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Evan Hartman

John Monnig

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The Balance Between Sleep and Lifestyle: How Lifestyle Impacts Insufficient Sleep

Evan Hartman and John Monnig

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Abstract

Sleep insufficiency is a common but overlooked problem for many people. This is harmful because adequate sleep is important to cognitive, emotional, and physical health. This study analyzed how food environment index, smoking, physical activity, and median household income impact sleep insufficiency on an Ohio population. All data was utilized from the County Health Rankings (CHR) database. This analysis presented that the food environment index ($r = -0.676$, $p < .001$) and median household income ($r = -0.743$, $p < .001$) negatively correlated to insufficient sleep percentage. Furthermore, both adult smoking percentage ($r = 0.735$, $p < .001$) and physical inactivity ($r = 0.761$, $p < .001$) positively correlated to insufficient sleep percentage. It is also important to note that there was a significant difference between Ohio and Indiana counties ($t = -12.347$, $p < .001$), two neighboring states that both contain a mixture of urban and rural populations. Lastly, there was no significant difference between rural and urban Ohio counties ($t = -1.521$, $p = .132$). This data presents that more physical activity and less smoking may have positive benefits on sleep along with eating healthier, more nutrient dense food. Moreover, increased median household income may also positively impact sleep. Lifestyle factors such as smoking, physical activity, and increased nutritious food consumption are all avenues for patients to try to implement into their own lives to improve their sleep. Hopefully, such lifestyle

modifications will improve sleep quality and thus result in an improvement in other aspects of their overall health.

Introduction

Sufficient sleep is essential for good health, but many variables play a role in impacting sleep. These relationships, however, are largely unexamined in Ohio. Determining these associations in rural and urban settings within Ohio is important for understanding sleep and will improve the quality of life and overall health outcomes for patients.

Adequate sleep is key for overall health. Sleep resulting in less than 7 hours per night is connected to worse health outcomes such as stroke, hypertension, obesity, diabetes, and even death.¹ In addition to sleep being an indicator of health, exercise is also an important factor for wellbeing. Unfortunately, exercise and sleep often compete for time. People report being deprived of either sleep or exercise or both.² This is concerning because physical activity is linked to improved sleep quality, so finding a balance is key for health optimization.³

Recently, researchers began to study how food quality impacts sleep, and the research suggests that poor diet and obesity play a role in poor sleep quality.^{4,5} This comes at a time of increasing concern over the intake of healthy food and access to quality food throughout the United States. Another study presented that excess added sugar and refined carbohydrate intake shows an increase in probability of insomnia while food like fruits and vegetables present a decreased probability.⁶ Food composition and its effects are very complicated especially in how different

people are impacted,⁷ so although there has been data presenting a link between diet and sleep, more research is needed for more conclusive results.

Socioeconomic status is a broad factor that has been linked to impacting sleep. The neighborhood where one lives or how much money the household makes are two examples that contribute to socioeconomic status. A lower socioeconomic status reported by persons is linked to poor sleep quality³ while people in neighborhoods with less noise experience better sleep quality.⁸ Furthermore, the issue of unemployment and lower income negatively impacting sleep⁹ is compounded by areas of decreased green space and higher crime also being associated with insufficient sleep.¹⁰ Socioeconomic factors may not commonly be thought of when thinking of sleep quality, but there is potential to positively impact health if safety and access to walkable areas in neighborhoods is increased.

Another variable of interest related to sleep is smoking. Smoking has many negative impacts on health, and one of those is sleep. Smoking cigarettes regularly has been shown to more than double the risk of insufficient sleep.¹¹ Additionally, smokeless tobacco also showed significant increases in the likelihood of insufficient sleep.¹¹ This may suggest that nicotine plays a major role in sufficiency of sleep, but nonetheless, cigarettes and smokeless tobacco presented a link to insufficient sleep.

Changing food intake, financial means, and daily habits to improve sleep outcomes is gaining more attention. Much of the current data requires more studies and has not analyzed a

Midwestern US state that has considerable populations in both rural and urban areas simultaneously as compared to a state having a population predominantly more urban or more rural. Due to the need for more research required for this topic, recent data across the general population was not as numerous. Consequently, cohort studies of a Wisconsin⁸ and a Finnish⁹ population were included in this introduction to demonstrate what some of the current data presents. Although these distinct populations may not be easily generalized to a population such as Ohio, we hypothesize that results will be similar because the variables analyzed here are common factors of daily life. As a result of a lack of generalizable data, a main goal of this report is to examine the state of Ohio to uncover a better understanding of overall sleep sufficiency and how common factors like food intake, physical activity, smoking status, and median household income have been linked to impact sleep.

Research Questions

RQ1. Is there a difference in percent with insufficient sleep between rural and urban counties in Ohio in 2022?

RQ2. Is there a difference in percent with insufficient sleep between Ohio and Indiana in 2022?

RQ3. What is the correlation between insufficient sleep and food environment index in Ohio in 2022?

RQ4. What is the correlation between insufficient sleep and adult smoking in Ohio in 2022?

RQ5. What is the correlation between insufficient sleep and physical inactivity in Ohio in 2022?

RQ6. What is the correlation between insufficient sleep and median household income in Ohio in 2022?

RQ7. How does food environment index, physical inactivity, adult smoking, and median household income predict insufficient sleep in Ohio in 2022?

Methods

Data Collection

All data was collected using the County Health Rankings (CHR) website.¹² Any counties not included in the data will be excluded from that variable's statistical test. In this analysis all counties had available data, so no counties were excluded. The variables that were compared to insufficient sleep were median household income, food environment index, adult smoking, and physical inactivity. CHR defined insufficient sleep as persons reporting fewer than 7 hours of sleep on average (age-adjusted). Due to age being a non-modifiable risk factor, different age groups may be linked with certain health behaviors, so insufficient sleep was age adjusted.¹² Insufficient sleep was collected from one year of survey data from a state based random digit dial phone survey using landlines and cell phones along with complex statistical modeling.

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Food environment index was an index of factors that contributed to a healthy food environment with 0 being the worst and 10 being the best. These factors measured income and access to healthy food. Data was used from the USDA Food Security Survey, Feeding America Survey because it modeled relationships between national average meal cost, cost-of-food index, food budget shortfall, and food insecurity rates and numbers.¹⁴ Furthermore, limited access to healthy food accounted for low income (< or equal to 200% of federal family

size poverty threshold) and close proximity to a grocery store (defined as within 10 miles in rural areas and less than 1 mile for nonrural areas).¹² Thus, lacking access to a reliable source of food in the past year indicated food insecurity. The next variable, physical inactivity, was defined as persons 18 years of age or older reporting no physical activity in their leisure time (age-adjusted). This is age-adjusted because age is a non-modifiable risk factor, so there is an increased likelihood of poor health outcomes as age increases.¹² CHR collected this data from a state-based random digital dial telephone survey conducted in all states. Both landlines and cellphones were used for the survey. Statistical modeling used one year survey data to generate better estimates for counties that provided low reporting or had fewer residents.¹² Next, CHR defined adult smoking as the percentage of adults who currently smoked (age-adjusted). Due to age being a non-modifiable risk factor, different age groups may be linked with certain health behaviors, so smoking was age adjusted.¹² Data was collected by the Behavioral Risk Factor Surveillance System (BRFSS) which was a random digit dial telephone survey conducted annually using both landlines and cellphones. Statistical modeling used one year survey data to generate better estimates for counties that provided low reporting or had fewer residents. CHR defined median household income as the income where half the households earned more than and half the households earned less than the income in that specified county. Data was collected by the Small Area Income and Poverty Estimates program by combining data estimates, administrative records, intercensal population estimates, and the decennial census.¹⁵ This all combined with estimates from the American Community Survey,¹² and statistical modeling used one year survey data to generate better estimates for counties that provided low reporting or had fewer residents. We used data on all Ohio counties from the year 2022 for all the variables, and data from all Indiana counties in 2022 was used for one analysis of insufficient sleep only to compare to Ohio. Lastly, when comparing urban vs. rural counties in Ohio, urban counties were

defined as a population of greater than or equal to 50,000 people while rural counties contained a population less than 50,000 persons.¹⁶

Data Analysis

All data was analyzed using IBM SPSS Statistics (Version 29.0.0.0). Different statistical tests were used to answer different research questions. An Unpaired t-test was used to answer RQ1 and RQ2 because two different groups were compared in each question. A Spearman Correlation was used to answer RQ3, RQ4, RQ5, and RQ6 because non-parametric data was used. A no/very weak correlation was defined as from 0 to ± 0.3 , weak correlation was from ± 0.3 to ± 0.5 , moderate correlation was ± 0.5 to ± 0.7 , and strong correlation was from ± 0.7 to ± 1.0 . A step-wise linear regression was used to answer RQ7 to identify which variables best predict the greatest impact on insufficient sleep.

Results

An Unpaired t-test indicated that the percentages of insufficient sleep (RQ1) were not significantly different between urban (40.159%) and rural (40.818%) Ohio counties in 2022 ($t = -1.521$, $p = .132$) (Table 1).

Table 1: Insufficient Sleep Between Urban and Rural Counties of Ohio in 2022

Ohio County	n	Mean	SD
Urban	49	40.159%	2.339%
Rural	39	40.818%	1.519%

Abbreviation: SD, standard deviation

An Unpaired t-test indicated that the percentages of insufficient sleep (RQ2) were significantly different between Indiana (37.200%) and Ohio (40.451%) counties in 2022 ($t = -12.347$, $p < .001$) (Table 2).

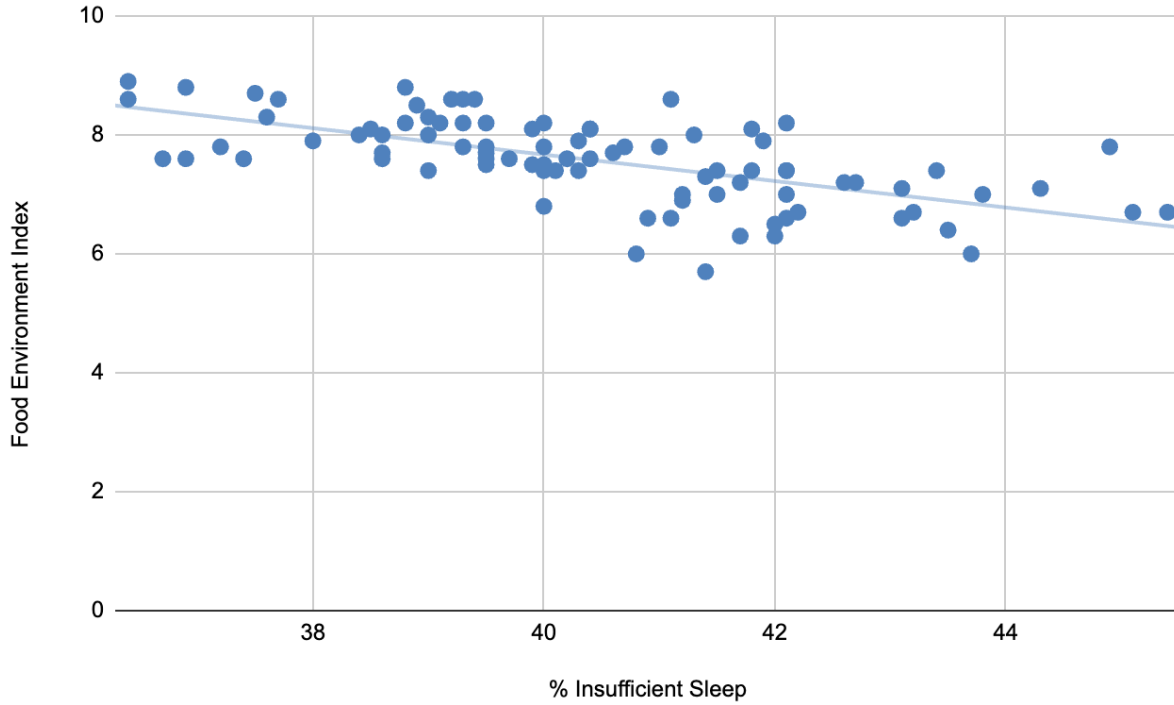
Table 2: Insufficient Sleep between Indiana and Ohio in 2022

State	n	Mean	SD
Indiana	92	37.200%	1.465%
Ohio	88	40.451%	2.034%

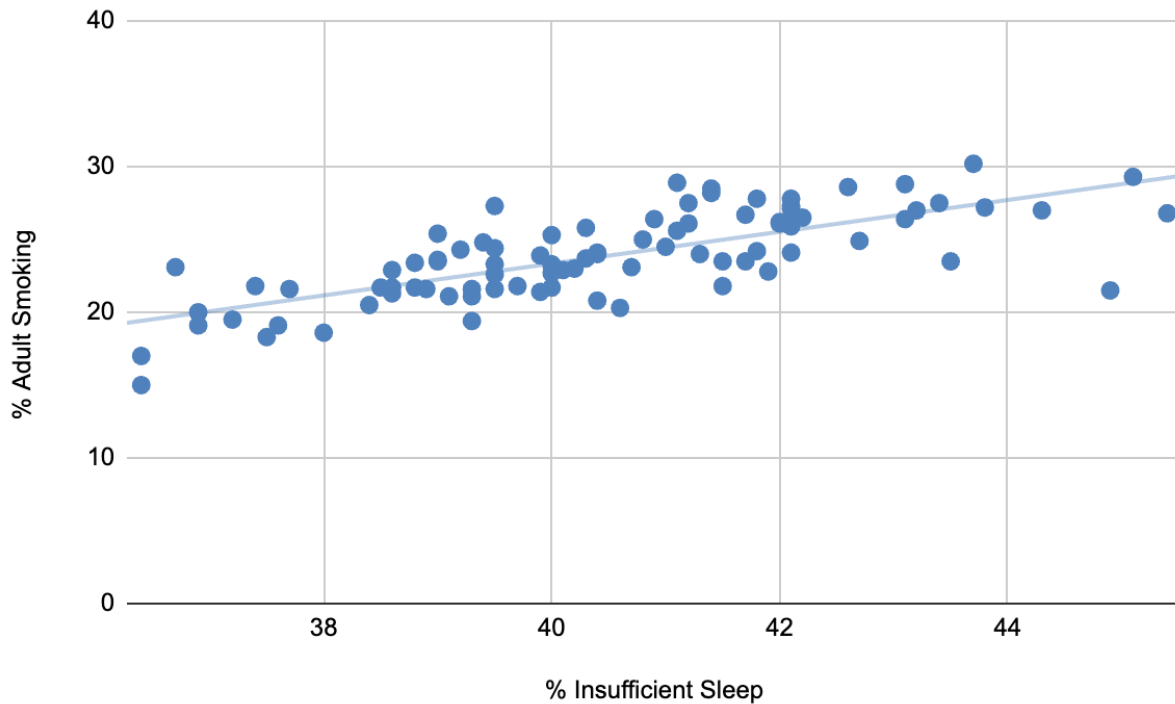
Abbreviation: SD, standard deviation

A Spearman Correlation analyzed the correlation between percent insufficient sleep and food environment index between Ohio counties in 2022 (RQ3) which indicated that a moderate and negative significant correlation ($r = -0.676$, $p < .001$) designated that as the food environment index decreased, the percent of insufficient sleep increased (Figure 1).

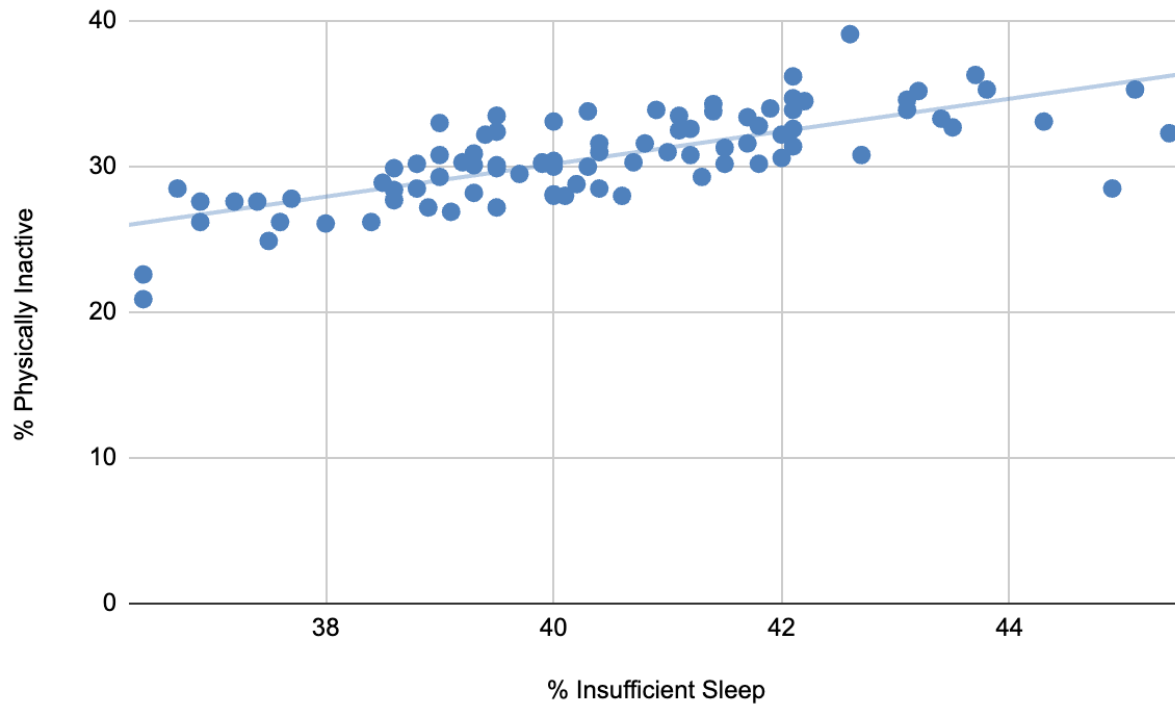
Figure 1: Correlation between Percent Insufficient Sleep and Food Environment Index in Ohio 2022



A Spearman Correlation analyzed the correlation between percent insufficient sleep and percent adult smoking between Ohio counties in 2022 (RQ4) which indicated that a strong and positive significant correlation ($r = 0.735$, $p < .001$) designated that as the percent of adult smoking increased, the percent of insufficient sleep increased (Figure 2).

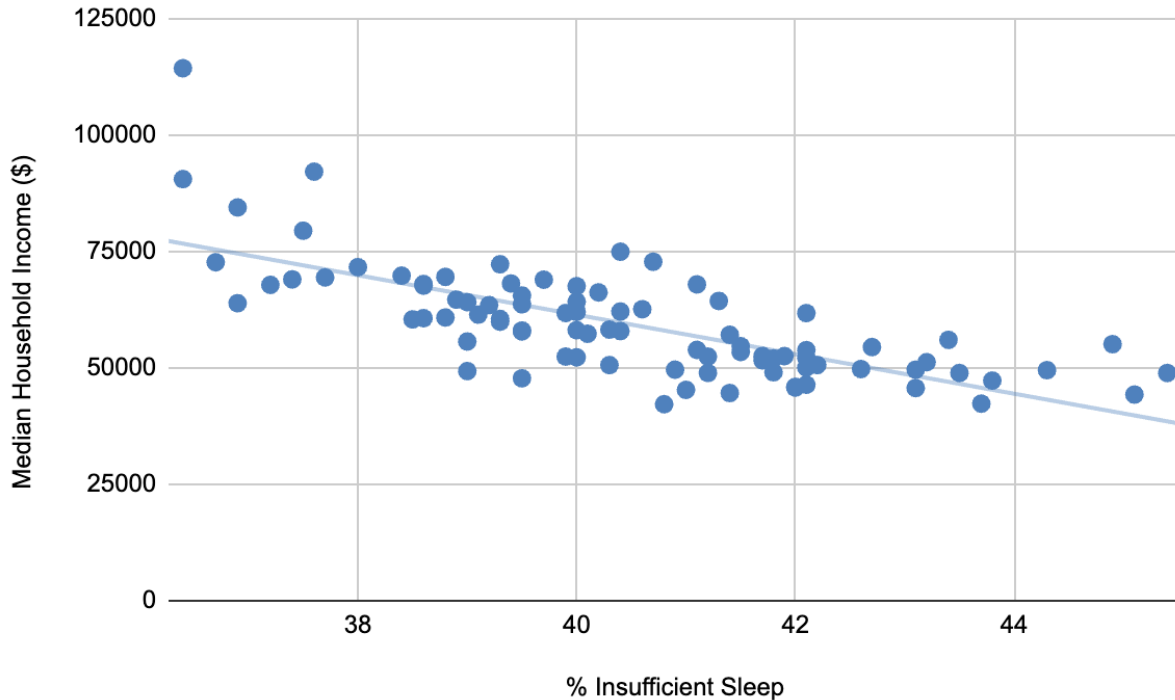
Figure 2: Correlation between Percent Insufficient Sleep and Adult Smoking in Ohio 2022

A Spearman Correlation analyzed the correlation between percent insufficient sleep and percentage of physically inactive adults between Ohio counties in 2022 (RQ5) which indicated that a strong and positive significant correlation ($r = 0.761$, $p < .001$) designated that as the percent of physically inactive adults increased, the percent of insufficient sleep increased (Figure 3).

Figure 3: Correlation between Percent Insufficient Sleep and Physical Inactivity in Ohio 2022

A Spearman Correlation analyzed the correlation between percent insufficient sleep and median household income between Ohio counties in 2022 (RQ6) which indicated that a strong and negative significant correlation ($r = -0.743$, $p < .001$) designated that as the median household income decreased, the percent of insufficient sleep increased (Figure 4).

Figure 4: Correlation between Percent Insufficient Sleep and Median Household Income in Ohio 2022



Lastly, RQ7 analyzed how food environment index, physical inactivity, percent adult smoking, and median household income predicted insufficient sleep in Ohio counties in 2022. This regression utilized a step-wise linear regression. The regression model designated that there was significance in the best fitting model ($F_{2,85} = 62.540, p < .001$) which explained 59.5% of the difference in insufficient sleep. Two variables contributed significance to the model with percent adult smoking contributing most significantly ($B = 0.296, t = 3.817, p < .001$). Additionally, median household income also contributed significantly to the model ($B = -6.420E-5, t = -3.275, p = .002$). The two variables that did not significantly contribute to this model were food environment index and percent physically inactive.

Discussion

First, insufficient sleep was analyzed between rural (<50,000 people per county) and urban (> or equal to 50,000) Ohio counties for RQ1. Although current literature in rural areas is more rare, some current research presents that persons in more populated areas with more noise and less green space experience poorer sleep outcomes.^{3,8} Contrarily, our analysis provided no significant difference found between rural and urban counties in Ohio as seen in Table 1. For RQ2, Indiana, a neighboring state of Ohio, was chosen to analyze how a state close in proximity would compare. In addition to proximity, Ohio and Indiana both have diverse economies, similar demographics, and a mixture of urban and rural populations. The goal was to observe whether these two neighboring states that possess some similarities presented any difference in sleep quality. After analysis, a significant difference was elicited between Indiana and Ohio counties (Table 2) where Indiana respondents reported less insufficient sleep than Ohio respondents. Therefore, Indiana respondents experienced better sleep than their Ohio counterparts. This was the only statistical analysis completed for a state other than Ohio. Due to Indiana only being used for sleep comparison with Ohio, it is difficult to establish why Indiana respondents experienced better sleep. Further analysis is needed to determine what contributes to this discrepancy. It could be beneficial to use the variables in RQ3-7 solely for Indiana to see how they contribute to sleep to be able to compare to Ohio and observe if a difference in those analyses might play a role in the sleep differences between Ohio and Indiana.

Because current literature looks at how sleep is impacted by various factors, a portion of the study used correlations aiming to observe the relationship between different lifestyle factors and sleep in a Midwestern state. RQ3 correlated insufficient sleep and food environment index. The

analysis represented a moderate negative significant correlation between insufficient sleep and food environment index, so as food environment index decreased, insufficient sleep increased (Figure 1). This builds upon current research that indicates that poor eating habits, processed foods, and decreased intake of fruits/vegetables are linked to poorer sleep.⁴⁻⁶ Another lifestyle factor related to sleep is smoking status. RQ4 examined the correlation between adult smoking and sleep insufficiency where a strong positive significant correlation was found. As adult smoking increased, there was increased insufficient sleep (Figure 2). This data is similar to current data that smoking has been associated with worse sleep outcomes.¹¹ The relationship of increased smoking to decreased sleep could be because smokers smoke more because they are awake more or that smokers are awake more because they smoke more. Likewise, the correlation between physical inactivity and insufficient sleep presented a similar result in RQ5. Analysis of the correlation between insufficient sleep and physical inactivity found a strong positive significant correlation which showed that as the percentage of physical inactivity increased, insufficient sleep increased (Figure 3). Although sleep and physical activity may often compete for time for many people, both are important for health. Current data presents a positive link between physical activity and sleep.³ The final correlation observed insufficient sleep to median household income in RQ6. Analysis showed a strong negative significant correlation elicited between insufficient sleep and median household income, so as median household income decreased, the percentage of insufficient sleep increased (Figure 4). Again, data from this study aligns well with current data regarding median household income. More income allows people to live in areas with better access to healthy food, more walkable space, and areas with less crime/violence. Additional income also presents more opportunity to have improved health and sleep outcomes because higher income people have more access to healthcare and more money to buy a better mattress. Therefore, the data in this study aligns with other data that shows a

positive correlation between increased median income household and better sleep outcomes.^{3,9}

Increased income may lead to better sleep because these persons have access to services that improve their overall health status, or they sleep better because an increased income helps lessen daily stresses related to finances.

For the last statistical analysis, RQ7 used a step-wise linear regression model to predict insufficient sleep using food environment index, adult smoking, physical inactivity, and median household income. Two variables contributed significance to the model with percent adult smoking contributing most significantly. For every one percent gained in adult smoking percentage, insufficient sleep increased by 0.296%. As previously stated, smoking has been connected with poorer sleep,¹¹ so this data aligns similarly to other data that is currently in the conversation. Additionally, median household income also contributed significantly to the model. For every increase of \$1 in median household income, there was a 6.420E-5% decrease in insufficient sleep. This data also aligns with current data presenting that employment and increased income show a positive connection with better living spaces and better sleep.^{3,9} These two variables best predicted the percentage of insufficient sleep as they accounted for 59.5% of the difference in insufficient sleep. Contrarily, the two variables that did not significantly contribute to this model were food environment index and percent physical inactivity, so these variables were not used to predict insufficient sleep. It is likely that these two excluded variables from the regression model were strongly correlated with one of the two variables that were included as the model's significant predictors of insufficient sleep.

Sleep quality has become more important in relation to how it impacts health, so more research is observing how different lifestyle factors impact sleep. Data from this study added to current research suggesting that there were significant correlations between insufficient sleep with food environment index, adult smoking, physical inactivity, and median household income amongst data that is current and nationally recognized. Within this study, it is also of note that amongst the significant correlations, both adult smoking and median household income predicted insufficient sleep the most.

Conclusion

One limitation was that categorical data was used for the adult smokers variable. This variable used a 'yes' or 'no' format which is not quantitative, so in the future, the smoking amount and frequency could be better defined with quantitative data. Another design limitation was the use of aggregated data. People in one area of the country may collect data differently than in another part of the country, so it would be best to collect data ourselves on the areas being analyzed. A second limitation in the data collection process is that a phone survey was utilized to collect the data. People without phones were not included in the data. Additionally, some people screen their incoming calls while other people answer phone calls which impacts responses. Email and mailed surveys could expand the opportunities for people to respond to the surveys. Lastly, data was only used for 2022. It would be beneficial to look at data and trends over multiple years to see how these variables impact sleep and how they change over time.

In the future, it would be interesting to analyze additional variables and how they are associated with sleep. A few ideas are how single parent households, violent crime, and education status are associated with sleep quality. Another interesting variable to analyze would be to see how different amounts of smoking impact sleep. Also, it would be beneficial to look at states in different parts of the country. A couple states could be selected in all regions of the United States to observe patterns of sleep and what impacts those patterns. Analyzing different geographical locations would give clinicians more knowledge on what is most important to address in different areas. The Midwest is unique because there exist concentrated populations surrounded by rural areas so what might apply in the cities along the coasts may be different than in the Midwest. The overall goal was to look at a small area in the Midwest to hopefully inspire future research to expand to and represent different parts of the country that possess different lifestyles.

Sleep is just one important aspect of overall health. It is imperative that people get adequate sleep, but it is also important to look for lifestyle factors that have significant impacts on sleep quality. Some variables may be easier to change than others, but this analysis showed that more physical activity and less smoking could be beneficial to sleep. These are changes that can be counseled with patients because they are modifiable. Increasing household income and healthy food intake appear to increase sleep quality, so it is important to inform the public in hopes that they can use this information to their advantage. Lack of quality sleep is a complaint of many people, so if they are educated with this information, some people will make changes to their lifestyle to better their sleep, their health, and hopefully make our society healthier and happier.

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