IMPACTS OF SOCIAL DETERMINANTS OF HEALTH ON ATTENTION-

DEFICIT/HYPERACTIVITY DISORDER DIAGNOSIS RATES WITHIN STATES

by

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Introduction

The diagnosis rate of Attention Deficit Hyperactivity Disorder has been steadily increasing in the last several decades (Taylor, 2009). As the diagnosis rate rises, the number of individuals impacted by ADHD multiplies. There are several theories about what has caused this upward trend in ADHD diagnosis, but nevertheless, this disorder is becoming more prevalent across the globe. In the United States, the proportion of children diagnosed with ADHD has jumped sixty-six percent from 2000 to 2010 (Garfield et al., 2012). As the diagnosis rate for ADHD continues to climb, it is important to understand as much as possible about the factors contributing to this disorder.

Like many other illnesses and disorders, national studies have shown a correlation between social factors and ADHD diagnosis. These social factors are referred to as social determinants of health, which are defined by The Office of Health Disease and Promotion as, "conditions in the environments in which people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks (healthypeople.gov)." More specifically, the social determinants of health studies have shown to correlate with ADHD include family income, parental education, healthcare access, and the child's insurance status (Simoni and Drentea, 2016; Rowland et al, 2017; Nyarko et al., 2017; Pastor et al., 2016). There are other social determinants of health associated with ADHD diagnosis, but this study will focus on those listed.

This study aims to further investigate the social determinants of health known to correlate with ADHD diagnosis. Are national patterns of a correlation between social determinants of health and ADHD diagnosis evident at the state level in North Carolina, South Carolina, Georgia, and Kentucky? When evaluated at a state level of analysis, does income, education, and

insurance correlate with ADHD rates? Are the associations established in national studies also seen when looking solely at the state level? Once it has been established whether social determinants of health are associated with state ADHD diagnosis rates, this study evaluates whether or not it is likely North Carolina is over or under diagnosed compared to Kentucky, Georgia, and South Carolina.

It is expected that the association between social determinants of health and ADHD diagnosis found in national studies will be supported on a state level of analysis. Secondly, based on these social determinants of health, it is predicted that children in North Carolina are likely underdiagnosed for ADHD. Lastly, when comparing the four similar states, it is indicated that Kentucky has the most representative diagnosis rate, while North Carolina, South Carolina, and Georgia are underdiagnosed based on social determinants of health, more specifically Kentucky's higher rate of insurance coverage, increased healthcare access, decreased education levels, and higher percentage of individuals in poverty. These socioeconomic factors have all been correlated in with higher rates of ADHD diagnosis in previous studies (Simoni and Drentea, 2016; Rowland et al, 2017; Nyarko et al., 2017; Pastor et al., 2016).

Background

Attention Deficit Hyperactivity Disorder alters brain development and brain activity to limit an individual's attention and self-control (CDC/Attention-Deficit/Hyperactivity Disorder). These symptoms can be found in most children; however, for children with ADHD, these symptoms are severe and persistent (CDC/Attention-Deficit/Hyperactivity Disorder). ADHD is the "most common neurodevelopmental disorder in children (CDC/Attention-Deficit/Hyperactivity Disorder)." The current diagnosis statistics in the United States sit at 9.4 percent of children or 6.1 million children nationwide (CDC/Attention-Deficit/Hyperactivity

Disorder). Although adults may suffer from ADHD, it is most prevalent in children. This

mental disorder has a variety of symptoms, and it can vary from one individual to another, which

makes it very difficult to diagnose and treat. In addition to affecting a vast number of children,

this disease has serious consequential implications. Therefore, it is important to understand the

factors that contribute to ADHD diagnosis. A better understanding of Attention Deficit

Hyperactivity Disorder can help improve diagnosis and treatment, as well as increase awareness

among citizens.

There are three types of ADHD found in children. Type one ADHD primarily presents as

an inability to focus or pay attention. Individuals with type one, are easily distracted and

forgetful in their day to day lives. A child with type one ADHD is often disorganized. It is

difficult for them to follow directions or complete a task. Type two ADHD is primarily a lack of

self-control. Type two ADHD emphasizes the hyperactivity in children with ADHD. These

children are unable to sit still. They often behave impulsively. They are constantly restless and

frequently fidget. The last type of ADHD is a combination of type one and type two. Children

with type three ADHD present symptoms from both categories; they struggle to pay attention

and sit still (CDC/Attention-Deficit/Hyperactivity Disorder).

This study analyzes how certain social determinants of health correlate with ADHD

diagnosis; however, there are other genetic and biological factors that may contribute to children

having ADHD. There is some evidence to indicate having ADHD is partially genetically

inherited, but genetics does not account entirely for ADHD diagnosis. Other biological factors

that have been linked with ADHD diagnosis include sustaining brain injury, low birth weight,

premature delivery, and harmful, environmental exposure during pregnancy. However, similar

to genetic inheritance, all of these factors still do not account for every instance of ADHD diagnosis (CDC/Attention-Deficit/Hyperactivity Disorder).

Diagnosing ADHD can be a difficult and complicated process. There is no single test to absolutely identify children with ADHD, so it is a very subjective diagnosis Sibley, 2012). The symptoms of ADHD can be very similar to the symptoms of other disorders like anxiety, depression, and other learning disorders.   Accurately identifying the which disorder, a child has can be difficult when the symptoms overlap with several diagnoses. Diagnosing ADHD is most often a two-step process. First a child is given a general medical exam to eliminate any other ailments that could be contributing to their symptoms. Second, the child's symptoms are compared to a checklist of symptoms in the *American Psychiatric Association Diagnostic and Statistical Manual (fifth edition)*. For an ADHD diagnosis, the child must display six or more symptoms from either the list of symptoms for inattention or the list of symptoms for hyperactivity. A limiting factor in diagnosing ADHD this way is the source of information. Physicians do not live with and interact with the children enough to thoroughly witness their behavior. Therefore, physicians rely on testimony from teachers and parents. This method of diagnosis presents several areas for potential error (CDC/Attention-Deficit/Hyperactivity Disorder).

Once an ADHD diagnosis is established, there are two primary methods of treatment. The least intrusive is behavioral therapy. This is most often recommended as an alternative or addition to medicinal treatment. Behavioral therapy can be especially beneficial for younger children. The primary goal of behavior therapy is to reinforce positive behaviors. This can be done in a variety of settings including home and school. Behavioral therapy treatment may also include an educational session for the parents. Organization workshops would also be

considered a form of behavioral therapy. For some children, behavioral therapy is combined

with the use of medication to alter the child's behavior. There are two types of medications used

to treat ADHD: stimulants and nonstimulants. Stimulants are the most common medicinal

treatment for ADHD. They are fast acting, and they are effective in seventy to eighty percent of

children with ADHD. Nonstimulants are not as fast acting, but their effects are longer lasting, up

to twenty-four hours (CDC/Attention-Deficit/Hyperactivity Disorder).

The most troubling impact ADHD can have on young children is limiting their academic

success. The symptoms associated with ADHD are not conducive to sitting and learning in a

classroom for extended periods of time. A child with ADHD has significant trouble paying

attention. Their mind is overly active, and their behavior is often impulsive. These symptoms

can result in a child with ADHD being labeled a troublemaker because of their inability to sit

still and focus in the classroom (CDC/Attention-Deficit/Hyperactivity Disorder).

Unfortunately, academic obstacles are not the only consequences of having ADHD. In

addition to struggling academically, children with ADHD often have a difficult time interacting

socially. Their hyperactivity can seem intrusive to other children, and their lack of self-control

can result in an inability to wait their turn. It is not just their relationships with other children

that suffer; children with ADHD also have strained relationships with authority figures including

their teachers and parents (CDC/Attention-Deficit/Hyperactivity Disorder).

Lastly, children with ADHD are more likely to have other behavioral or learning

disorders. The combination of ADHD and a learning disorder can especially hinder the success

of a student. Similarly, a child with ADHD and a behavioral disorder often struggle even more

with peer relationships. Obstacles with school and with relationships can lead to a feeling of

isolation, which can give rise to anxiety or depression (CDC/Attention-Deficit/Hyperactivity Disorder).

This disorder impacts over six million children's lives daily (CDC/Attention-Deficit/Hyperactivity Disorder).   Children with ADHD face a plethora of challenges in their day to day lives both socially and academically. It is important to analyze as much as possible about Attention Deficit Hyperactivity disorder to better understand the entirety of the disorder (CDC/Attention-Deficit/Hyperactivity Disorder).

Previously Studied Correlations between Social Determinants of Health and Attention Deficit Hyperactivity Disorder

Attention Deficit Hyperactivity Disorder is a "serious and debilitating" mental disorder that primarily impacts children (Simoni and Drentea, 2016). ADHD is reported as the "most prevalent mental disorder among children in the United States," and it has significant implication on children's capabilities to learn in school (Simoni and Drentea, 2016)." The reported estimates for ADHD prevalence in the United States vary drastically; the subjective method of diagnosis for ADHD makes accurate identification of this mental disorder difficult. A similar difficulty in studying ADHD is the method of data collection. Most information collected for ADHD studies is self-reported by parents, which potentially leads to misinformation (Simoni and Drentea, 2016). Despite these limitations, it is important to investigate the influence social and economic environments have on ADHD prevalence and diagnosis.

Individuals from disadvantaged backgrounds have been frequently associated with increased rates of mental health disorders (Russel, Ford, & Russel, 2015). Similarly, studies have shown both biological factors in addition to sociological environments can contribute to the diagnosis of ADHD (Rowland, Skipper, Rabiner, Qeadan, Campbell, Naftel, & Umbach, 2017).

Although it has been found that ADHD has a 76 percent heritability rate, home and environmental factors still play a significant role in the causation of the remaining 24 percent (Russel, Ford, & Russel, 2015). Specifically, ADHD has been linked to mother's age at birth, family size, family adversity, smoking during pregnancy, and parental employment; however, the social factors most frequently evaluated and documented are parental social status, health care access, and insurance coverage, which are often collectively represented as socioeconomic status.

Parental Social Status

The correlation between ADHD and socioeconomic factors remained unidentified following the initial medicalization of ADHD in the 1960s. Despite significant evidence supporting a link between social status and ADHD since the 1960s, this connection is still widely debated (Simoni and Drentea, 2016). Fifty-two out of fifty-five studies investigating the relationship between socioeconomic factors and mental health in children saw inverse results between the two variables (Russel et al, 2015).

In 2016, Simoni and Drentea conducted a study using the National Survey of Children's Health to establish a connection between socioeconomic status and the likelihood medication would be used in the treatment of ADHD. Although their study focused on treatment disparities between classes, they also identified patterns in diagnosis among varying social classes. Children with the lowest socioeconomic status reported the highest prevalence of ADHD at 6.4 percent, and this pattern continued with those in the middle socioeconomic status reporting the second highest prevalence rates at 5 percent, and those in the highest socioeconomic status reporting the lowest diagnosis rates of ADHD at 3.2 percent. This pattern is consistent with other mental illnesses (Simoni and Drentea, 2016). In their study, socioeconomic status was

evaluated using three factors: parental income, parental education, and insurance coverage. Of these three measurements of socioeconomic status, parental income was identified as the most significant predictor of ADHD diagnosis in children (Simoni and Drentea, 2016).

Another study conducted in 2017 evaluated the impact of socioeconomic status on ADHD diagnosis, while also investigating the influence of parental history of ADHD (Rowland et al, 2017). These authors drew their conclusions from a survey conducted in a single county of North Carolina. Johnston County, North Carolina had a similar demographic break down as the rest of the state and the nation as a whole. Therefore, the researchers felt the conclusions could be applied representatively to the nation. However, the rate of ADHD was 14.7 percent, which is representative of North Carolina, but it is relatively high for the nation.

This study used family income and parental education as indicators of socioeconomic status (Rowland et al, 2017). They found that children in the lowest income bracket were 6.2 times more likely to be diagnosed with ADHD; this figure was established among individuals without parental history of ADHD, establishing the significant impact of income on the prevalence of this disorder without confounding variables (Rowland et al, 2017). This data also led to the conclusion that environmental and social predictors were stronger among children with less genetic vulnerability. Similarly, this study identified ADHD diagnosis rates were highest among children whose family household income was less than 20,000 dollars a year (Rowland et al, 2017). Ultimately, these figures indicate a strong correlation between family income and ADHD diagnosis.

Lastly, congruent results were found in a more comprehensive study conducted in 2015 (Russel et al, 2015). This study evaluated the impacts of social disadvantages on ADHD using the Avon Longitudinal Study of Parents and Children; this data allowed for an observation of

these factors over time, rather than the snapshot provided by most survey data. They looked at the same children from the age of three to the age of seven. This allowed for more complete investigation of the impact of these predictors. Another aspect of this study that grants validity is the large sample size of 8,132 children. Additionally, their definition of socioeconomic status was more extensive than most other studies. They included eight measurements of status rather than just a few. They included housing tenure, family adversity, maternal age at birth, and parental occupation in their socioeconomic determination (Russel et al, 2015).

This study established correlations between almost all of the previously listed factors and the prevalence of ADHD. Most interestingly, they went beyond numerical figures in their evaluation of the family's financial status. They looked at family financial difficulty in addition to family income. Financial difficulty was measured based on a survey question regarding "difficulty affording basic necessities (Russel et al, 2015)." This study identified financial difficulty as the strongest measure in the correlation between social factors and ADHD prevalence, stating that children whose families were experiencing financial difficulties were 2.23 times more likely to be diagnosed with ADHD (Russel et al, 2015). They found as income decreased and financial difficulties increased, ADHD diagnosis rates also increased (Russel et al, 2015). It seems unlikely that as individuals become more financially limited, they are more inclined to seek treatment and diagnosis for mental disorders. However, if the availability of public insurance is factored in, it reveals a more complete picture. As a family's income decreases, there is an increased likelihood they will qualify for public insurance, which would allow them resources to seek proper diagnosis for ADHD and other illnesses. Although their income has decreased, they may have more access to health care with Medicaid than they did

with an increased income and no public insurance. This study's data analysis supports this, revealing increased prevalence of ADHD among individuals with public insurance.

Among the numerous studies evaluating the impact of socioeconomic status on ADHD diagnosis in children, parental income stands out as a significant contributor. In almost every study investigating correlations between social factors and mental disorders income is discussed. However, there are other important measurements of socioeconomic status to be considered when evaluating the diagnosis of ADHD.

In the previously mentioned study by Simoni and Drentea, parental income was the most important predictor of ADHD identified; however, it was not the sole social factor found to impact ADHD rates (2016). Parental education was also established as an influential factor in ADHD diagnosis (Simoni and Dretea, 2016). Although parental income and parental education often go hand in hand, they are not the same measurement, and they can have different implications on patterns observed in health disparities, specifically in the treatment of ADHD. A higher education status can indicate an increased knowledge and familiarity with mental disorders. Increased awareness of ADHD can aid parents in their pursuit of treatment; however, how does parental education impact diagnosis rates?

According to Simoni and Drentea, lower education levels in parents correspond to higher rates of ADHD diagnosis (2016). This finding is consistent with other research, and it speaks to the significance of class health disparities. This correlation also supports the impact of genetic hereditability on ADHD, which is why it is important to remember social determinants of health may only account for a small portion of factors that influence ADHD diagnosis. Even the increased knowledge advantage of those parents who are more educated is not enough to alter the disproportionately high diagnosis rates among the less educated. Therefore, parental

education is an important and influential factor in the evaluation of social determinants of health and their impact on ADHD.

This correlation is supported by the study conducted by Rowland and other associates (2017). As they analyzed parental income and education, they found ADHD diagnosis to be highest among children whose parents who had acquired less than a high school education (Rowland et al, 2017). Similar patterns were established by Gipson and his associates' study, which also identified that as parental education decreased ADHD prevalence increased (Gipson, Lance, Albury, Gentner, & Leppert, 2014). To further emphasize the role parental education can play in ADHD diagnosis, Russel's comprehensive study based on longitudinal survey data also identified a correlation between decreased parental education and an increase in ADHD rates (Russel et al, 2017).

It is unfortunate that despite thorough evidence supporting the correlation between status and ADHD, this connection is frequently disregarded, which is why it deserves more consideration in research and treatment application (Rowland et al, 2017). A common theme throughout these studies of ADHD, is an emphasis on the importance of breaking down the term socioeconomic status (Rowland et al, 2017). This is a widely used term with very broad implications. By breaking down and analyzing the various contributing characteristics, it becomes easier to identify the most significant contributors to ADHD diagnosis (Rowland et al, 2017) (Russel et al, 2015). It is important to "further investigate the social structural components which lead to ADHD health disparities (Simoni and Drentea, 2016)." Distinguishing between these different measurements of socioeconomic status allows researchers to identify "where the burden of disorder lies and where resources are needed (Rowland et al, 2017)."

Insurance Coverage

Parental characteristics have a well-studied and thoroughly documented correlation with ADHD prevalence in their children; however, there are other social determinants of health that have an impact on ADHD diagnosis and treatment. Whether a child is insured or uninsured correlates with their likelihood of diagnosis and quality of ADHD treatment. Furthermore, the type of insurance a child has can alter the availability and method of treatment used for children with ADHD (Nyarko et al., 2017; Pastor et al., 2016).

The Center for Disease Control has reported significant discrepancies in the prevalence of diagnosis based on whether or not a child has insurance, and more specifically what type of insurance they have (CDC/data briefs). Children without any insurance were consistently diagnosed at lower rates than children who are insured. Similarly, children with public insurance were consistently diagnosed at higher rates than children covered by private insurance (CDC/data briefs). Among children between the ages of four and five, 4.3 percent of those publicly insured were diagnosed compared to only 1.4 percent of those privately insured (CDC/data briefs). The pattern remains the same in children ages six to eleven, with 12.2 percent of children publicly insured diagnosed with ADHD, and only 8 percent of those privately insured diagnosed (CDC/data briefs). Similarly, for children ages twelve to seventeen, 14.9 percent of those publicly insured were diagnosed compared to only 11.1 percent of those privately insured (CDC/data briefs). In comparison among children ages six through eleven who are uninsured, only 6.7 percent are diagnosed with ADHD. Lastly, children ages twelve to seventeen, who are uninsured, are only diagnosed at a rate of 5.7 percent (CDC/data briefs).

In a longitudinal study from 2009 to 2015, researchers evaluated administrative data from Truven Health Marketscan and found unique trends in ADHD diagnosis and treatment between

employer sponsored insurance and Medicaid (Nyarko et al, 2017). From 2009 to 2015 children with employer sponsored insurance saw a steady increase in ADHD rates, from 4.5 percent in 2009 to 6.7 percent in 2015. Meanwhile, children with Medicaid saw a similar increase from 2009 to 2012, with rates going from 11.3 percent to 13.3 percent. However, in 2012, individuals with Medicaid saw a drop in ADHD prevalence that remained steady throughout 2015 (Nyarko et al, 2017).

As seen in these percentages, there is significant discrepancy in rates between those with employer-sponsored insurance and those with Medicaid (Nyarko et al, 2017). Prevalence rates are consistently higher among children insured by Medicaid, when compared to children with other private insurance provided by employers. There are potential explanations for this discrepancy; as shown in the articles previously discussed, poverty has a strong correlation with ADHD diagnosis (Nyarko et al, 2017). This correlation may indicate that individuals that qualify for Medicaid may be socially predisposed to ADHD by another confounding social determinant of health. Another explanation is that ADHD, as a disability, has the potential to qualify children for Medicaid, which would saturate the Medicaid patient population with individuals diagnosed with ADHD (Nyarko et al, 2017).

Another discrepancy observed between employer sponsored insurance and Medicaid is the drop experienced by children covered by Medicaid, in 2012, but not shared by individuals with private insurance provided by employers (Nyarko et al, 2017). The year of this relative drop is an important factor in understanding a potential explanation. In 2012, The Patient Protection and Affordable Care Act was signed into law and implemented, and Medicaid saw its enrollees increase by almost a third of their current participants (Nyarko et al, 2017). This influx of children potentially diluted the impact of children with ADHD in the Medicaid program.   If

one assumes a large portion of the children that qualified for Medicaid in 2012 did not have an ADHD diagnosis, this would explain the sudden drop in the percentage diagnosed with ADHD (Nyarko et al, 2017).

This study clearly identifies discrepancies in ADHD prevalence between children with employer-sponsored insurance and children with Medicaid. More importantly, this data displays the potential that public policy has to alter the rate statistics of ADHD. The potential impact of policy is why it is exceptionally important to understand all the social factors that contribute to ADHD diagnosis.

These are not the only discrepancies observed when looking at the impact of insurance on the prevalence and treatment of ADHD. A study in 2016 used the National Health Interview Survey to look at the mental health services provided to children with ADHD, and how they varied between individuals who were insured and those who were uninsured (Pastor, Simon, & Reuban, 2016). Additionally, they compared the types of services received by publicly and privately insured children with ADHD.

Pastor, Simon, and Reuban found variation between all three insurance statuses (publicly insured, privately insured, and uninsured) (2016). Children who were insured, either publicly or privately, were more often treated with medication for ADHD (Pastor, Simon, and Reuban, 2016). 57.3 percent of those privately insured reported receiving medication, while 57 percent of children with public insurance were reported to have received medication. In contrast, only 33.1 percent of children without insurance received medication for their ADHD diagnosis (Pastor, Simon, and Reuban, 2016). Similarly, children who were uninsured were most likely to receive no services at all. With only 28.9 percent of all children diagnosed with ADHD receiving no

services, almost half of uninsured children received no services, at 48.8 percent (Pastor, Simon, and Reuban, 2016).

Variations were also identified between children insured privately and those insured publicly. Publicly insured children were most likely to receive non-medical treatment. Additionally, those publicly insured had their first prescription prescribed by a mental health professional at a rate higher than those privately insured and those uninsured (Pastor, Simon, and Reuban, 2016).

Studies have indicated a need for continuous mental health services in the treatment of ADHD, but this study indicates that this suggestion is not strictly adhered to by most children. This is likely a result of discrepancies in insurance coverage, and what various insurance companies are willing to provide. There seems to be "more extensive coverage for child mental health conditions in Medicaid than many private policies (Pastor, Simon, and Reuban, 2017). The lack of sustained treatment for uninsured children can have serious implications on their ADHD management and important consequences for their future (Pastor, Simon, and Reuban, 2017).

Social Determinants in North Carolina, South Carolina, Georgia, and Kentucky

In order to evaluate how these national studies, translate on a more discrete scale, this study will compare North Carolina to three similar states. These states are similar in basic demographics including race, gender, and age. In addition to comparing the four states, this study looks within each state to evaluate the impacts of social determinants of health on ADHD diagnosis within the states. The states selected include South Carolina, Georgia, and Kentucky. These states maintain varying rates of ADHD diagnosis, so they provide a comprehensive look at how social determinants of health may influence ADHD diagnosis on the state level. North

Carolina and South Carolina have an ADHD diagnosis rate of 11.6 and 11.7 percent respectively. However, Georgia has a much lower diagnosis rate of 9.3 percent, and Kentucky has a much higher rate of ADHD at 14.8 percent (CDC/Attention-Deficit/Hyperactivity Disorder). Based on these social determinants and their association with ADHD diagnosis, the comparison between these four states should grant insight into potential over and underdiagnosis within the states. When these states are compared on the basis of parental education, parental income, access to health care, insurance status, and type of insurance, which all correlate with ADHD prevalence, will the patterns that have been established in the national studies previously discussed hold true?

This study aims to evaluate how statewide reports of previously studied social determinants of health correlate with the state's prevalence of ADHD, with all other factors maintained as constant as possible. By comparing four states with relatively similar demographics, this study minimizes the potential for unrelated factors such as race or gender to skew the statistical results. Based on the studies previously discusses, it is expected to see the state with the lowest average income, lowest rates of education, highest rate of insurance coverage, and highest percent of Medicaid coverage to exhibit the highest ADHD diagnosis rates, and as these factors are improved, the rate of ADHD diagnosis should decrease.

North Carolina Statistics

North Carolina has a population of 10,488,084 individuals, with 22.2 percent under the age of eighteen (census.gov). Since this study focuses on ADHD diagnosis in children, the percentage of children is an important comparative statistic. There has been significant research emphasizing the discrepancy in ADHD diagnosis between males and females, so it is also important to identify states with a similar male to female ratio, in order to prevent that confounding variable (Bruchmuller, 2012). North Carolina's population is 51.4 percent female

(census.gov). Similarly, many studies have identified discrepancies in diagnosis rates between whites and minorities, so in the comparison, states with a similar racial breakdown is important to prevent outside factors from skewing results. North Carolina is made up of 62.8 percent Caucasian individuals, 22.2 percent African American individuals, and 9.6% Latino individuals, with the remaining 5.4 percent categorized as other (census.gov). The diagnosis process of ADHD is subjective, and it often relies on teacher and parent evaluations. Additionally, since this study looks at school aged children, it is important to control for educational environments as much as possible. To compare the state's education systems, average scores in reading, math, and science have been obtained from The National Report Card. North Carolina's average score on a scale from 0 to 500 is 218.80 (NationalReportCard.gov). Another variable that ideally will be similar between the four states being compared is their human development index, which creates a value based on an education index, income index, and most importantly a health index (Social Sciences Research Council). Establishing a baseline health rating of the states allows for more meaningful conclusions to be drawn about the similarities and differences seen in ADHD diagnosis. North Carolina maintains a below average score of 4.85 on the human development index (Social Sciences Research Council). This study also aimed to identify states with similar geography and location. North Carolina is on the east coast of the United States, with a density of 196.1 population per square mile and a total land area of 48,617.91 square miles (census.gov). In identifying states to compare, this study attempted to maintain similar demographics in gender, race, age, and geography for the states selected for comparison. Although the states selected do share many demographic similarities it is impossible to keep all outside variables identical.

South Carolina Statistics

For the purpose of this study, South Carolina acts as a control. South Carolina has the most similar geography and demographics, as well as a near identical rate of ADHD diagnosis to North Carolina. Although South Carolina has a significantly smaller population of 5,148,714, the similar demographic makeup of the population should provide an effective comparison (census.gov). Approximately 21.8 percent of South Carolina's population is under the age of eighteen and 51.5 percent of the population is female, which is very similar to North Carolina's percentages (census.gov). Similarly, South Carolina is made up of 63.7 percent white individuals, 27.1 percent black individuals, and 5.8 percent Hispanic individuals, with the remaining 3.4 percent classified as other (census.gov). The test scores of students in South Carolina is slightly below North Carolina at 215.80 (NationalReportCard.gov). South Carolina's score on the human development index is slightly below North Carolina's at 4.57 (Social Science Research Council). Geographically, South Carolina also resides on the east coast of the United States. Despite the fact South Carolina's population is half that of North Carolina, the states' differences in density are not so drastic, which is more important in this comparison. South Carolina has a population density of 153.9 individuals per square mile compared to North Carolina's 196.1 individuals per square mile (census.gov).

Georgia Statistics

In this comparison, Georgia serves as a state with a lower ADHD diagnosis than North Carolina. However, it is still very important for the states' demographics to be as similar to North Carolina as possible. Georgia's population is nearly identical to North Carolina's at 10,617,423 people, with 23.8 percent under the age of eighteen and 51.4 percent females (census.gov). The racial breakdown in Georgia varies in comparison to North Carolina.

Georgia's population is composed of only 52.4 percent Caucasian individuals, with 32.4 percent African American individuals, 9.8 percent Latino individuals, and 5.4 percent categorized as other individuals (census.gov). The test scores of Georgia students are comparable to the other three states at 216.95 (NationalReportCard.gov) Georgia has the closest human development score to North Carolina at 4.88 (Social Science Research Council). Geographically, Georgia mirrors North Carolina in the fact it is on the east coast, but its population density is slightly lower at 168.4 individuals per square mile (census.gov).

Kentucky Statistics

The last state to be compared with North Carolina is Kentucky, which has a significantly higher ADHD diagnosis rate than North Carolina. Similar to South Carolina, Kentucky's population is much smaller than North Carolina at 4,467,673 individuals. However, the percent of youths and females remains relatively similar, with 22.6 percent of the population under the age of eighteen and 50.7 percent of the population female (census.gov). Kentucky has a significantly decreased minority population. An overwhelming majority of Kentucky's population is white at 84.3 percent, with only 8.4 percent black, 3.8 percent Latino, and 3.5 percent other individuals (census.gov). Kentucky has the highest student test scores among these four states at 219.80 (NationalReportCard.gov). However, Kentucky has the lowest score on the human development index than any other state in this study at 4.26, but it remains relatively comparable (Social Science Research Council). Another major discrepancy between Kentucky and North Carolina is their population densities, with Kentucky having only 109 individuals per square mile (census.gov). However, geographically Kentucky remains in the eastern United States, although not on the coast.

Table 1

State Control Demographics

        Table one displays the demographic statistics used as a control in this study. Population

density, age of the population, and racial breakdown were all used to select the states for this

comparison. Showing the similarities between the states in regard to these demographic factors

decreases the likelihood of confounding variables skewing this study's results. Table one

displays these demographics by state.

	North Carolina	South Carolina	Georgia	Kentucky
Population	10,488,084	5,148,714	10,617,423	4,467,673
Population Density (per square mile)	196.1	153.9	168.4	109.0
HDI	4.85	4.57	4.88	4.26
Average Academic Test Scores	218.80	215.80	216.95	219.80
Population <18 (%)	22.2	21.8	23.8	22.6
Female (%)	51.4	51.5	51.4	50.7
White (5)	62.8	63.7	52.4	84.3
Black (%)	22.2	27.1	32.4	8.4
Latino (%)	9.6	5.8	9.8	3.8
Geography	Eastern U.S.	Eastern U.S.	Eastern U.S.	Eastern U.S.
ADHD Diagnosis (%)	11.6	11.7	9.3	14.8

Social Determinants of Health Measurement

As previously discussed, there are several social factors correlated with ADHD diagnosis. This study will look at parental education, parental income, health care access, insurance coverage, and type of insurance when comparing North Carolina to three similar states in an effort to identify whether these correlations are consistent on a state level of analysis. To measure these variables, values will be taken from various sources. The median household income of the states will be recorded from the United States' census and is recorded in 2018 dollars. This figure will represent parental income for the purposes of this study. Additionally, parental education will be acquired from the United States' census using the percentage of individuals reported to have a bachelor's degree or higher within the state. In order to evaluate health care access in each state, this study will use the health care access index provided by Smart Asset. This index applies various methods of measuring health care access, including the state's rank in prevention and treatment, the cost of insurance, and the state's physician access ranking. The percentage of individuals uninsured within each state will be gathered from the United States Census, additionally, it provides the percent of individuals publicly versus privately insured. Lastly, rates of Medicaid coverage in each state will be acquired from the Kaiser Family Foundation.

Social Determinants of Health in North Carolina

In North Carolina, the median household income is reported at 52,413 dollars, with a poverty level of 14 percent (census.gov). Of North Carolina's population, 30.5 percent have acquired an education of a bachelor's degree or higher (censuc.gov). North Carolina's health care access score is just below average at 27.33 (SmartAsset). The U.S. Census Bureau also reports 10.7 percent of North Carolina's population is without insurance of any kind. Of the

individuals insured, 67.3 percent are privately insured, and 34.7 percent are publicly insured (census.gov). More specifically, 18 percent of the population is insured by Medicaid (kff.org). These factors have all been determined to have a correlation with ADHD diagnosis on an individual level.

Social Determinants of Health in South Carolina

Similarly, in South Carolina the median household income is 51,015 dollars, with a poverty level of 15.3 percent (census.gov). South Carolina reports 30.7 percent of its population has acquired a bachelor's degree or higher. South Carolina's health care access index score is slightly above North Carolina's at 31.67 (SmartAsset). In South Carolina, 10.5 percent of the population is reported to have no insurance, with 65.9 percent privately insured, and 37.8 percent publicly insured (census.gov). Individuals in South Carolina covered by Medicaid is slightly higher than those of North Carolina, at 19 percent (kff.org). South Carolina's social determinants of health statistics mirror those of North Carolina very closely, which is consistent with their similar statewide rate of ADHD diagnosis.

Social Determinants of Health in Georgia

The median household income in Georgia sits slightly above North Carolina at 55,679 dollars, with a similar poverty rate at 14.3 percent (census.gov). Individuals in Georgia with a bachelor's degree or higher is 30.7 percent, which is comparable to North Carolina's 30.5 percent (census.gov). Georgia's health care access score is significantly lower than North Carolina's at only 18.67 (SmartAsset). However, the percent of individuals uninsured in Georgia is 13.7 percent, which is higher than the rate of those uninsured in North Carolina. Of those insured, 65.8 percent are privately insured, while 31.2 percent are publicly insured (census.gov).

Specifically, Medicaid coverage in Georgia is 17 percent (kff.org). The greatest discrepancy

between North Carolina and Georgia is the percentage of individuals uninsured.

Social Determinants of Health in Kentucky

Kentucky's median household income is slightly below the other three states at 48,392

dollars, with poverty at 16.9 percent (census.gov). Similarly, only 23.6 percent of individuals in

Kentucky have a bachelor's degree or higher, which is significantly lower than each of the other

comparison states (census.gov). Kentucky's access to health care score doubles North Carolina's

at 68.67 (SmartAsset). However, Kentucky's rate of uninsured individuals is much lower at only

5.6 percent. Of the individuals with insurance in Kentucky, 64.2 are privately insured, 43.5 %

are publicly insured, and 27 % are covered by Medicaid (census.gov and kff.org).

Table 2

State Social Determinants of Health Statistics

Table two summarizes the social determinants of health this study evaluates in relation to ADHD, including income, education, health care access, insurance coverage, and insurance type. These social demographics are shown broken down by state. The states' percentage of children with ADHD is also included in table two.

	North Carolina	South Carolina	Georgia	Kentucky
Median Household Income (2018 dollars)	52,413	51,015	55,679	48,392
Percent of Population in Poverty	14.0	15.3	14.3	16.9
Percent of Population with bachelor's degree or higher	30.5	27.4	30.7	23.6
Health Care Access Index	27.33	31.67	18.67	68.67
Percent Uninsured	10.7	10.5	13.7	5.6
Percent Privately Insured	67.3	65.9	65.8	64.2
Percent Publicly Insured	34.7	37.8	31.2	43.5
Percent Insured by Medicaid	18	19	17	27
ADHD Diagnosis (%)	11.6	11.7	9.3	14.8

Comparison Limitations

The uncontrollable, slight variations between these states' demographics is a significant limitation to this study. Without all other factors held constant, it is difficult to ascertain true correlations between the independent variables (social determinants of health) and the dependent variable (ADHD diagnosis rates). The most noticeable variation is in the racial demographics of these four states. Although most studies that investigate the impact of race on ADHD diagnosis conclude it is actually a result of socioeconomic factors, it is impossible to exclude the potential genetic implications various races compositions may have on ADHD diagnosis within the states (Fairman, 2017). Another contrast between these states is their populations densities. Although there is no obvious correlation between either urban or rural living on the prevalence of ADHD, it would be naïve to exclude population density as a potential confounding variable.

Methodology

This study compares the association between social determinants of health and ADHD diagnosis between four similar states. The four states selected were North Carolina, South Carolina, Georgia, and Kentucky. The criteria for selecting these four states were similar demographic factors, such as population density, geography, age of the population, and racial breakdown of the population.

The specific determinants of health were selected for this study based on their prevalence in literature concerning ADHD prevalence and diagnosis. The social factors most strongly associated with ADHD diagnosis were used in this study. In addition to sufficient previous literature, the social determinants of health were selected based on data that was available for analysis.

This study utilizes data from the 2011-2012 National Survey of Children's Health, which is sponsored by the Center for Disease Control (CDC/ADHD). This survey is a representative sample of all fifty states and some U.S. territories, and the data was collected by telephone survey. From this survey, data on insurance coverage, insurance type, parental education, and income was analyzed.

From the National Survey of Children's Health, ADHD diagnosis was measured based on whether the respondent had ever been told by a doctor or health care provider that the child had ADHD. The variable used to measure income was derived from a series of questions addressing the income range of the child's household. Based on the range of the household income, each respondent was placed on a scale relative to the poverty level for that particular state. This derivative was used to represent income in the data analysis. The variable used to represent insurance coverage and insurance type was a compilation of two questions from the survey. The first being- whether or not the respondent's child was covered by insurance. The second question used to evaluate insurance type asked the respondent whether the child's insurance was Medicaid or CHIP, which was then used to evaluate whether the child's insurance was public or private. By collapsing these two responses, three categories were created: uninsured, publicly insured, and privately insured. Parental education was measured as either less than high school, a high school graduate, or more than high school. This was answered for both parents individually. When analyzing the survey data, nonresponses and missing data were recoded and excluded from the data analysis.

To analyze the NSCH data, the software SPSS was used. First, a chi-square test was run on the states and ADHD diagnosis to evaluate their association within the data. The independent variable was the state of residency, and dependent variable was ADHD diagnosis. Second, a

binary logistical regression was run on all four states in question, to analyze the relationship

between the social determinants and ADHD diagnosis across all four states. Lastly, a binary

logistical regression was run on each state individually to see the association between the social

determinants of health and ADHD diagnosis within each state.

<div align="center">

Results

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This data analysis aimed to evaluate the association between social determinants of health

and ADHD diagnosis within four demographically similar states. Additionally, this study

compares the associations between the states, with the intention of evaluating the likelihood of

under- or over-diagnosis within these states.

First, a chi-square test of independence was done to evaluate the association between

states and the number of individuals with ADHD. Without considering any other variables, there

was no significant relationship between state of residence and ADHD diagnosis rates, X^2 (3,

N=6,691) = 5.398[a], p=.145. A crosstabulation between states and ADHD diagnosis can illustrate

this lack of distinction between state diagnosis rates (see Table 3 below).

Table 3

Crosstabulation between States and ADHD Diagnosis

		Has the Child ever been diagnosed with ADHD?		
		NO	**YES**	**Total**
State of	**GA (%)**	21.8	2.7	24.5
Residence	**KY (%)**	21.4	3.4	24.9
	NC (%)	21.4	3.0	24.4
	SC (%)	22.8	3.4	26.2
Total	**% of Total**	87.5	12.5	100.0

Next, a binary linear regression was performed to predict ADHD diagnosis based on insurance coverage, insurance type, parental education, and family income. The first binary linear regression included cases from all four states of interest. The statistical model is statistically significant, X^2 (7, N=6,691) = 41.64, p<.001. This model was able to accurately classify 88.8 percent of cases. Of the several predictor variables, only father's education, insurance coverage, and insurance type had a significant association with ADHD diagnosis. Dummy variables were used to code the scenario for insurance and parental education. For insurance, pubic insurance was used as the reference variable, and for parental education, more than a high school degree was used as the reference variable.

The model showed that children with public insurance were 1.97 times more likely to be diagnosed with ADHD than children with private insurance. Similarly, the model showed that children with public insurance were 2.17 times more likely to be diagnosed with ADHD than children with no insurance. The last significant variable in this model showed that a child whose father had only a high school education were 1.32 times more likely to be diagnosed with ADHD than a child whose father had more than a high school education. All other predictor variables, including mother's education and income were not statistically significant in this model. The variables used in this regression equation are shown below in Table 4.

Table 4

Binary Logistic Regression All Four States

	B	S.E.	Wald	df	Sig.	Exp (B)
Private Insurance	.676	.151	20.187	1	.000	1.967
Uninsured	.775	.271	8.180	1	.004	2.170
Father HS Graduate	-.280	.127	4.886	1	.027	.756
Father Less than HS	-.139	.210	.441	1	.507	.870
Mother HS Graduate	-.112	.139	.658	1	.417	.894
Mother Less than HS	.250	.242	1.066	1	.302	1.284
Income	.035	.029	1.477	1	.224	1.036
Constant	-3.017	.413	53.425	1	.000	.049

Then, a binary logistic regression was performed for each state of interest. The predictor variables remained insurance coverage, insurance type, parental education, and family income. The North Carolina binary linear regression was statistically significant X^2 (7, N=1,852) = 19.09, p=.008. Similar to the statistical model for all four states, insurance type and insurance coverage had a statistically significant association with ADHD diagnosis. However, father education and other predictor variables did not have a significant association in the North Carolina model. This model showed children with public insurance were 3 times more likely to be diagnosed with ADHD than those with private insurance and 3.5 times more likely to be diagnosed with ADHD than children with no insurance.

The South Carolina binary linear regression was not statistically significant, X^2 (7, N=1,930) =10.57, p=.159. Therefore, no information can be obtained from the South Carolina model.

The Kentucky binary linear regression was statistically significant, X^2 (7, N=1,864) = 27.36, p<.001. Similar to the North Carolina model, insurance type and insurance coverage had a statistically significant association with ADHD diagnosis, but father education and other predictor variables did not have a significant relationship with ADHD prevalence. The Kentucky model showed that children with public insurance were 2.07 times more likely to be diagnosed with ADHD than children with private insurance and 11.06 times more likely to have an ADHD diagnosis than uninsured children.

The Georgia binary linear regression model was not statistically significant, X^2 (7, N=1,848) = 10.57, p=.159. Therefore, no information can be obtained from the South Georgia model.

Discussion

This study aimed to evaluate the association between social determinants of health and ADHD diagnosis within four states. It was predicted that the association between ADHD diagnosis and social determinants of health studied on a national level would also be supported on the state level. The statistical models revealed partial support for these established associations. Within every statistically significant model, there was a significant relationship between insurance coverage/insurance type and ADHD diagnosis. This was seen in the binary regression of all four states, the Kentucky model, and the North Carolina model. Therefore, the association between insurance and ADHD diagnosis is supported in this study.

Only one facet of parental education was found to have a significant association with ADHD diagnosis, and it was only supported in one of the regression models. The binary logistic regression that calculated all four states found a statistically significant difference in ADHD diagnosis between children whose father was a high school graduate and children whose father obtained more than a high school education. Children whose father had only a high school education were more likely to be diagnosed with ADHD than those whose father had an education beyond high school. However, this association was only supported in one regression model. Within the individual states, this association was not supported. Similarly, mother's education was not associated with ADHD diagnosis in any of this study's statistical models. Therefore, this study does not support the association between parental education and ADHD diagnosis.

As discussed above, income has been previously correlated with ADHD diagnosis rates. However, the association between ADHD diagnosis and family income is not shown in any of the statistical models. Therefore, this study does not support the relationship between ADHD diagnosis and family income. There are several factors that could contribute to this shocking result. First, the variable used to measure income was derived based on the respondent's range of income. Based on their range relative to the poverty level within their state, the respondents were placed in a poverty category. This derivative could have been an ineffective measure of income for the purposes of this data analysis and compromised the results. Another explanation for this unexpected result is the influx of individuals entering Medicaid in the year the survey was conducted. The National Survey of Children's health conducted this survey in 2011 and 2012, which directly followed the implementation of is the Affordable Care Act in 2010 (healthcare.gov/The Affordable Care Act). As an increased number of individuals qualified for

public insurance and received diagnoses and treatment, the impact of income on ADHD prevalence could have been diluted.

Based on the regression models in this study, the association between ADHD and whether or not the child is insured is supported. Similarly, this study supports an association between ADHD rates and whether or not insurance is public or private. In this study, no other social determinant of health, including parental education and family income, is shown to have an association with ADHD diagnosis. Based on the statistical model, individuals with public insurance were almost two times more likely to be diagnosed with ADHD than individuals with private insurance or no insurance. A possible explanation for this discrepancy is the quality of insurance provided. Increased health care access and coverage for mental health for those with public insurance could inflate the number of children diagnosed with ADHD. It is also possible that individuals with public insurance serve as a proxy for individuals of a lower socioeconomic status, and these factors contribute to the increased number of children with ADHD that have public insurance. It is important to further investigate this discrepancy and identify the source distinction.

Unfortunately, a comparison between the four states is not complete because only two of the four states produces statistically significant regression models, but information can still be inferred from the Kentucky and North Carolina models. Insurance coverage and insurance type were shown to correlate with ADHD diagnosis in every model. In every model, children with public insurance were diagnosed with ADHD at a much higher rate than those without insurance or with private insurance. This association can be used to predict the likelihood of over and underdiagnosis in North Carolina.

Of the four states originally selected, Kentucky had the highest rate of ADHD diagnosis. Similarly, Kentucky had the lowest rate of uninsured individuals, with the highest rate of publicly insured individuals. After establishing a significant association between these rates of insurance coverage and ADHD diagnosis within the state, it is inferred that Kentucky has the most accurately representative ADHD diagnosis rate of the four states compared. This inference assumes an expected accuracy in diagnosis. Similarly, the association between insurance and ADHD was supported in North Carolina, so it is likely possible North Carolina's decreased ADHD rate is a result of a decreased number of insured children. Both these regression models established children with public insurance are diagnosed at a much higher rate than individuals with private insurance. Therefore, North Carolina's decreased public insurance coverage would also insinuate that North Carolina's prevalence of ADHD is underestimated.

The results of this study speak to the importance of increased insurance coverage, especially among children. An increase in health insurance for children would likely result in increased ADHD diagnosis rates. It is likely many children without insurance are not obtaining a proper diagnosis for their Attention Deficit Hyperactivity Disorder. It is likely the differentiation in diagnosis between those publicly insured and those uninsured is a result of decreased access to health care. However, future research should look to support this assumption. Additionally, future research should investigate the discrepancy of ADHD diagnosis rates between publicly and privately insured individuals. Are there any factors contributing to the disproportionately high ADHD rates for children publicly insured? Lastly, while researching ADHD statistics across the United States, it became evident that there is no available data on ADHD diagnosis by county in North Carolina or any other state. Filling this information gap could aid in future studies of ADHD diagnosis.

Conclusion

With the steadily rising diagnosis rate of Attention Deficit Hyperactivity Disorder, it is increasingly important to fully understand the causes and impacts of ADHD (Taylor, 2009). The number of individuals impacted by this disorder continues to multiply. This study looked at the social factors potentially contributing to children's ADHD diagnosis.

This study analyzed the potential associations between social determinants of health and ADHD diagnosis. There are several well documented social factors that have been correlated with ADHD diagnosis on the national level, including insurance coverage, insurance type, parental education, and family income. Was this association evident on the state level? This study supported the association between insurance type/insurance coverage and ADHD diagnosis; however, the relationship between ADHD and other social determinants of health were not supported in this study's regression analysis.

The comparison portion of this study was limited by the insignificance of two state models; however, it is supported that Kentucky has the most representative diagnosis rate for ADHD. Additionally, it can be posited that North Carolina children are likely underdiagnosed for ADHD.

As the prevalence of ADHD has increased in recent years, the disorder has become increasingly normalized, but children suffering from this mental disorder experience an uphill battle in almost every aspect of their life. This study has demonstrated the plethora of information about ADHD, but there is still much more to understand about this disorder and the impacts on its diagnosis. A better understanding of the factors contributing to rising ADHD rates can assist in better treatment for children. Additionally, this study has supported the correlation between insurance coverage/insurance type and ADHD diagnosis. Health insurance in the United

States is frequently debated, and this study supports the importance of this issue.   The solution

to helping these children may not be found in a laboratory or developing medication. The best

solution may be found on Capitol Hill. Access to health care is vital for treating so many

illnesses, and ADHD is no different. Children cannot seek treatment without a diagnosis, and it

is difficult to obtain a diagnosis without insurance.   In order to best treat these children with

ADHD, they have to be able to access the necessary facilities and personnel. It is unfortunate

that social factors have any influence on the health, diagnosis, and treatment of children, but the

results of this study support this association in regard to ADHD diagnosis within states.

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