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The Relationship Between Insufficient Sleep and Mental Health Distress in Ohio Compared to West Virginia and New Jersey

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Abstract

Objective: To compare and establish the importance of the relationship between insufficient sleep and the frequency of mental health distress in Ohio in contrast to that in West Virginia and New Jersey in 2022.

Methods: The data used included information on insufficient sleep, frequency of mental health distress, and premature death per each state studied and was collected from County Health Rankings and then analyzed using a Pearson's correlation, one way analysis of variance, and multiple linear regression. Ohio was chosen as the reference state with New Jersey and West Virginia as comparisons based on their equivalent population size and apparent differences in trends in the studied variables.

Results: There was a strong and significant positive correlation between insufficient sleep and frequency of mental health distress in all three states in 2022. The percent of insufficient sleep in 2022 within Ohio (40.45%) was betwixt the states under study with New Jersey being lower (38.09%) and West Virginia being higher (43.34%). The percent of frequent mental health distress is highest in West Virginia (21.19%), then Ohio (17.76%), and lowest in New Jersey (13.11%) in 2022. A linear regression revealed that insufficient sleep could explain 87.3% of the variance in the frequency of mental health distress in 2022. When insufficient sleep was controlled for, the percent of mental distress in Ohio was 1.8% lower than West Virginia and 3.33% higher than New Jersey in this measure in 2022. A linear regression indicated the frequency of mental health distress accounted for 65.5% of the variance in life expectancy in 2022. When controlled for frequency of mental health distress the life expectancy in Ohio was 2.22 years lower than New Jersey and 1.79 years higher than West Virginia in 2022.

Key Words: insufficient sleep, mental health distress, Ohio, New Jersey, West Virginia

Introduction

      Mental health crises are an important and worsening dilemma among residents of the United States (US). According to a recent report by the White House, the financial burden caused by unmet mental health needs exceeded 280 billion USD in the year 2020. Sources concurrently indicate a worsening in sleep quality in many states, but these trends are not consistent nationwide[1]. The link between sleep quality and mental health has been established in

the literature, but trends relating to the impact of sleep on specific mental health outcomes are less clear, especially across varied regions of the US. A better understanding of how poor sleep quality can manifest mental health crises will support targeted measures at improving overall health across the US population and reduce the financial burden of these unmet needs.

Published studies have established a link between insufficient sleep and negative mental health outcomes. Ohio demonstrates poorer than average performance in both of these variables, but the relationship between these two indicators is unclear. Insufficient sleep in Ohio across the years demonstrates an upward trend[2]. When comparing state to state, a 2020 analysis found that Ohio had the highest amount of insufficient sleep[2]. It is predicted that as these levels continue to rise so will the risk for poor health outcomes, leading to an increased burden on the health care system[2]. Levels of insufficient sleep vary across the US and are especially elevated in Ohio's Appalachia region[3]. There appears to be a connection between poor sleep and disease risk, as residents of Ohio's Appalachia region experience a significantly increased risk for obesity, cardiovascular disease, diabetes, lung disease, and cancer compared to other geographic locations[3].

The problem of insufficient sleep is frequently overlooked in the medical community and patients suffer the consequences. Clinicians often fail to recognize the health consequences of lack of sleep, instead attributing them to other causes, such as stress or social issues[4]. Patients tend to underreport sleep insufficiency due to the lack of public concern, which contributes to this breakdown in provider patient collaboration[4]. This is a critical gap, as insufficient sleep can contribute to negative outcomes in cognition, mood, judgment, respiratory system, mental health, cardiovascular system, immune system, obesity, metabolism, cancer, migraine, and burnout[4]. Addressing poor sleep quality will benefit patients because it may prevent future mental illness in the healthy population[5]. This prevention effect is based on the strong and independent connection of insomnia to mental health[5].

Insomnia and sleep quality have been identified as risk factors for the development of mental health disorders. Without sufficient sleep, integral physiologic systems become dysregulated and may contribute to mental health disorders[6]. This state encourages a condition of chronic stress, which overloads the brain causing damage to neuroplasticity and neuronal connections to emotional, immune, and endocrine regulatory areas[7]. Lack of control over these systems results in overactivation of stress pathways, chronic inflammation, alterations in

serotonin production, and increased glutamate levels[6]. Impaired emotion regulation leads to a lack of proper emotional processing, thus placing an individual at an increased risk for psychopathology[8]. In addition, the neuroplasticity promoted by adequate sleep is lost and this is the basis for the pathology of select mental disorders, such as depression, anxiety, and potentially psychosis[8]. This relationship is further evidenced by the significant benefit treatment of insomnia has on mental health[7]. For these reasons, sleep quality is a valuable predictor of mental health outcomes[9]. Because of the strong correlations between these factors, insomnia is expected to be a valuable predictor of mental health outcomes in aggregate data such as those used here. The combined presence of both insomnia and decreased sleep duration compound and yield an even greater impact on mental health outcomes[10].

In order to provide a context for the productive discussion of sleep health, the field identifies specific measures of health ranging from qualitative assessments to more quantitative recordings and documented comorbidities[11]. While efforts still exist to standardize these metrics for greater comparative power, the number of varied measures that can demonstrate effect shows some of the incredible complexity of the field that has yet to be described. As evidenced by these studies, there is a wealth of important factors contributing to overall health and one of the most well-recognized negative influencers is insomnia[12,13].

While studies have well-established these pathophysiological links between sleep and mental health, less is known about how specific outcomes are manifested by these links in differing regions across the country. In this investigation, we have chosen to compare Ohio with two states with comparable population sizes that sit at alternating ends of the range for both variables. Data collected by countyhealthrankings.org shows differing trends for these states, but the significance of these trends is not yet known[14,15]. Further study will be necessary to determine the significance of these trends and the interdependence of these variables.

Research Questions

The overarching goal of this study was to investigate if insufficient sleep significantly contributes to the frequency of mental health distress and determine if this corresponds to state of residence, with a focus on comparing West Virginia and New Jersey to Ohio. It also re-establishes the importance of mental health based on life expectancy for this specific population.

RQ1: How do insufficient sleep and frequency of mental distress correlate within Ohio counties in 2022?

RQ2: How do insufficient sleep and frequency of mental distress correlate within West Virginia counties in 2022?

RQ3: How do insufficient sleep and frequency of mental distress correlate within New Jersey counties in 2022?

RQ4: How does insufficient sleep compare across Ohio, West Virginia, and New Jersey in 2022?

RQ5: How does frequency of mental health distress compare across Ohio, West Virginia, and New Jersey in 2022?

RQ6: What contribution does state of residence and insufficient sleep have on the frequency of mental health distress in 2022 within Ohio, West Virginia, and New Jersey?

RQ7: What contribution does state of residence and frequency of mental health distress have on average life expectancy in 2022 within Ohio, West Virginia, and New Jersey?

Methods

Data Collection

Data were gathered from published information on the County Health Rankings and Roadmaps program provided by the University of Wisconsin Population Health Institute. The factors measured by this program were determined through literature review, modification opportunity, data availability, an expert panel, and internal analysis. These rankings were compiled and standardized from Ohio, West Virginia, and New Jersey health databases for the year 2022. This study compares data concerning insufficient sleep, frequency of mental health distress, premature death, and county of residence within Ohio, West Virginia, or New Jersey. Insufficient sleep and frequent mental health distress data was gathered using the Behavioral Risk Factor Surveillance System telephone survey and are age adjusted. The insufficient sleep measure reports the percent of participants per county who confirmed they sleep on average less than seven hours per night, while the frequency of mental health distress measure represents the percent of participants per county who reported at least fourteen poor mental health days out of the past thirty. Premature death was described as years of potential life lost before age 75 per

100,000 population, is age adjusted, and deaths were counted based on county of residence regardless of where the death occurred.

Ohio was selected as the state of study with New Jersey and West Virginia being used as comparisons. West Virginia and New Jersey were chosen as comparisons since they represent populations that are the most different in reported frequency of mental health distress, while having a similar population size. Other states were not included in this analysis because the focus of this study is comparing Ohio to one state with poorer mental health, New Jersey, and one state with better mental health, West Virginia, thus all other states were excluded.

Data Analysis

Correlations between insufficient sleep and frequency of mental distress for Ohio, West Virginia, and New Jersey were found. Before correlation, values for these variables were plotted to determine goodness of normal fit, followed by analysis using Pearson's correlation. Values were obtained for comparison of insufficient sleep and comparison of frequency of mental distress across the three states. The impact state of residence and insufficient sleep have on the frequency of mental health distress, as well as dependency of premature death on the frequency of mental health distress were determined by regression. Statistical analysis was conducted using Pearson's correlation, one way analysis of variance (ANOVA), and multiple linear regression.

Results

To assess the relationship between insufficient sleep and frequency of mental health distress, a correlation was performed comparing the two variables within each independent state. The frequency distribution of each dataset was plotted against a bell curve to determine goodness of normal fit and confirm Pearson's correlation as the appropriate test. Figure 1 shows the data and trend between frequency of insufficient sleep and frequency of mental health distress for each state in our investigation. Table 1 compiles the Pearson correlation coefficients and significance values for each test (RQ1,2,3).
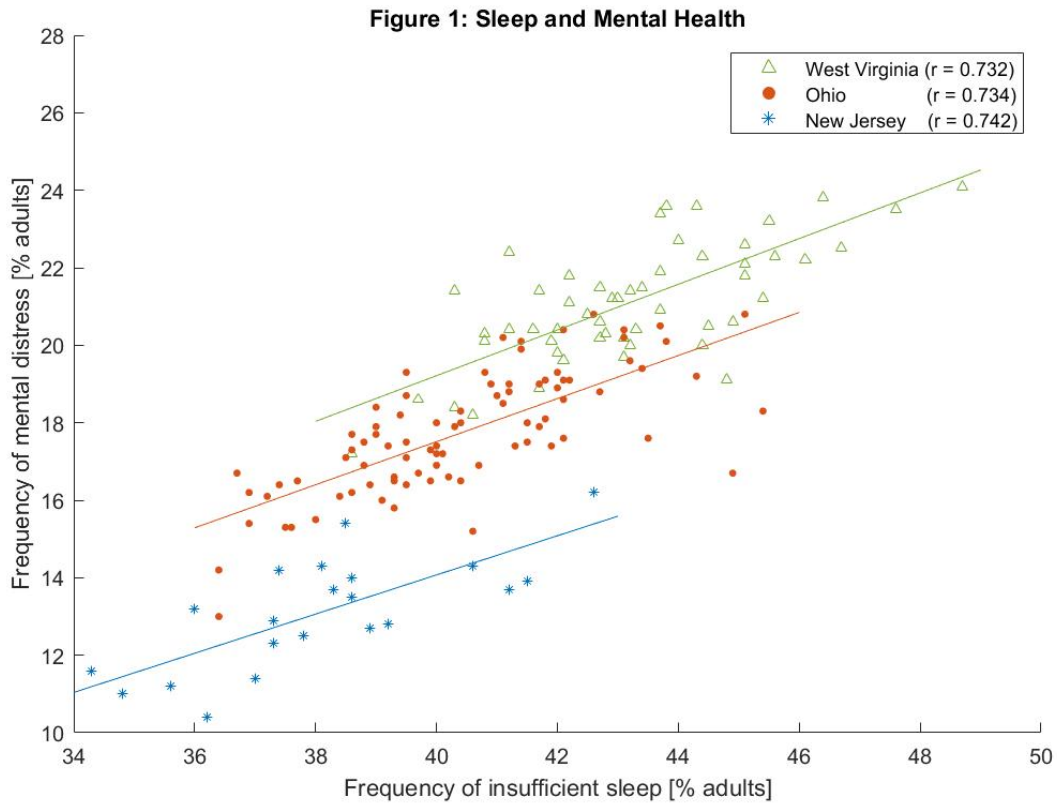
Figure 1: Sleep and Mental Health

Figure 1: Frequency of insufficient sleep (measured as percentage of adults reporting fewer than 7 hours of sleep per 24h period on average) correlates with frequency of mental distress (measured as percentage of adults reporting greater than 13 poor mental health days per month) within each state. Data points represent an individual county within each respective state.

Table 1: Sleep and Mental Health correlation tests			
State	n	Pearson Correlation	Significance (2-tailed)
New Jersey	21	0.742	<.001
Ohio	88	0.734	<.001
West Virginia	55	0.732	<.001

An ANOVA revealed that the percent of insufficient sleep in 2022 between New Jersey, Ohio, and West Virginia (RQ4) was significantly different ($F_{2,161} = 59.48$, $p < .001$). Bonferroni

Post Hoc tests indicated that New Jersey had a significantly lower percent of insufficient sleep (38.09%) than Ohio (40.45%), and West Virginia (43.34%) at the $p <$.001 level. Looking at West Virginia, this state had a significantly higher percent of insufficient sleep (43.34%) than New Jersey (38.09%) and Ohio (40.45%) at the $p <$.001 level (Table 2).

Table 2: Percent Insufficient Sleep in 2022 Across Three States			
State	**n**	**Mean**	**SD**
New Jersey	21	38.09%[a,b]	2.16%
Ohio	88	40.45%[b]	2.03%
West Virginia	55	43.34%[a]	2.06%

Abbreviation: SD, Standard Deviation
[a]statistically significantly different from Ohio (p <.001)
[b]statistically significantly different from West Virginia (p <.001)

An ANOVA revealed that the percent of frequent mental distress in 2022 between New Jersey, Ohio, and West Virginia (RQ5) was significantly different ($F_{2,161} = 212.16$, $p < .001$). Bonferroni Post Hoc tests indicated that New Jersey had a significantly lower percent of frequent mental distress (12.11%) than Ohio (17.76%), and West Virginia (21.19%) at the $p < .001$ level. Comparing West Virginia, this state had a significantly higher percent of frequent mental distress (21.19%) than New Jersey (12.11%) and Ohio (17.76%) at the $p <$.001 level (Table 3).

Table 3: Percent Frequent Mental Distress in 2022 Across Three States			
State	**n**	**Mean**	**SD**
New Jersey	21	13.11%[a,b]	1.47%
Ohio	88	17.76%[b]	1.54%
West Virginia	55	21.19%[a]	1.66%

Abbreviation: SD, Standard Deviation
[a]statistically significantly different from Ohio (p <.001)
[b]statistically significantly different from West Virginia (p <.001)

This research question (RQ6) examined the contribution state of residence and insufficient sleep have on the frequency of mental distress in 2022 comparing across Ohio, West Virginia, and New Jersey. A linear regression revealed that the best fitting model was significant ($F_{3,160} = 366.32$, $p < .001$) and was able to explain 87.3% of the variance in the frequency of mental distress. Insufficient sleep was a significant predictor of frequency of mental health distress (B = 0.560, $t = -13.65$, $p < .001$). After controlling for insufficient sleep. the percent with mental distress in New Jersey is 5.14% lower than that in West Virginia (B = -5.14, $t = -14.68$, $p < .001$), the percent with mental distress in Ohio is 1.8% lower than that in West Virginia (B = -1.80, $t = -8.22$, $p < .001$), and the percent with mental distress in Ohio is 3.33% higher than that in New Jersey (B = 3.33, $t = 11.98$, $p < .001$).

Our final research question (RQ7) investigated if life expectancy was dependent or independent of frequency of mental health distress in 2022 across Ohio, West Virginia, and New Jersey. A linear regression indicated the best fit model was significant ($F_{3,160} = 101.43$, $p < .001$) and accounted for 65.5% of the variance in life expectancy. Frequency of mental distress was a significant predictor of average life expectancy (B = -1.03, t = -13.41, p < .001). After controlling for frequency of mental health distress, the life expectancy in Ohio is 2.22 years lower than in New Jersey (B = 2.22, $t = 4.31$, $p < .001$), the life expectancy in West Virginia is 4.01 years lower than in New Jersey (B = 4.01, $t = 5.48$, $p < .001$), and the life expectancy in Ohio is 1.79 years higher than that in West Virginia (B = -1.79, $t = -4.83$, $p < .001$).

Discussion

Studies have shown that there is a significant inverse relationship between sleep and mental health[2,3,4,9,10]. Results from the work presented here build upon this relationship by investigating the regional context in the year 2022. A strong correlation was established between insufficient sleep and frequency of mental distress within Ohio, New Jersey, and West Virginia (Figure 1, Table 1). When comparing each variable individually across the states included in this study, there was a significantly different regional variation in the level of sleep and frequency of mental health distress (Table 2, 3). The impact of state of residence and insufficient sleep on the frequency of mental health distress was explored, and both variables had a significant and independent effect on mental health. In addition, the frequency of mental health distress accounted for 65.6% of the variance in life expectancy within the surveyed population. Therefore, insufficient sleep exerts a significant impact on levels of mental distress in Ohio, New Jersey, and West Virginia according to the regional variation in percentages of adults experiencing these afflictions.

The strong positive correlation between insufficient sleep and frequency of mental health distress was a relationship found individually in Ohio, New Jersey, and West Virginia (Figure 1, Table 1). This is consistent with past findings, which demonstrate a significant and persistent association between sleep and mental health. These studies indicate that as sleep quality and duration increase mental health improves[2,3,4,9,10]. The underreported nature of sleep insufficiency and the lack of recognition of the consequences of it by physicians is an issue, because it leads to a breakdown in mental health maintenance[9,10]. This becomes increasingly important in light of the consistency of this relationship, specifically for clinicians caring for patients who live in the population of study, Ohio, New Jersey, and West Virginia. These findings are dependent on the goodness of normal fit estimation made for this data. We anticipate that a higher level of reporting would improve the accuracy of this assumption and further bolster the relationship shown here.

Insufficient sleep and frequency of mental health distress vary significantly based on residence in Ohio, New Jersey, or West Virginia (Table 2, 3). This indicates that these states follow the established trends that levels of insufficient sleep and frequency of mental health distress differ amongst regions of the United States[8,15]. Those residing in geographical areas with a severe lack of sleep have been demonstrated to be more susceptible to developing select

chronic diseases[8]. The implication of this variation is that geographic location in Ohio, New Jersey, or West Virginia has an impact on health and the factors that effect it, like sleep and mental health. There are numerous factors contributing to insufficient sleep, such as culture, sleep apnea, insomnia, restless leg syndrome, mood disturbances, psychosis, and comorbid conditions[9,16]. In addition, multiple elements like income, housing, discrimination, family relationships, and physical health have all been found to impact mental health[17]. The multifactorial nature of sleep and mental health indicate there are other factors which potentially vary regionally than those analyzed in this study and could be causing the state-to-state difference in these variables. Therefore, further study is needed to confirm that sleep and mental health differ across wider regions of the US, and that this phenomenon is not a result of underlying factors which contribute to these two variables.

Our investigation built upon the aforementioned statistical differences between frequency of mental health distress, and insufficient sleep with respect to state of residence by further showing that both state of residence and insufficient sleep exert significant and independent effects on the frequency of mental health distress reported. Together, these variables account for 87.3% of the variance in frequency of mental health distress in the selected populations in the year 2020. Demonstration of this significant relationship should motivate further study into the resultant health outcomes and whether parallels can be drawn with other geographic regions. Limited by time and availability of data, we briefly pursued these directions and demonstrated that life expectancy for the surveyed population is dependent on both state of residence and frequency of mental health distress. The regression model built with these two variables accounted for 65.5% of the variance in life expectancy, further motivating the need for in-depth study of these relationships.

Conclusion

Insufficient sleep exerts a significant impact on levels of mental distress in Ohio, New Jersey, and West Virginia according to the regional variation in percentages of adults experiencing these afflictions. In the work presented here, we show that levels of insufficient sleep and mental health are correlated within 3 states of residence, that these variables are significantly different between states, and that at different levels within each state, insufficient sleep contributes to poor mental health which further contributes to adverse impact on life

expectancy. Next steps in this investigation should include further regional study, how specific regional variables may contribute to these differing levels of sleep and mental health distress, and how public policy can best be implemented to address these health disparities.

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