a paired t-test to investigate the relationship between MUD and smoking in Ohio between 2016 and 2022. For our fourth test, we used an ANOVA test to investigate MUD in Ohio vs. Michigan, Kentucky and Indiana. For our fifth test, we used an ANOVA test to investigate smoking in Ohio vs. Michigan, Kentucky, and Indiana. For our sixth test, we used a paired t-test to investigate smoking in all Ohio counties in 2016 and 2022. For our seventh test, we used a paired t-test to investigate MUD in all Ohio counties in 2016 and 2022.

**Results**

Investigating the correlation between percent smokers and average number of mentally unhealthy days in Ohio in 2022 (RQ1), a spearman correlation indicated a strong and significant correlation ($r=0.960$) ($p<0.001$) whereas the percent smokers increases, the number of unhealthy days also increases (Figure 1) Spearman Correlation
Figure 1. Correlation between percent smokers and mentally unhealthy days in Ohio 2022

Table 1. Mean percent smokers and mentally unhealthy days in Ohio 2022

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Smokers</td>
<td>88</td>
<td>23.836</td>
<td>3.0103</td>
</tr>
<tr>
<td>Mentally Unhealthy Days</td>
<td>88</td>
<td>5.384</td>
<td>0.2678</td>
</tr>
</tbody>
</table>
The average number of mentally unhealthy days was significantly different in rural Ohio counties (5.454) vs urban Ohio counties (5.069) in 2022 (RQ2). \((t=4.381, p=<0.001)\) (Table 2) Unpaired t-test

Table 2. Difference in mentally unhealthy days in Urban vs Rural counties of Ohio

<table>
<thead>
<tr>
<th>County Type</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>72</td>
<td>5.454</td>
<td>0.3094</td>
</tr>
<tr>
<td>Urban</td>
<td>16</td>
<td>5.069(^A)</td>
<td>0.3572</td>
</tr>
</tbody>
</table>

\(^{A}\) = Significantly lower than Rural \((p<0.001)\)

There are more rural counties in Ohio than urban counties. The results showed strong statistical significance that Urban county residents have less mentally unhealthy days per month.

The average percent smokers in rural Ohio counties (24.357\%) was significantly different than that in urban Ohio counties (21.494\%) in 2022 (RQ3). \((t=3.6810, p=<0.001)\) (Table 3) unpaired t-test

Table 3. Difference in smoking percentage in rural vs urban counties in Ohio

<table>
<thead>
<tr>
<th>County Type</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>72</td>
<td>24.357%</td>
<td>2.7403</td>
</tr>
<tr>
<td>Urban</td>
<td>16</td>
<td>21.494%(^A)</td>
<td>3.1402</td>
</tr>
</tbody>
</table>

\(^{A}\) = Significantly lower than Rural \((p<0.001)\)
Comparing the average of mentally unhealthy days in Ohio in 2016 (4.049) to 2022 (5.384), we found that the number of days significantly increased (RQ4). (p<0.001) paired t-test

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>88</td>
<td>4.049</td>
<td>0.3500</td>
</tr>
<tr>
<td>2022</td>
<td>88</td>
<td>5.384(^A)</td>
<td>0.2678</td>
</tr>
</tbody>
</table>

\(^A\) = Significantly higher than 2016 (p<0.001)

Comparing the average smoking percentage in Ohio in 2016 (19.720%) to 2022 (23.836%), we found that the number of days significantly increased (RQ5). (p<0.001) paired t-test

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>88</td>
<td>19.720</td>
<td>1.8746</td>
</tr>
<tr>
<td>2022</td>
<td>88</td>
<td>23.836(^A)</td>
<td>3.0103</td>
</tr>
</tbody>
</table>

\(^A\) = Significantly higher than 2016 (p<0.001)

An ANOVA showed that the percent of smokers in 2022 between multiple states (RQ6) were significantly different (F 3, 379=67.190) (p<0.001). Post-hoc tests showed that Kentucky significantly had the highest percent smokers (26.709%) and that Ohio (23.836%) had a
significantly lower percentage than Kentucky and a significantly higher percentage than Indiana (22.010%) and Michigan (21.313%). Indian and Michigan, separately, both had significantly lower smoking percentages than Kentucky and Ohio. (Table 6) ANOVA with post-hoc

Table 6. Comparing percent smokers among Midwest states

<table>
<thead>
<tr>
<th>Year</th>
<th>N (counties)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky</td>
<td>120</td>
<td>26.709&lt;sup&gt;ABC&lt;/sup&gt;</td>
<td>3.5979</td>
</tr>
<tr>
<td>Ohio</td>
<td>88</td>
<td>23.836&lt;sup&gt;BCD&lt;/sup&gt;</td>
<td>0.3209</td>
</tr>
<tr>
<td>Indiana</td>
<td>92</td>
<td>22.010&lt;sup&gt;AD&lt;/sup&gt;</td>
<td>2.4113</td>
</tr>
<tr>
<td>Michigan</td>
<td>83</td>
<td>21.313&lt;sup&gt;AD&lt;/sup&gt;</td>
<td>2.6355</td>
</tr>
</tbody>
</table>

A=statistically significantly different than Ohio  
B=statistically significantly different than Indiana  
C=statistically significantly different than Michigan  
D=statistically significantly different than Kentucky

An ANOVA showed that the number of unhealthy days in 2022 between multiple states (RQ7) were significantly different (F 3, 379=41.870) (p<0.001). Post-hoc tests showed that Kentucky significantly had the highest average number of mentally unhealthy days (5.663) and that Indiana (5.110) had the significantly lowest number of mentally unhealthy days. Ohio (5.384) and Indiana (5.346) both had significantly lower mentally unhealthy days than Kentucky and significantly higher than Indiana (Table 7) ANOVA with post-hoc.

Table 7. Comparing average number of mentally unhealthy days among Midwest states
<table>
<thead>
<tr>
<th>Year</th>
<th>N (counties)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky</td>
<td>120</td>
<td>5.663&lt;sup&gt;ABC&lt;/sup&gt;</td>
<td>0.4335</td>
</tr>
<tr>
<td>Ohio</td>
<td>88</td>
<td>5.384&lt;sup&gt;CD&lt;/sup&gt;</td>
<td>0.3500</td>
</tr>
<tr>
<td>Michigan</td>
<td>83</td>
<td>5.346&lt;sup&gt;CD&lt;/sup&gt;</td>
<td>0.3206</td>
</tr>
<tr>
<td>Indiana</td>
<td>92</td>
<td>5.110&lt;sup&gt;B&lt;/sup&gt;&lt;sup&gt;C&lt;/sup&gt;&lt;sup&gt;D&lt;/sup&gt;</td>
<td>0.2935</td>
</tr>
</tbody>
</table>

<sup>A</sup>=statistically significantly different than Ohio
<sup>B</sup>=statistically significantly different than Michigan
<sup>C</sup>=statistically significantly different than Indiana
<sup>D</sup>=statistically significantly different than Kentucky

**Discussion**

It is heavily researched, documented, and generally perceived by the public that smoking cigarettes is associated with negative health outcomes. These include an increased risk of premature death due to the development of chronic obstructive pulmonary disease and other respiratory complications, hypertension, and cancer. However, there has been less research and emphasis on the negative mental health effects of cigarette smoking. The negative physical effects have been used in targeted advertisements in efforts to reduce the frequency of smoking in the United States. These advertisements can be deemed successful when comparing today's smoking rates to those of the 20th century. However, the rates of smoking in the state of Ohio have increased between the years of 2016 and 2022 (Table 5) and other states have found themselves in similar predicaments. Therefore, it may be time for targeted advertisements to find a new angle to use in the fight against cigarette smoking based on the effects it has on mental health. Our research hopes to establish this connection, so that this new approach can be used
effectively in the anti-cigarette campaign. Once that is established, further studies can be done to find out exactly what specific negative mental health outcomes are caused by smoking cigarettes and why.

The major question we were asking in this study was whether or not there was a correlation between smoking rates and the number of mentally unhealthy days in Ohio in the year 2022. As seen in Figure 1, there is a significant positive correlation between smoking rates and mentally unhealthy days, meaning that increased smoking rates will coincide with an increased number of mentally unhealthy days and vice versa. Although this is important, there is a limitation in this study which is that the direction of causality was not able to be determined from the data set used. This is an area for future research. Our other questions showed significance in additional areas. Between the years 2016 and 2022, the frequency of smoking cigarettes increased in the state of Ohio (Table 5). The number of reported mentally unhealthy days in Ohio also increased between 2016 and 2022 (Table 6). This further solidifies a positive association between these two variables.

This research also aimed at finding the difference between rural and urban counties in Ohio, specifically in the areas of smoking rates and mentally unhealthy days. It was found that smoking rates are higher in the rural counties of Ohio (Table 2). Coinciding with our hypothesis, these counties also had a higher number of reported mentally unhealthy days in 2022 (Table 2). Thus, this data further supports the positive association between smoking and poor mental health.

Prior to our research, we predicted that poor mental health and smoking rates would be positively correlated variables with areas of increased smoking rates also having increased
numbers of mentally unhealthy days. Our results were as expected and agree with other research that negative mental health can be positively correlated with smoking\textsuperscript{5,6}. However, this research does not prove that if an individual smokes cigarettes, they will have more mentally unhealthy days. But, it does show that an individual who lives in a county with a higher smoking percentage, is significantly more likely to have more mentally unhealthy days. It also tells us that individuals from rural counties in Ohio are more likely to smoke and thus experience more negative side effects associated with smoking as well as mental health problems.

Although the data and research we conducted was significant, there are limitations in our study. For one, the direction of causality could not be determined and therefore it is unable to be concluded if smoking directly causes poor mental health or if poor mental health causes smoking. Another limitation is our sample size as it pertains to rural counties in Ohio as there are very few counties categorized as rural in the state of Ohio. Also, 22 counties were omitted as they were considered “partially rural”. Perhaps with more data from neighboring states, or different research parameters or guidelines determining what counties can be considered rural, our data could be even more significant. Another limitation of our study also pertains to sample size and that is that the data that was collected could not be demonstrative of the actual Ohio population as there could have been many county residents that did not participate in the data collection.

For future research directions, the question of whether smoking causes poor mental health or poor mental health causes smoking should be investigated. If it is found that smoking causes poor mental health, the specific effects it has should be investigated. As for the differences between rural and urban counties, this could also be an area for future research, specifically for smoking rates. Specifically, the reason for the elevated smoking frequency should
be investigated. This research, along with the future research to be done, can aid in reducing smoking rates in not only rural counties, but all counties in the United States. As the importance of mental health continues to rise and people continue to look for ways to improve their mental health, the positive association between smoking and poor mental health can be used to deter people from smoking, as well as serve as an incentive for cessation. It will also serve as a tool for physicians as they will recognize this positive association and will be better able to take care of their patients. This research and future research regarding this topic will contribute to helping Ohio, and all states, become a healthier and happier population.

Conclusion

Smoking and mental health are critical for public health. Many studies have described the negative contributions of smoking on health and the factors contributing to poor mental health. This study illustrates the evidence of a positive correlation between smoking rates and mentally unhealthy days in Ohio. Counties that have higher smoking rates have significantly more mentally unhealthy days. These have significantly increased from 2016 to 2022. Rural Ohio counties have significantly more mentally unhealthy days and high smoking percentages compared to urban Ohio counties. The issues of smoking and mentally unhealthy days are complex and plausibly intertwined, but are both critical to public health. Future research should study the direction of causality to investigate whether smoking rates contribute to mentally unhealthy days or if mentally unhealthy days contribute to smoking rates. This paper explored the connections between these variables using data from the County health Rankings national database and could ultimately provide direction for future research in these areas, ultimately with the goal to start prevention and intervention initiatives to advocate for well-being and reduce burdens of mental health disorders and smoking related diseases.
References


