Journal of Biostatistics and Epidemiology

J Biostat Epidemiol. 2023;9(3):351-362

Original Article

Analysis of Mental Health and Drug Use in the Top 21 Most Populated U.S. States

Grace Castillo, Sneh Gulati*, B.M. Golam Kibria

Department of Mathematics and Statistics, Florida International University, Miami, USA.

ARTICLE INFO

Received 01.03.2023
Revised 19.03.2023
Accepted 23.04.2023
Published 15.09.2023

Key words:
Alcohol;
Correlation test;
Drug;
Mental health;
Nonparametric test;
Tobacco

ABSTRACT

Introduction: Most people in the United States live busy stressful lives which can lead to significant health challenges, especially to one's mental health. After years of being ignored and stigmatized, mental illness has been given the recognition it deserves. It is now associated with the overall health of a person and treated seriously. The same could be said about substance abuse disorder though on a lesser scale. This paper attempts to understand the relationship between drug use and mental health illness differentiated across age groups. The understanding of these causations and relationships could help us better understand the rate and triggers of mental illness in the United States.

Methods: We used data from a 2023 survey, which contains a total of 69,850 completed interviews. The data collected were taken from each state individually with each of them implementing the same survey to collect responses. Instead of looking at all fifty states, we decided to analyze only the highest twenty-one most populated states. Various non-parametric tests were used to analyze age groups and their rate of mental health illnesses and drug use within the country.

Results: We found that tobacco use is associated with mental illness, while alcohol use is associated with attempted suicide. It appears that indicators of drug use are not homogeneous across states for either age group. We also found that the alcohol consumption is related to a declining proportion of attempted suicides.

Conclusion: In this research we found a significant association between drug use and inidcators of mental illness. The association differed across different age groups and also across states. Since we found that the alcohol consumption is related to a declining proportion of attempted suicides, it will be interesting to explore why this is the case and what could be observed to decrease suicidal rates.

*.Corresponding Author: gulati@fiu.edu

Copyright © 2023 Tehran University of Medical Sciences. Published by Tehran University of Medical Sciences.
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (https://creativecommons.org/licenses/by-nc/4.0/). Noncommercial uses of the work are permitted, provided the original work is properly cited.

Introduction

No one would ever say that someone with a broken arm or a broken leg is less than a whole person, but people say that or imply that all the time about people with mental illness."

Elyn R. Saks, 2007

Over the course of the past decade, there's been increased willingness to recognize mental health as an essential part of one's well-being."

Nicole Spector, 2020

These are just two quotes from several on attitudes towards mental health but are very apropos. Mental health issues have plagued humans for Millenia and yet it is only recently that society has begun to treat them seriously and with compassion. It turns out that 1 out of 5 people in the United States have mental health disorder annually.[1] According to the centers for disease control,[2] mental health of a person includes their emotional, psychological, and social well-being. Mental health and physical health are intricately linked where certain ailments can increase the risk of mental illness and vice versa. As per data from the National Institutes of Mental Health (NIMH), in 2021 57.8 million people in the United States suffered from mental illness, with an estimated 14.1 million adults with a severe case of it.[3] NIMH also reports that the prevalence of mental health illness is higher amongst females than males and that the highest prevalence of mental health was seen amongst young adults rather than any other age group. The Figures 1 and 2 show the breakdown of prevalence of mental health by gender and age:

Despite the prevalence of mental health illness, treatment for mental health illnesses has had a tortured past. In the 1800's, people with mental illnesses were treated like criminals and shunned by society. Even when society started to accept that mental illnesses could be treated, patients were forced into asylums, treated like prisoners, and subjected to unusually cruel treatments like electroconvulsive therapy.[4] Fortunately, now mental health is accepted as being a part of a person's overall health. This change in attitude owes its birth to the book "A Mind That Found Itself" by Clifford

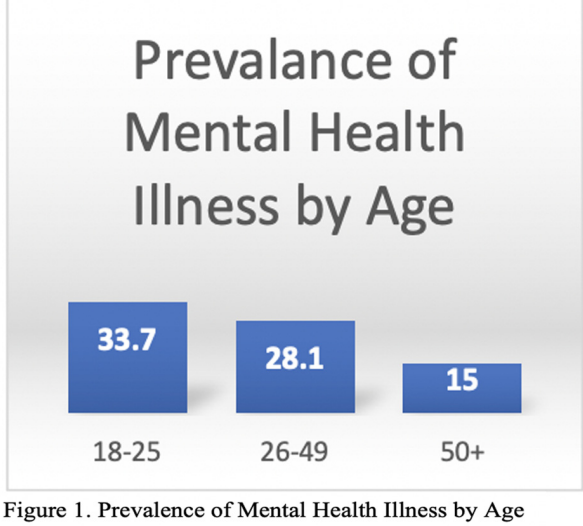

Figure 1. Prevalence of Mental Health Illness by Age
https://www.nimh.nih.gov/health/statistics/mental-illness#part_2542

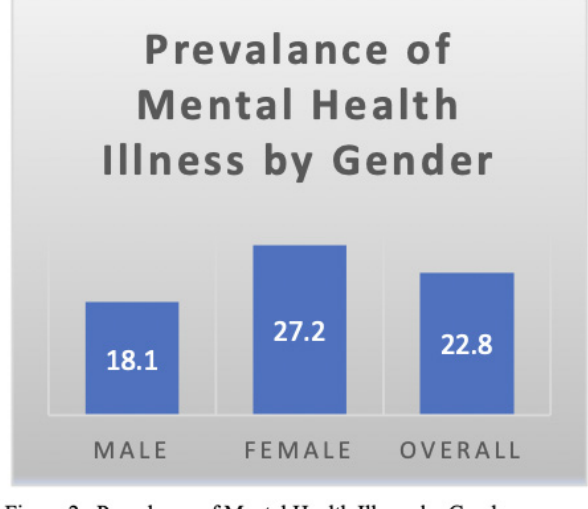

Figure 2 . Prevalance of Mental Health Illness by Gender
https://www.nimh.nih.gov/health/statistics/mental-illness#part_2542

Beers.[4] Clifford Beers had spent time in mental institutions proposed the creation of an agency that would educate the public about mental health. His efforts did lead to the creation of the first agency that concerned itself with mental health issues. The efforts to destigmatize mental illness continued and eventually led to the creation of a federal agency under the National Institute of Mental Health.[4] The educational efforts have continued and have gained momentum recently. Admissions of mental health struggles by famous athletes and actors have helped increase awareness and acceptance of mental health issues. Today there are a lot of services for people seeking help for such illnesses although there appears to be some societal reluctance to seek care for mental illness. According to NIMH, only about half the people with mental illness received mental health care in different forms, such as inpatient treatment, counseling, or prescriptions. When comparing genders, a higher percentage of women (57.1%) received mental health care rather than men (40.05). Observing the age groups, the highest percentage of people with mental illness were those aged 26-49, making up 48.1%. However, the highest percentage of those with a severe case of mental illness is the age group 18-25 this growing prevalence shows a national mental health crisis that has seen a disproportionate response to its severity. Figures 3 and 4 show the percentage of people seeking care for mental illness by age and gender:

Mental Illness can lead to several other health issues in individuals and substance abuse is just one of them. While there is an inextricable link between mental health illness and drug addiction, acceptance of mental health illness has not led to the acceptance of people with substance abuse issues. Substance abuse is not uncommon in the United States with tobacco and alcohol being the two most commonly used drugs. On an average 63% of all US adults use alcoholic beverages and 12.5% use tobacco.[5] In addition, according to the department of health and human services,[6] 21.9% of the population in the United States has used illicit drugs in the past year and 12.5% of the population can be classified as having a substance abuse disorder. When one examines this in conjunction with substance abuse

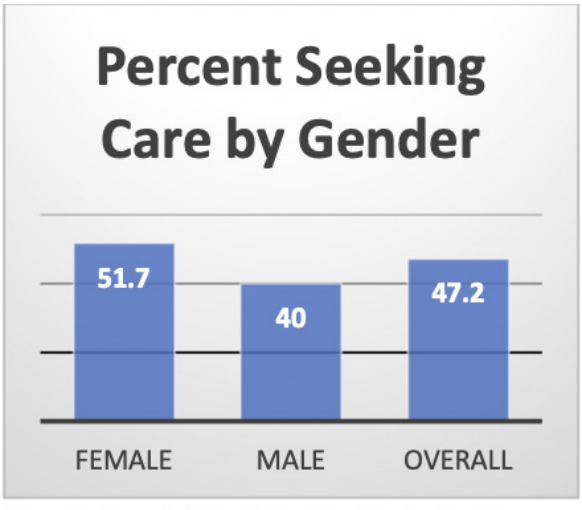

Figure 3. Percent of People Seeking Care by Gender
https://www.nimh.nih.gov/health/statistics/mental-illness#part_2542

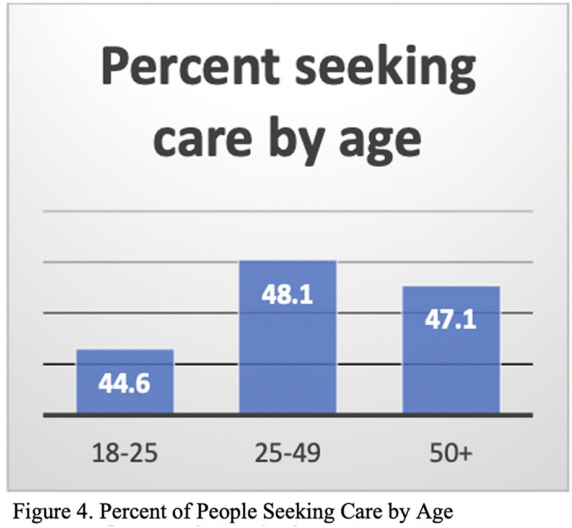

Figure 4. Percent of People Seeking Care by Age
https://www.nimh.nih.gov/health/statistics/mental-illness#part_2542

disorder, almost 33% of the adults have either a mental illness or a substance abuse disorder. While substance abuse was associated with criminals and the dregs of society, today it is being reluctantly accepted as a chronic disease that needs to be treated. The goal of this paper is to dive deeper into the relationship between mental illness and substance abuse with the hope that understanding the relationship will help foster treatment for both conditions. For more on mental illness and drug abuse, we refer our readers to[7-9] and very recently[10] among others.

The rest of the paper is organized as follows. Section 2 describes the data (materials and methods) used in the paper. Section 3 presents the analysis and results of the data while the Sections 4 and 5 discuss the conclusion and further analysis.

Methods

To conduct our research, we used data from Substance Abuse and Mental Health Services Administration (SAMHSA) an agency within the U.S. Department of Health and Human Services. SAMHSA was founded in 1992 with the goal of making information on substance use, mental health disorders and related services more accessible. SAMHSA (www.samhsa.gov) now leads the nation's efforts to advance mental health. One of the tools that SAMHSA uses in its mission to improve mental health and reduce substance use disorders is the data obtained from the National Survey on Drug Use and Health (NSDUH). NSUDH is essentially a nationwide study that provides comprehensive current statistics on alcohol, tobacco, and drug use along with information on mental health and mental health issues. Each year NSUDH interviews approximately 70,000 people aged 70 or older to get information on their use of tobacco and drugs, mental health, and several demographic characteristics (age, gender, race, education level, state of residence). The data are collected from each state using in person and web interview.[11] For this paper, we used the data from the 2023 survey. There were a total of 69,850 completed interviews in the survey from the approved screening of 220,743 addresses. The data collected were taken from each state individually with each of them implementing the same survey to collect responses.[12] Instead of looking at all fifty states, for this initial study, we decided to analyze only the highest twenty one most populated states. We did so under the assumption that the highly populated states will give us a better picture of the state of mental health in the country although we do plan to analyze all fifty states in subsequent studies. We also decided to analyze the data for only the adults in the population as the data for the population under 17 years of age were incomplete.

The original study presents data on thirty-five indicators of substance abuse and drug and tobacco use by age groups. These include first time drug or tobacco use, use of different classes of drugs and tobacco products, perceptions of risk of using these products amongst others. We narrowed our analysis to the following variables as we feel that these are the most relevant to our goal.

- llicit drug use in the past month (Illicit Drug Use)
- Alcohol use in the past month (Alcohol Use)
- Tobacco product use in the past month (Tobacco Use)

- Any mental illness in the past year (AMI) defined as any emotional, behavioral or emotional disorder according to the National Institutes of Mental Health (NIMH)
- Serious mental illness in the past year (SMI) defined by NIMH as a mental health disorder that seriously impairs one's ability to function and can limit one or more life's activities.
- Attempted suicide in the past year (AS)[13]

For the analysis, we focused on the following three main relationships:

- An evaluation of the correlation between the three variables of mental health (AMI, SMI, and AS) against all three of the drug use variables.
- A test to determine if the two age groups have different means within each category. Finding some significance with this test would give insight into the differences between the two age groups and how they are affected.
- Lastly, a chi square test of independence to determine whether there exists a dependency between the states and indicators of mental health and drug use rates.

The next section presents the data analysis. (Note: The data are available on request to anyone wishing to replicate the results or conduct further analyses).

Results

One of the main goals of this paper is to see if there is a relationship between mental health illness and substance abuse. So we decided to investigate the correlation between the three categories of mental illness (AMI, SMI and AS) with the three indicators of substance abuse (Illicit Drug Use, Alcohol Use and Tobacco Use). Since the data are categorical, the Spearman Rank correlation[14] test was used on the proportion of each category to test whether there was a significant association between any of the variables. The analysis was done using the R software. The results of the analysis are presented in Tables 1-6. Tables 1-3 give the correlations for the adults in the 18-25 age range while Tables 4-6 give the correlations for adults over 26 years of age. In general we noticed the following:

- For people in the age group 18-25, tobacco use has a significant strong positive association with any mental illness but only a moderate association with strong mental illness.
- Also for people in the age group 18-25, alcohol use has a negative association with attempted suicide with higher alcohol is associated with a decreased rate of attempted suicide.
- For older adults, tobacco use was only moderately associated with mental illness, although both alcohol and tobacco use were associated with attempted suicide. Higher alcohol use was associated with lower suicide rates but higher tobacco use was associated with higher rates of attempted suicide.

Detailed Interpretations of the values are given along with the tables.

The secondary goal of this paper is to examine the differences in the substance abuse indicators for the different age groups and to see if there were state-wide differences in the different indicators The procedure to do so is described below. Figure 5 shows the distribution of the

Table 1. Any mental illness (AMI) correlation test (18-25)

Variable	Spearman's ρ	P value
Illicit Drug Use	0.1060	0.3862
Alcohol Use	0.2013	0.3799
Tobacco Use	0.6416	0.002187

We can see from Table 1 that tobacco use appears to have an significant association (0.6412) with mental illness which signifies that higher values of tobbaco use are associated with any mental illness.

Table 2. Severe mental illness (SMI) correlation test (18-25)

Variable	Spearman's ρ	P value
Illicit Drug Use	-0.0039	0.9887
Alcohol Use	-0.2117	0.3553
Tobacco Use	0.42078	0.05876

None of the values are high enough to assume that there is an association of ranks with severe mental illness. Tobacco use does show a moderate positive association (ρ=0.421, Pvalue=0.05876) with serious mental illness.

Table 3. Attempted Suicide (AS) correlation test (18-25)

Variable	Spearman's r	P value
Illicit Drug Use	-0.0289	0.8976
Alcohol Use	-0.6285	0.002276
Tobacco Use	-0.0871	0.7074

Alcohol use appears to have a significant association with attempted suicide with a value of -0.63 which signifies higher values of alcohol use are associated with lower rates of attempted suicide.

Table 4. Any mental illness (AMI) correlation test (26+)

Variable	Spearman's ρ	P value
Illicit Drug Use	0.11042	0.6337
Alcohol Use	-0.0617	0.7905
Tobacco Use	0.32413	0.1517

None of the values are high enough to conclude that there is an association between substance abuse indicators and any mental illness for adults although tobacco use shows a weak association with incidence of any mental illness.

Table 5. Severe mental illness (SMI) correlation test (26+)

Variable	Spearman's ρ	P value
Illicit Drug Use	-0.08899	0.7013
Alcohol Use	-0.2189	0.3404
Tobacco Use	0.41461	0.06179

Tobacco has a moderate correlation with serious mental illness as per Table 5. This implies that as the rate of tobacco use increase, it seems that the rate of severe mental illness in the 26+ age group also increases.

Table 6. Attempted Suicide (AS) correlation test (26+)

Variable	Spearman's ρ	P value
Illicit Drug Use	-0.3532	0.1114
Alcohol Use	-0.6597	0.001001
Tobacco Use	0.41688	0.0614

Alcohol use appears to have a significant value of -0.6597 (P-value=0.001). We can assume that the relation is montonically decreasing. It also appears that tobacco use is positively associated with attempted suicide, which means the relation is montonically increasing.

Table 7. Mean of each proportion for categories of 18-25 and 26+ age groups

	Drug Use	Alcohol	Tobacco	AMI	SMI	AS
18-25	26.321	51.472	17.174	34.215	11.515	2.651
26+	13.887	52.97	22.073	21.083	4.437	0.351

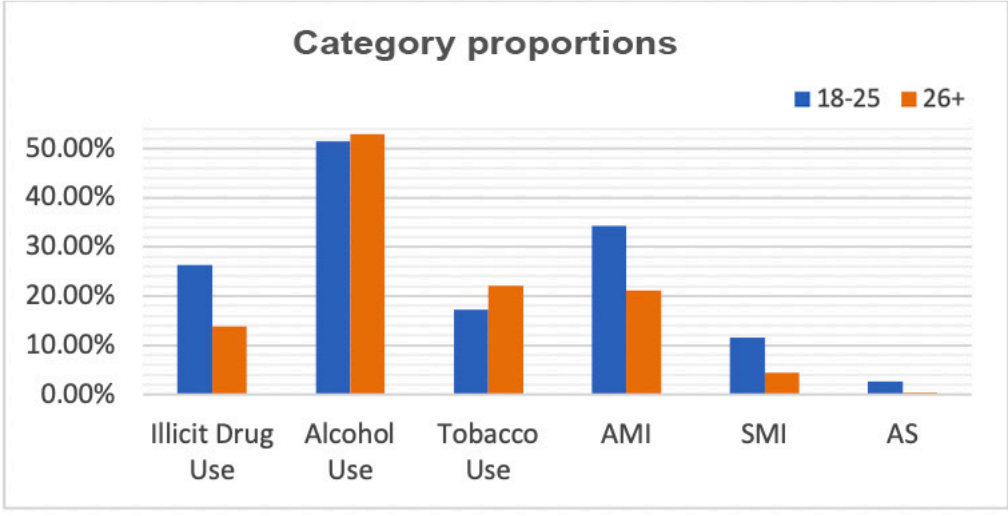

Figure 5. Category Average Proportions Separated by Age Groups

indicators for the two age groups while Table 7 displays the values of the average proportions (across all states) for each category for the two age groups. Figure 5 and Table 7 indicate that the average proportion of the indicators are different across different age groups with perhaps the exception of alcohol use. They also indicate the need for a formal test. In order to conduct the test, we took a random sample of 5 states was taken from the top 21 U.S. states (the sample resulted in the selection of Texas, Ohio, Virginia, Washington, and Tennessee.) We use the mean proportions from these states for further testing.

The Two-Proportions Z test was used to test the hypothesis of whether the substance abuse indicators for the age group 18-25 and the age group 26+ have the same mean proportion. Table 8 presents the results of this analysis. Note that pA represents the proportion of the age group 18-25 and pB represents the proportion of the age group 26+. In Table 8, we can see a significant difference in proportions between the population of each age group within all the categories (p values $< 10\text{-}7$ in all cases). The tests corroborate reports on mental health in that mental health illness is more prevalent amongst younger people. Also as expected, substance abuse indicators are higher for older individuals.

Next, we looked at whether the indicators of substance abuse and mental health illness were different across the twenty-one states we picked for this analysis. The distribution of the indicators for the two age groups is displayed in Figures 6-9. These graphs indicate that the proportion of the indicators might be different across the states.

Next, we perform a chi-squared test of independence with 4 subsets of the collected data. Table 9 displays the results of the analysis: It appears from Table 9 that indicators of drug

Table 8. Two-Proportions Z test between both age groups variables

Variable	Test statistic	P-value	
Drug use	459.22	<2.2e-16	$p_A > p_B$
Alcohol use	25.614	4.141e-07	$p_A > p_B$
Tobacco use	136.4	<2.2e-16	$p_A > p_B$
AMI	436.88	<2.2e-16	$p_A > p_B$
SM	474.03	<2.2e-16	$p_A > p_B$
AS	387.93	<2.2e-16	$p_A > p_B$

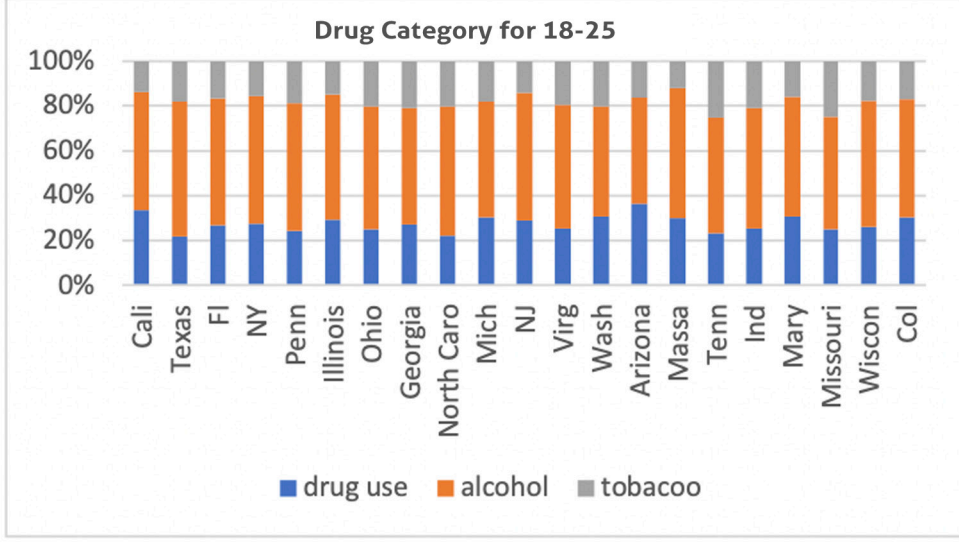

Figure 6. Stacked column figure of each state's estimated values for drug use categories in 18-25 age qroup

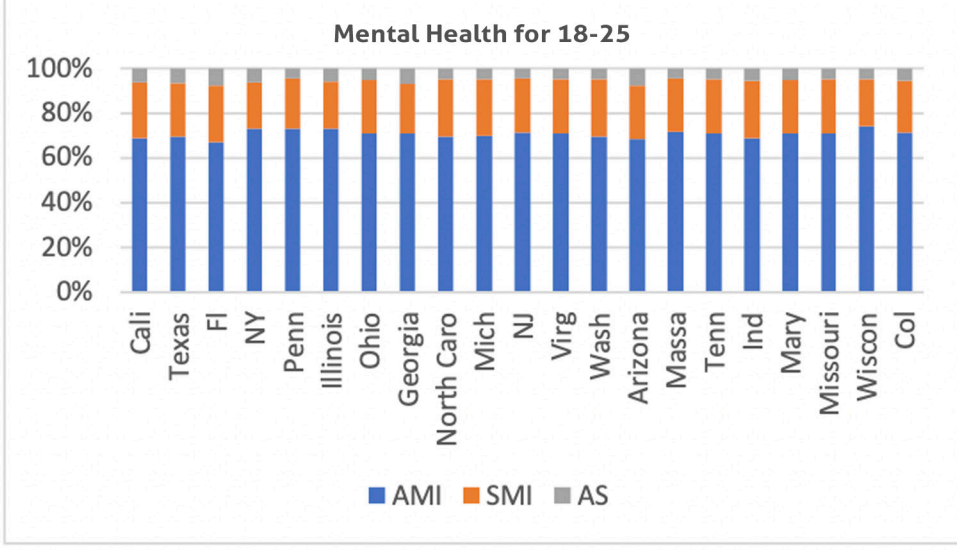

Figure 7. Stacked column figure of each state's estimated values for mental health categories in 18-25 age group

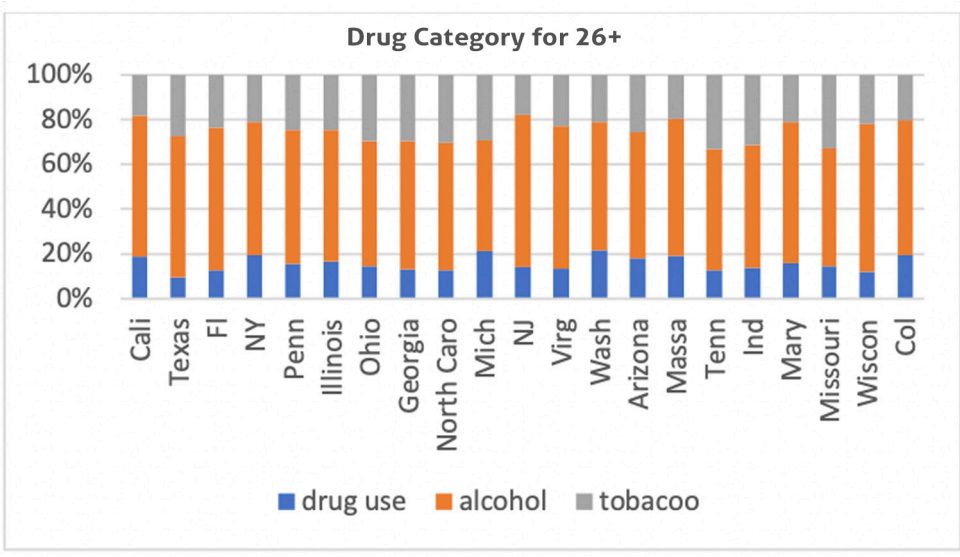

Figure 8. Stacked column figure of each state's estimated values for drug use categories in 26+ age group

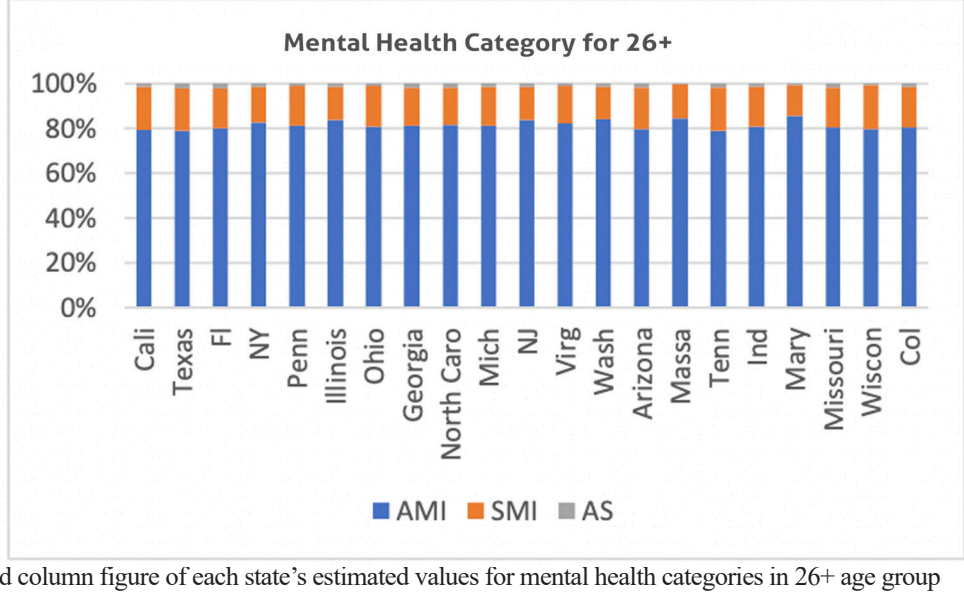

Figure 9. stacked column figure of each state's estimated values for mental health categories in 26+ age group

Table 9. Chi-square test of Independence between States and Indicators

	X^2- Statistic	P value
Drug Use in 18-25	306.1	<2.2e-16
Mental Health in 18-25	38.238	0.5498
Drug Use in 26+	2479.8	<2.2e-16
Mental Health in 26+	148.72	2.007e-14

use are not homogeneous across states for either age groups. However, while the incidence of mental health illness is dependent on the state for the 26+ age group, there is no difference in the incidence of mental health illness across the states for the 18-25 age group.

Discussion

In this paper, we analyzed the data on drug use and mental illness rates within the most populated 21 states in the United States in order to find relationships between the indicators of drug use on mental illness as well as to find whether age groups carry a different risk in one or more of these categories. We used correlation testing to conclude that the proportion of mental illnesses and symptoms had significant associations with rates of drug uses. The tests also demonstrated the differences in these associations across the 18-25 and 26+ age groups. We concluded that within the 18-25 age group, tobacco use had a positive association with any mental illness and severe mental illness, while alcohol use had a strong negative association with attempted suicide rate.

Moreover, illicit drug use had a positive association with any mental illness in the same age group but no association with severe mental illness. Within the 26+ age group, we concluded that tobacco use had a positive association with all the mental health categories, alcohol had a strong negative association with attempted suicide rate, and illicit drug use had no significant association with any of the mental health indicators. With this evidence, we can begin to understand how drugs and mental health interact. The most significant observation that was found was the notable trend that tobacco had with these proportions, it seems like tobacco use has a monotonically increasing relationship with mental health in almost every category. This is no surprise, however, as the use of tobacco has been heavily associated with users experiencing increased anxiety and the development of depression.[15] For such an addictive substance that is so prevalent in our society, it continues to have a hold on the mental wellbeing of individuals. A factor of interest in this category is why this is especially apparent within the 26+ age group as tobacco use gave a much stronger association with its values. Further analysis into this relationship could unveil more about the affects of tobacco as a user ages. A suggested model would be used to analyze the rate of mental illness as a smoker ages to observe how their mental health may deteriorate as they continue to smoke. Another factor to consider is that relationship between alcohol use and attempted suicide's relation is montonically decreasing. For future research into this, it would be interesting to observe what the usage of alcohol does to a suicidal individual and why this relationship was observed. If there is a direct link between these two variables, then it warrants a deeper analysis on what could be found.

A comparison between the mean values of each category for the two different age groups showed that the indicators differ significantly between the two age groups. Having deduced this, we can assume that the rates of each category are influenced by the age of the individual, therefore making a person's age a risk factor in using drugs and developing mental health issues. People twenty six years and older are more susceptible to alcohol and tobacco use while illicit drug use seems to be more prevalent amongst the 18-25 year olds possibly a reflection of the cultural differences amongst younger versus older individuals. Of note was the fact that the adults in the age group 18-25 were much more susceptible to mental illness than the older adults. This

could be due a variet of reasons, such as how most young individuals face many challenges in the transition into adulthood. It could also be a declining rate of mental health in newer generations due to globalchanges. It is also worth noting that while the adults in the 26+ had a greater propensity for substance use, they had lower incidence rates of mental illness than the 18-25 age group. Further questioning and analysis would be appropriate to conclude how these factors truly relate.

Finally, we investigated whether the prevalence of mental illness and drug use differed across the states. The analysis showed significant dependence between the two indicators and the states for the adults in the 26+ age group. The rates of mental illness were not significantly different for the different states for the younger adults but the rates of drug use were. This difference in the rates of drug use amongst the younger adults could be due to different state policies on drug use, the ease with which drugs can be obtained in the different states and maybe proximity to countries where drugs are easily available. The disparity definitely warrants further investigation.

Conclusions and Future Research

As mentioned in the previous section, our research found a significant association between drug use and indicators of mental illness, We found that the association differed across different age groups and also across states. We would like to investigate these relationships in greater depth in future research. Moreover, since we found that the alcohol consumption is related to a declining proportion of attempted suicides, it will be interesting to explore why this is the case and what could be observed to decrease suicidal rates. Finally, in this paper we considered 21 states. Going forward, it would be interesting to consider the data from all states and for different variables, say, Race, Education level, Income and such possibility is under the current investigation.

Acknowledgement

The authors are grateful to the anonymous referee whose comments helped to improve the quality of this paper significantly.

Conflicts of Interest

Authors have no conflict of interests.

Funding statement

Authors have no funding to report.

References

1. U.S. Department of Health and Human Services. (2023, March 23). Mental Health During the COVID-19 Pandemic. National Institutes of Health. Retrieved April 27, 2023, from https://covid19.nih.gov/covid-19-topics/mental-health#:~:text=In%20a%202021%20study%2C%20nearly,the%20beginning%20of%20the%20pandemic.

2. CDC report on Mental Health from https://www.cdc.gov/mentalhealth/learn/index.htm.

3. U.S. Department of Health and Human Services. (2023, March). Mental illness. National Institute of Mental Health. Retrieved April 26, 2023, from https://www.nimh.nih.gov/health/statistics/mental-illness.

4. History of Mental Illness from history of mental illness.

5. Report, S. (2023, March 8). 2021 NSDUH state estimates of Substance use and mental disorders. SAMHSA.gov. Retrieved April 26, 2023, from https://www.samhsa.gov/data/report/2021-nsduh-state-estimates-substance-use-and-mental-disorders.

6. Survey on Drug Use and Mental Health https://www.hhs.gov/about/news/2023/01/04/samhsa-announces-national-survey-druguse-health-results-detailing-mental-illness-substance-use-levels-2021.html.

7. Lasser K, Boyd J W, Woolhandler S, Himmelstein D U, McCormick D, Bor DH. Smoking and Mental Illness: A Population-Based Prevalence Study. Journal of the American Medical Association (JAMA). 2000;284(20):2606–2610. doi:10.1001/jama.284.20.2606.

8. Cook BL, Wayne GF, Kafali EN, Liu Z, Shu C, Flores M. (2014). Trends in smoking among adults with mental illness and association between mental health treatment and smoking cessation Journal of the American Medical Association. 2014;311(2):172-182. doi:10.1001/jama.2013.284985Definition of Mental Illness https://www.nimh.nih.gov/health/statistics/mental-illness#:~:text=Two%20broad%20categories%20can%20be,the%20NIMH%20Health%20Topics%20Pages.

9. Ma, W. and R. Sankar (2016). Impact of Drug Addiction on Mental Health. Journal of Mental disorders and treatment. 2(1), 1-3.

10. Gail et al. (2023). Effect of a Tobacco Cessation Intervention Incorporating Weight Management for Adults with Serious Mental Illness. A Randomized Clinical Trial. JAMA Psychiatry. Published online June 28, 2023. doi:10.1001/jamapsychiatry.2023.1691.

11. Survey on Drug Use and Mental Health https://nsduhweb.rti.org/respweb/about_nsduh.html.

12. 2021 NSDUH state estimates of Substance use and mental disorders. ttps://www.samhsa.gov/data/report/2021-nsduh-state-estimates-substance-use-andmental-disorders

13. U.S. Department of Health and Human Services Statistics on Mental Health. https://www.nimh.nih.gov/health/statistics/mental-illness#part_2542.

14. National Spearman C. (1904). The proof and measurement of association between two things. American Journal of Psychology. 15 (1): 72–101. doi:10.2307/1412159. JSTOR 1412159.

15. Center for Drug Abuse Statistics. (2023, January 1). Substance abuse and addiction statistics [2023]. NCDAS. Retrieved April 26, 2023, from https://drugabusestatistics.org.