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Depression and anxiety in children with epilepsy and other chronic health conditions: National estimates of prevalence and risk factors

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Abstract

Objective: This study estimates the national prevalence of depression and anxiety among children with epilepsy and determines which demographic variables and comorbidities increase the risk of these psychopathologies. We also compare the rates of depression and anxiety in pediatric epilepsy to those of other chronic health conditions in childhood.

Methods: We used the 2009–2010 National Survey of Children with Special Health Care Needs to identify children with epilepsy with and without depression and anxiety. We assessed demographic factors and comorbidities associated with depression and anxiety using weighted multivariable logistic regressions. The rates of psychiatric comorbidity in children with chronic conditions other than epilepsy were also determined.

Results: The final sample included 1,042 children over the age of five with epilepsy. After applying the sampling weights, we estimated that 283,000 children between 5 and 17 years of age have epilepsy in the United States. Among these children, 25 percent have depression and/or anxiety. This figure was not significantly different from the rates seen among children with asthma (16.5 percent) or allergies (21.6 percent) but was significantly lower than the rate seen among children with migraines (43.2 percent). In our analyses of children with epilepsy, low-income children (regardless of race) and children whose needs for specialist care were unmet (relative to those whose needs were met) were more likely to have depression. Low-income black children were less likely to have anxiety than high-income white children. Gender, age, and epilepsy severity were unrelated to depression or anxiety.

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Conclusions: One in four U.S. children with epilepsy has depression and/or anxiety. Therefore, physicians should consider the various factors that are related to depression and anxiety in children with epilepsy so that at-risk children can be screened and managed appropriately.

Keywords

pediatric; epilepsy; depression; anxiety; demographic; risk factors

1. Introduction

Six of every 1,000 children in the United States have epilepsy [1]. These children are more likely than children without epilepsy to have depression or anxiety [1–3]. Such psychiatric comorbidities are associated with reduced quality of life and suicidality [2–4]. For some individuals, psychiatric comorbidities contribute more to health-related quality of life than epilepsy-related factors such as seizure frequency and the side effects of anti-epileptic seizure drugs (AEDs) [5,6].

Several factors are known to be associated with comorbid depression or anxiety in pediatric epilepsy, including psychosocial factors such as family relationship satisfaction (lower satisfaction = more depressive symptoms) [7] and treatment factors such as AED polytherapy (AED polytherapy = increased risk of anxiety disorders) [2]. However, there are additional factors that are understudied or poorly understood. These include demographic factors such as age, race, ethnicity, health insurance type, and income level as well as comorbidities such as migraines and autism-spectrum disorder [2,8]. Understanding these factors may have clinical relevance, in that they may help clinicians effectively determine who is most at risk for developing depression and anxiety, and therefore intervene appropriately.

Here, we use a large national survey to estimate the prevalence of depression and anxiety among children with epilepsy and to characterize the demographic factors and comorbidities associated with the presence of depression and anxiety. We also compare the rates of depression and anxiety in pediatric epilepsy to that of other chronic health conditions, in order to place epilepsy comorbidities in the larger context of child health.

2. Material and methods

2.1 Study Design / Data Source

The National Survey of Children with Special Health Care Needs (NS-CSHCN), conducted periodically by the Child and Adolescent Health Measurement Initiative, is a cross-sectional national survey of the health information of children who have serious or chronic conditions that require increased health services compared to healthy peers [9]. We utilized the 2009–2010 NS-CSHCN, which was the most current version available at the time of this study. We opted to use the NS-CSHCN over a clinical sample because the survey includes weights from the complex survey design, which allows for national estimates of prevalence. In addition, the use of a national survey with a large sample size increases external validity and

statistical power to a greater extent than a smaller clinical sample would when examining the risk factors associated with depression and anxiety.

The data set was obtained online from the Data Resource Center for Child and Adolescent Health. The Institutional Review Board (IRB) at Weill Cornell Medicine determined the study as exempt from review (IRB #1803019036A003).

2.2 Sample

The sample of children in the NS-CSHCN was gathered via a telephone survey of households in the United States from July 2009 to March 2011 [9]. Households were called using both list- assisted and independent random-digit-dial. A household was deemed eligible for participation in the study if it had at least one child aged 0 to 17 that had special health care needs, as determined by a validated screener answered by the parents [10]. If there were multiple children with special health care needs in the home, then one was randomly selected to be the focus of the study [11].

We utilized three subsets of the survey data in our analyses. In our analysis of pediatric epilepsy, we included all children with a current diagnosis of epilepsy. In our analysis of all children with special health care needs, we included all children in the data set. For our analysis of children with chronic health conditions other than epilepsy, we excluded children with a current diagnosis of epilepsy. Children younger than five years were excluded from all three subsets of the data, as is typically done in studies of comorbid depression and anxiety [12,13]. We also excluded children who had an unknown depression or anxiety status from all three subsets of the data.

A participant's response to a question was coded as missing and excluded from analyses if the participant answered "I don't know" or "refuse to answer." We explored missing data for each variable. We handled missing data by performing Little's MCAR test to determine if data was missing completely at random [14]. If so, we planned to use a complete case analysis; else we planned to do multiple imputation analysis of the missing data.

2.3 Measurement

2.3.1 Epilepsy Diagnosis—The diagnosis of epilepsy was assessed by two survey items answered by the parent/guardian. One asked "Has a doctor or other medical provider had ever told you that [the child] had epilepsy or seizure disorder?" and a second asked "Does [the child] currently have epilepsy or seizure disorder?" [9]. The parent/guardian needed to respond "yes" to both questions for the child to be deemed to have epilepsy in our analyses.

2.3.2 Psychiatric Comorbidities—The outcomes of interest were the presence of depression and the presence of anxiety. Two questions determined whether the child currently had depression: one asked "Has a doctor or other medical provider ever told you that [the child] had depression?" and a second asked "Does [the child] currently have depression?" [9]. The parent/guardian needed to respond "yes" to both questions for the child to be deemed to have depression in our analyses. Two other questions determined whether the child currently had anxiety: one asked "Has a doctor or other medical provider

ever told you that [the child] had anxiety problems?” and a second asked “Does [the child] currently have anxiety problems?” [9]. The parent/guardian needed to respond “yes” to both questions for the child to be deemed to have anxiety in our analyses.

2.3.3 Demographic characteristics—We grouped the sample into young children (ages 5–11) and adolescents (12–17). Children were grouped into one of three categories for race (white only, black only, other race) and two categories for ethnicity (Hispanic, non-Hispanic). Each child’s home state or district was grouped into one of four regions (Northeast, Midwest, South, West) in accordance with the U.S. Census Bureau [15].

The highest education level of the parents was also noted (less than high school, high school, more than high school). Insurance was categorized into three groups—private or other comprehensive insurance only, public insurance (with or without private insurance), or uninsured.

Children were also grouped into three groups based on whether the parent/guardian believed their child needed a specialist in the past year, and if so, whether those needs were met (specialist not needed, specialist needed and needs met, specialist needed but needs unmet).

Children were divided into two groups based on the income of their household—those below 100 percent of the federal poverty line (“low-income”) were compared to those above 100 percent of the federal poverty line (“high-income”). In addition, given previous research demonstrating an interaction between income and race in relation to psychiatric disorders, we searched for an interaction between race and income in relation to depression or anxiety [16,17]. We planned to stratify the race factor by income if the interaction was significant, thereby creating a six-level race/income variable (low-income blacks, high-income blacks, low-income other race, high-income other race, low-income whites, high-income whites).

2.3.4 Epilepsy Severity—Parents/guardians were asked whether they would rate their child’s epilepsy as mild, moderate, or severe. “Epilepsy severity” is a validated measure for use in surveys and corresponds roughly with seizure frequency [18].

2.3.5 Comorbidities—In addition to depression and anxiety, we examined current diagnoses of other psychiatric and neurologic disorders including attention deficit disorder or attention deficit hyperactive disorder (ADD/ADHD), autism spectrum disorder (ASD), behavior disorder (i.e., any behavioral or conduct disorders including oppositional defiant disorder and conduct disorder), migraines or frequent headaches, and concussion. We also examined current diagnoses of two common medical conditions—asthma and allergies.

2.4 Analysis

We estimated the national prevalence of depression and anxiety in the pediatric epilepsy population using the sampling weights of the data set [19]. Error was calculated by multiplying the standard error by 1.96, yielding a 95 percent confidence interval.

Weighted bivariate analyses were performed between each independent variable and each of the two outcomes of interest: the presence of depression and the presence of anxiety among children with epilepsy.

We determined what factors were related to depression and anxiety among children with epilepsy in two weighted multivariable logistic regressions. We included all the variables from the bivariate analyses in the multivariate regressions regardless of significance for two reasons. First, many of these variables have been underexplored in previous research. Second, we wanted to generate unbiased estimates of depression and anxiety [20]. We examined for multicollinearity to ensure the variables were not strongly intercorrelated.

To determine whether the burden of depression and anxiety in epilepsy is different from that of other chronic conditions, we evaluated the odds of having depression and/or anxiety in children with epilepsy relative to children with special health care needs other than epilepsy, while controlling for demographic variables. We also compared the odds of having depression and/or anxiety in children with epilepsy relative to children with asthma, allergies, and migraines, while controlling for demographic variables. Given that the focus of the current study was on pediatric epilepsy, the demographic variables associated with other chronic health conditions are not reported here.

2.5 Statistical Software

We utilized R software environment (version 3.5.1) [21] and the packages “survey” [22], “usdm” [23], and “BaylorEdPsych” [14] to analyze the survey data.

3. Results

3.1 National Estimates of Depression and Anxiety among Children with Epilepsy

There were 40,242 total respondents in the 2009–2010 NS-CSHCN. 1,226 children had epilepsy. After excluding 178 children who were under age five and six children who had unknown depression or anxiety status, 1,042 children remained as the final sample for the analysis of pediatric epilepsy (Figure 1). These included 799 children without either depression or anxiety, 21 with depression but no anxiety, 125 with anxiety but no depression, and 97 with both anxiety and depression. The demographic data for the sample are shown in Supplemental Table S1.

Applying the sampling weights to the 1,042 children indicated there were 283,575 [95% confidence interval \pm 33,732] children aged 5–17 with epilepsy in the United States, which represented 3.1% of all children aged 5–17 with special health care needs and 0.53% of all children aged 5–17 in the United States as per 2010 census reports [24]. Among the 283,575 children with epilepsy, there were 4,483 [\pm 1,483] with current depression but no current anxiety, 33,563 [\pm 8,405] with current anxiety but no current depression, and 32,712 [\pm 7,578] with both current anxiety and current depression (Figure 2a). These findings indicate that 25% of children aged 5–17 with epilepsy have depression and/or anxiety. More specifically, the weighted prevalence rates were 1.6% for depression alone, 11.8% for anxiety alone, and 11.5% for both. The demographic characteristics of the population are described in Table 1.

3.2 Interaction Between Race and Income

To identify a potential interaction between race and income, we performed several weighted logistic regressions of race on depression and anxiety. We compared the effect of race in individuals below 100 percent of the federal poverty level (FPL; low income extreme) to the effect of race in individuals above 400 percent of the FPL (high income extreme). Black race was positively related to depression in those over 400 percent of the FPL (odds ratio [OR] = 14.4, $p = 0.02$) but negatively related to depression in those below 100 percent of the FPL (OR = 0.31, $p = 0.02$). The difference in effect size between income groups was statistically significant ($p = 0.002$) in a t -test analysis of the two log odds. Black race was negatively associated with anxiety in those under 100 percent FPL (OR = 0.23, $p = 0.004$) but unrelated to anxiety in those over 400 percent FPL (OR = 2.31, $p = 0.35$). The difference in effect size between income groups was statistically significant ($p = 0.02$). Given these findings, we analyzed race and income as one stratified race/income variable for all analyses in this study.

3.3 Correlates of Depression in Pediatric Epilepsy

In bivariate analyses, depression was associated with public insurance (relative to private or other insurance), low-income other race and low-income white race (relative to high-income white race), and unmet needs for specialist care (relative to those whose needs for specialist care were met). Several comorbidities were also related to depression, including ADD/ADHD, anxiety, behavior disorder, ASD, migraines or frequent headaches, asthma, and allergies (Supplemental Table 2).

In the multivariable weighted analysis, low-income children of all races were more likely to have depression relative to high-income white children. Children with unmet needs for specialist care had increased odds of depression relative to children whose needs for specialist care were met. Anxiety, behavior disorder, ADD/ADHD, and migraines or frequent headaches were associated with depression. Public insurance and more severe epilepsy were not associated with depression (Table 2).

3.4 Correlates of Anxiety in Pediatric Epilepsy

In bivariate analyses, anxiety was associated with low-income white race (relative to high-income white race), unmet needs for specialist care (relative to those whose needs for specialist care were met), ADD/ADHD, depression, behavior disorder, ASD, migraines or frequent headaches, asthma, and allergies. High-income other race (relative to high-income white race) was negatively associated with anxiety (Supplemental Table 2).

In the multivariable weighted analysis, low-income black children were less likely to have anxiety relative to high-income white children. Children with behavior disorder, depression, asthma, and allergies were more likely to have anxiety. More severe epilepsy was not associated with anxiety (Table 2).

3.5 Missingness and Multicollinearity

No variable had more than 1.5 percent missing values. Little's MCAR test was non-significant ($p = 0.29$), indicating that a complete-case analysis was unbiased.

All of the predictor variables were examined for multicollinearity using the Variance Inflation Factor (VIF). None had a VIF value greater than 1.5, and therefore all were retained in the regression models.

3.6 Rates of Depression and Anxiety among Other Children with Special Health Care Needs

There were 33,786 respondents with a child aged 5–17 who did not have epilepsy. Applying the sampling weights indicated that there are 9,086,851 [+/- 148,241] children aged 5–17 with a special health care need other than epilepsy in the United States. Among those with known depression/anxiety status, 22.1% have depression and/or anxiety (i.e. 3.5% with depression alone, 10.7% with anxiety alone, and 7.9% with both). In a regression of all children with special health care needs, having epilepsy did not increase the odds (OR = 0.89 [0.68–1.15], $p = 0.37$) of having depression and/or anxiety while controlling for age, region, gender, ethnicity, race/income, highest parent education, insurance, and needs for specialist care.

We also examined three specific chronic conditions among children aged 5–17: allergies, migraines, and asthma. Of all children aged 5–17 with special health care needs, 49.7% had allergies, 11.1% had migraines, and 31.4% had asthma. When comparing our estimates to 2010 United States census figures, we estimate that of all children aged 5–17 in the United States, 8.3% had allergies, 1.9% had migraines, and 5.9% had asthma [24]. The rates of depression and/or anxiety among children with these conditions are depicted in Figures 2b, 2c, and 2d. Relative to all children with epilepsy, estimated rates of depression and/or anxiety were not significantly different among children with asthma (16.5%, $p = 0.36$) or allergies (21.6%, $p = 0.31$) but were significantly higher among children with migraines (43.2%, $p < 0.001$) while controlling for age, region, gender, ethnicity, race/income, highest parent education, insurance, and needs for specialist care.

4. Discussion

4.1 Summary of Findings

Our estimates indicate 283,000 children between 5 and 17 years of age have epilepsy in the United States, representing 3.1 percent of all children with special health care needs and 0.53 percent of all children in the United States. One in four children with epilepsy has depression and/or anxiety. This figure is comparable to the overall rate seen among children with other special health care needs. In two multivariable regressions, children from households of poverty (regardless of race) and children whose needs for specialist care were unmet were more likely to have depression. Low-income black children were less likely to have anxiety. Several comorbidities were also associated with having depression or anxiety – those with ADD/ADHD, anxiety, migraines, or a behavior disorder were more likely to have depression, while those with asthma, allergies, ASD, depression, or a behavior disorder were more likely to have anxiety. Gender, age, and epilepsy severity were not significantly associated with depression or anxiety.

4.2 Prevalence of Depression and Anxiety in Children with Epilepsy

When comparing the 283,575 children with epilepsy to United States census data from 2010, we estimate that 0.53 percent of children aged 5–17 in the United States have epilepsy, which is consistent with previous estimations of 0.6 percent in the general pediatric population [1,24]. Among children with special health care needs, 3.1 percent have epilepsy, which is about five times greater than estimates of prevalence in the general pediatric population [1]. This is likely because the survey was administered only to parents/guardians of children with special health care needs and thus the data represents a sicker population of children compared to the general population.

Our results show that among children with epilepsy in the United States, 13.1 percent have depression and 23.3 percent have anxiety. These prevalence figures are consistent with those reported in a study of the 2007 National Survey of Children's Health [1]. In that study, among children with epilepsy, depression was present in 8 percent and anxiety in 17 percent. Many other studies have estimated the prevalence of depression and anxiety among children with epilepsy but estimates vary widely between studies—rates of depression range from 8 to 33 percent, while rates of anxiety range from 5 to 48.5 percent [1,3,12,25–28]. The broad ranges of estimates are likely due to varying methodologies and different study samples.

It is important to note that 11.5 percent of all children with epilepsy had both depression and anxiety. This finding suggests that when one of the two disorders is present, there is a high likelihood the child has the other. This is unsurprising given the two disorders can have overlapping symptoms [29]. We found that anxiety was more prevalent in children with depression than depression was in children with anxiety – 88 percent of children with depression had anxiety whereas 49 percent of children with anxiety had depression. This signifies that anxiety often occurs alone in children with epilepsy but that depression is usually comorbid with anxiety, which is consistent with previous research on pediatric epilepsy [4].

4.3 Depression and Anxiety in Children with Other Special Health Care Needs

Among all children with special health care needs, having epilepsy did not increase the odds of having depression and/or anxiety while controlling for demographic variables. Interpreted differently, the rate of depression and/or anxiety among all children with epilepsy was not significantly different from that of children with other special health care needs. This finding supports past research demonstrating that chronic health conditions in general are associated with increased risk of depression and/or anxiety and add that epilepsy is not unique in its high psychiatric comorbidity [30]. This idea is further supported by our finding that the rate of depression and/or anxiety among children with epilepsy was comparable to the rates seen among children with asthma or allergies without epilepsy. It is important to acknowledge that for each chronic illness there may be specific risk factors which make individuals more or less susceptible to depression or anxiety.

It is noteworthy that our estimated prevalence rates of allergies, asthma, and migraines among children with special needs are higher than that of the general population [31–32].

This overestimation is likely due to the fact that this study focused on children with special health care needs, which represents a sick portion of the population.

Our estimated prevalence rates of allergies and asthma in the general pediatric population are consistent with previous reports [31]. However, our estimate of migraine prevalence in the general pediatric population was lower than that seen in the literature, which may be attributed to differences in the ages included for each study [32].

4.4 Novel Associations in Pediatric Epilepsy

Income has received little attention in studies of depression among children with epilepsy [2]. Our study indicates that poverty is associated with depression regardless of race among children with epilepsy. This relationship between poverty and depression is also seen in the general population and is explained by many potential factors including low self-esteem and poor social support [33].

Children with unmet needs for specialist care were more likely to have depression. Though there is little research on the role of unmet specialist needs in depression, one possible interpretation is that the stress of being unable to access appropriate medical care can contribute to depression [33]. Or, it may be that inadequate or insufficient interactions with a specialist contribute to a feeling of loss of control over the disease, which could perpetuate feelings of depression [34]. We also found that low-income black children with epilepsy had lower odds of anxiety relative to high-income white children with epilepsy. There are several potential interpretations of this finding. Given research showing that black race and low socioeconomic status (SES) are associated with lower mental health service utilization, one possible explanation is that low-income blacks are less likely to visit the doctor for anxiety than other groups [35,36]. This interpretation mirrors the findings of general pediatric health studies, which demonstrate that black children have lower rates of asthma specialist visits relative to non-minorities [37]. It is also possible that, due to stigma, low-income black parents are less likely than high-income white parents to report that their child has an anxiety disorder. This idea is supported by research by Dirks and colleagues [38] showing that discrepancies in parent and child estimates of the child's anxiety symptoms were greater in African Americans than in non-Hispanic whites. Underreporting may be exacerbated in low-income blacks given the increased personal stigma experienced by individuals from lower SES backgrounds [39].

Inherent racial biases within the healthcare system may also contribute to disparities in anxiety diagnosis. It is possible that, due to implicit bias, providers are less likely to diagnose or treat black children for anxiety, as has been observed in the adult primary care setting [40,41]. In addition, the widely known criteria for recognizing anxiety may not be universal given that many are based on population research, which has historically focused on the majority population [42]. Research in panic disorder indicates that the Brief Panic Disorder Screen is less reliable and less valid in African Americans than it is in Caucasians [43]. Thus, it is possible that anxiety diagnoses may be missed to a greater extent in black children than in white children. A deeper understanding of this finding is warranted in future research.

The strongest predictor of depression was anxiety while the strongest predictor of anxiety was depression. This finding is most likely due to the high comorbidity between depression and anxiety, which is seen not only among children with epilepsy [4] but also in the general population [44]. Other comorbidities associated with depression and anxiety included migraines or frequent headaches, ADD/ADHD, ASD, behavior disorder, allergies, and asthma. These associations were unsurprising given that these disorders increase the risk of depression and anxiety in individuals without epilepsy [45–50].

4.5 Confirmation of Previous Findings in Pediatric Epilepsy

The absence of a relationship between gender and depression or anxiety aligns with many previous studies of pediatric epilepsy [2,8]. This finding is interesting because in the general pediatric population, girls are more likely to have a mood or anxiety disorder than boys [51]. Future research might investigate why this trend is not seen in pediatric epilepsy.

In this study age was unrelated to depression or anxiety. Some studies suggest depression is more common in older children with epilepsy [52,53]. However, Dunn and colleagues [26] did not find any relationship between age and depressive symptoms. Reports on age and anxiety have also been inconsistent—while some studies find adolescents at higher risk, others suggest younger children are more at risk [2,8]. Our findings suggest that depression and anxiety are equally prevalent across age groups of pediatric epilepsy.

Interestingly, we did not find an association between epilepsy severity and the prevalence of internalizing affective disorders. Some studies have found increased rates of depression in children with more severe epilepsy or more frequent seizures whereas other studies have not confirmed such relationships [2,54]. Our findings support the notion that epilepsy severity does not impact the risk of psychopathology.

4.6 Clinical Implications

The finding that one in four children with epilepsy has depression and/or anxiety reinforces the importance of screening children with epilepsy for psychopathology [55]. Moreover, the lack of an age predilection for depression or anxiety highlights the need that all children with epilepsy be screened for depression and/or anxiety, not just adolescents as is recommended in the general pediatric population by the U.S. Preventative Services Task Force [56]. Physicians can use instruments such as the emotional component of the Strengths and Difficulties Questionnaire (SDQ) [57] or the Revised Child Anxiety and Depression Scale (RCADS) [58] to screen for depression and anxiety. Recommendations for the treatment of depression and anxiety in children with epilepsy are discussed elsewhere [2].

An understanding of the demographic risk factors for depression and anxiety also has clinical implications. Given that depression and anxiety symptoms are major determinants of health-related quality of life among children with epilepsy, early identification and treatment of psychiatric comorbidities can vastly improve the well-being of such children [5]. In addition, it has been shown that the presence of internalizing psychiatric disorders, including depression and anxiety, is associated with lack of seizure remission five years after the onset of childhood epilepsy [59]. Thus, knowing who is most at risk for psychiatric comorbidities

allows physicians to identify and manage these psychiatric comorbidities as early as possible and thereby maximize the probability of seizure remission. Physicians may also be able to prevent suicide attempts among children with epilepsy through early identification and treatment of psychiatric disorders, as the risk of suicidal ideation increases with each additional psychiatric diagnosis [60]. This concept is especially important to consider given that 11.5 percent of children with epilepsy had both depression and anxiety.

4.7 Limitations

Several limitations merit discussion. First, the NS-CSHCN relies on parental-report. A diagnosis of epilepsy could not be verified from medical records as has been done in previous studies [4,12]. We were also unable to interview the children to determine whether they currently have a diagnosis of depression or anxiety, as others have done [25,28,53]. In fact, given the ambiguous wording of the anxiety survey items, it may be that some parents reported the presence of anxiety symptoms rather than a diagnosis of anxiety, which would inflate estimates of psychopathology. This is further complicated by evidence that parents may overestimate internalizing behaviors due to projection of their own emotional concerns into the response [61], meaning some parents may have reported depression and anxiety that was not truly present in their children. In contrast, another study found that parents underestimate the severity of anxiety symptoms in their children [38]. However, these studies focused on rating scales of psychiatric behaviors and symptoms rather than asking parents to recall whether the child had a specific diagnosis made by a medical professional. For the more straightforward question of presence / absence of a condition, parents have acceptable levels of recall for their child's medical and psychiatric diagnoses [62–64].

We recognize that our findings rely on parental report, rather than clinical assessment, for the diagnosis of depression or anxiety. We note, however, that our study replicated several well- described associations in the literature, including the finding that gender is not related to psychopathology among children with epilepsy, which strengthens confidence in these associations [2,8]. We also found several risk factors previously understudied in the literature, including income and unmet needs for specialist care. Future studies should use clinical samples of children with epilepsy to confirm our novel findings.

Another limitation was that we did not have sufficient data to determine the role of other important epilepsy-related variables, such as the use of AEDs, which can contribute to depression and anxiety and potentially interact with demographic factors [8]. Other variables such as family relationship satisfaction [7] and feelings of stigma [25] are also associated with depression and anxiety but were not measured in the NS-CSHCN. Future work may be valuable to further specify the relative importance of demographic, psychosocial, and epilepsy-related variables in determining the risk for depression and anxiety.

4.8 Conclusion

One in four U.S. children with epilepsy has depression and/or anxiety. This high rate of psychiatric comorbidity is similar to that seen in children with other special health care needs. The experience of depression and anxiety can lead to reduced quality of life [2,4,5], suicidality [2,4], and potentially lower rates of seizure remission among children with

epilepsy [58]. Therefore, physicians should consider the various factors that are related to depression and anxiety in children with epilepsy, including income, race, needs for specialist care, and various comorbidities, so that at-risk children can be screened and managed appropriately.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Declarations of Interest

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Highlights

- Approximately 0.53 percent of US children aged 5–17 have epilepsy
- One in four children with epilepsy across the US has depression and/or anxiety
- This high comorbidity rate is comparable in children with other chronic conditions
- Income, race, and needs for specialist care are associated with psychopathology
- Gender, age, and epilepsy severity are unrelated to the risk of psychopathology

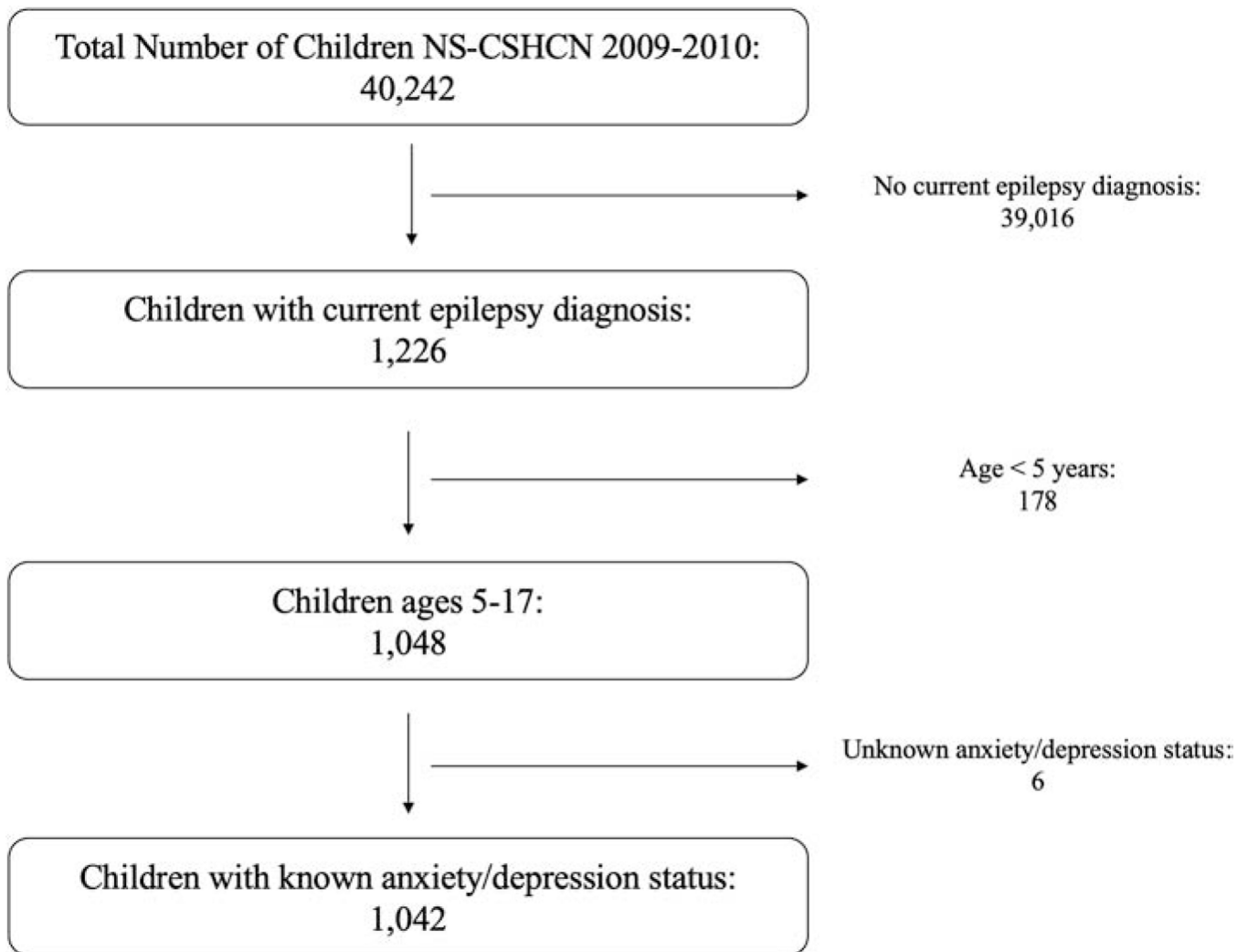


Figure 1. Breakdown of the pediatric epilepsy sample used in the study. After excluding children without epilepsy, children under the age of 5, and children with unknown depression/anxiety status, 1,042 children remained as the final sample for the study. NS-CSHCN = National Survey of Children with Special Health Care Needs.

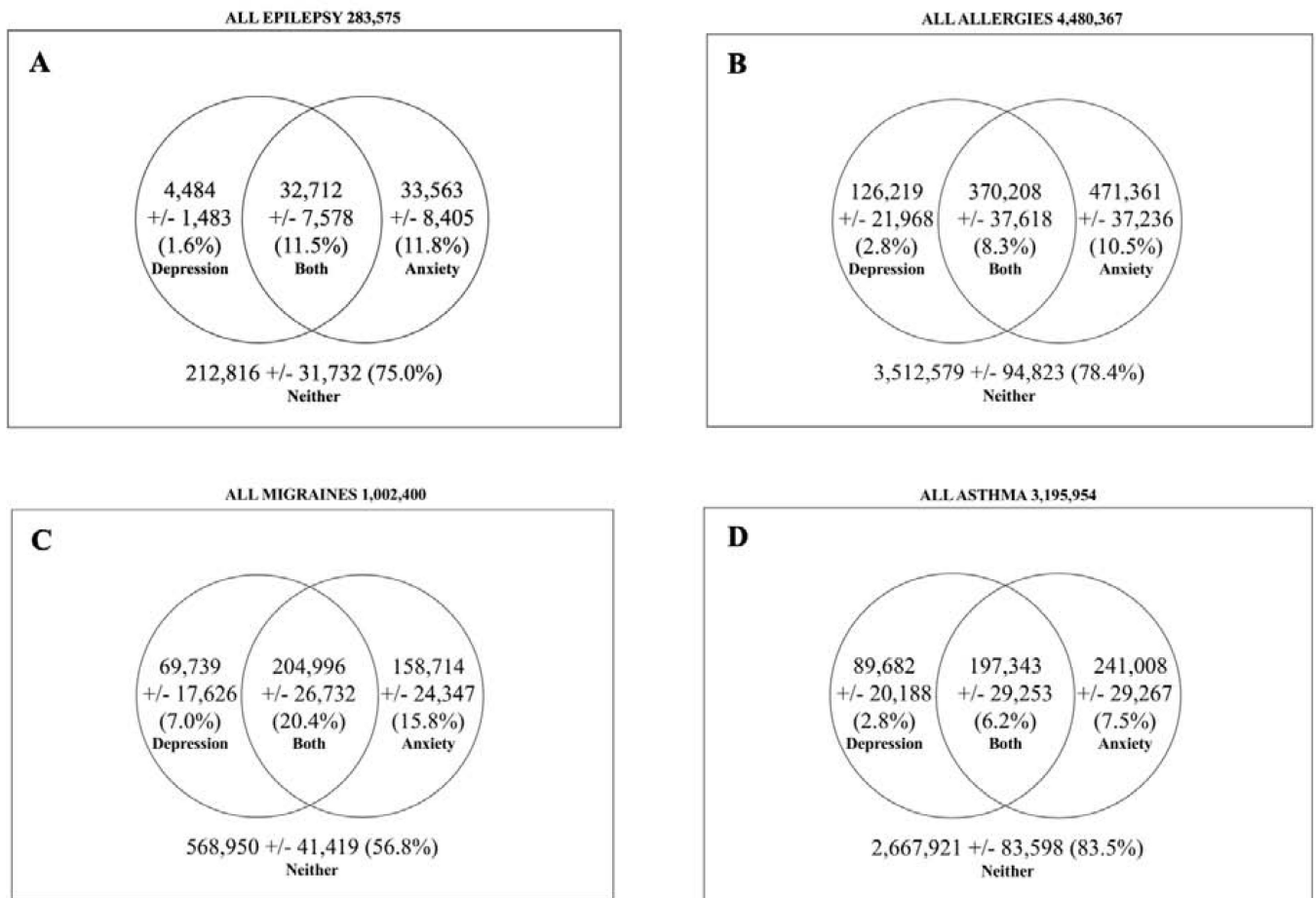


Figure 2. Rates of depression and anxiety among children with epilepsy and other chronic conditions. The population rates of depression, anxiety, both, or neither are depicted among U.S. children with current **A**) epilepsy, **B**) allergies but no epilepsy, **C**) migraines but no epilepsy, **D**) asthma but no epilepsy.

Table 1:

Demographic analysis of the population of children with epilepsy in the U.S.

Variables	No depression or anxiety (N = 212,816)	Depression, but no anxiety (N = 4,484)	Anxiety, but no depression (N = 33,563)	Both depression and anxiety (N = 32,712)
Age[†] (years)	11.17 (3.63)	11.43 (3.87)	11.56 (3.60)	12.92 (3.41)
Adolescents (12–17)	97,499 (45.8)	2,495 (55.6)	17,634 (52.5)	20,086 (61.4)
Young children (5–11)	115,317 (54.2)	1,989 (44.4)	15,929 (47.5)	12,626 (38.6)
Gender				
Male	126,107 (59.3)	3,052 (68.1)	22,586 (67.3)	20,432 (62.5)
Female	86,651 (40.7)	1,432 (31.9)	10,977 (32.7)	12,280 (37.5)
Region				
Northeast	32,581 (15.3)	504 (11.2)	6,544 (19.5)	4,800 (14.7)
Midwest	47,184 (22.2)	908 (20.2)	6,598 (19.7)	9,213 (28.2)
West	34,285 (16.1)	699 (15.6)	8,652 (25.8)	5,187 (15.9)
South	98,766 (46.4)	2,373 (52.9)	11,770 (35.1)	13,513 (41.3)
Race/Income				
Low-income black	19,870 (9.5)	1,097 (24.5)	768 (2.4)	2,719 (8.3)
High-income black	30,525 (14.6)	0 (0)	1,499 (4.7)	2,531 (7.7)
Low-income other race	13,261 (6.3)	403 (9.0)	2,120 (6.6)	4,441 (13.6)
High-income other race	27,597 (13.2)	504 (11.2)	1,831 (5.7)	1,309 (4.0)
Low-income white	19,625 (9.4)	716 (16.0)	2,346 (7.3)	12,324 (37.7)
High-income white	98,698 (47.1)	1,764 (39.3)	23,395 (73.2)	9,345 (28.6)
Ethnicity				
Hispanic	31,977 (15.2)	571 (12.7)	6,458 (20.2)	5,380 (16.5)
Non-Hispanic	178,354 (84.8)	3,913 (87.3)	25,503 (79.8)	27,288 (83.5)
Insurance				
Public	125,135 (58.8)	3,321 (74.1)	18,262 (54.4)	27,874 (85.2)
Uninsured	2,315 (1.1)	19 (0.4)	0 (0)	414 (1.3)
Private or other comprehensive	85,366 (40.1)	1,144 (25.5)	15,301 (45.6)	4,424 (13.5)
Highest parent education level				
Less than high school	18,134 (8.5)	520 (11.6)	1,054 (3.1)	5,354 (16.4)
High school	60,445 (28.4)	2,110 (47.1)	8,098 (24.1)	8,155 (24.9)
More than high school	134,238 (63.1)	1,854 (41.3)	24,410 (72.7)	19,203 (58.7)
Epilepsy Severity				
Moderate	67,478 (31.7)	1,882 (42.0)	8,182 (25.4)	6,803 (20.9)
Severe	39,767 (18.7)	680 (15.2)	8,428 (26.1)	5,972 (18.3)
Mild	105,300 (49.5)	1,922 (42.9)	15,625 (48.5)	19,776 (60.8)
Specialist Needs				
Specialist not needed	41,631 (19.6)	814 (18.2)	3,009 (9.0)	7,419 (23.1)
Specialist needed and needs unmet	5,060 (2.4)	115 (2.6)	742 (2.2)	5,336 (16.6)

Variables	No depression or anxiety (N = 212,816)	Depression, but no anxiety (N = 4,484)	Anxiety, but no depression (N = 33,563)	Both depression and anxiety (N = 32,712)
Specialist needed and needs met	166,112 (78.1)	3,555 (79.3)	29,811 (88.8)	19,391 (60.3)
ADD/ADH	37,995 (18.1)	2,982 (66.5)	16,670 (49.8)	21,630 (66.1)
Behavior Disorder	26,921 (12.7)	1,645 (36.7)	15,634 (46.6)	23,778 (73.2)
ASD	24,799 (11.8)	238 (5.3)	15,706 (46.8)	13,260 (40.5)
Migraines/Frequent Headaches	30,766 (14.5)	2,072 (46.2)	7,676 (25.1)	15,709 (48.0)
Concussion	27,552 (13.0)	702 (17.6)	3,560 (10.6)	3,379 (10.4)
Depression	0 (0)	4,484 (100)	0 (0)	32,712 (100)
Anxiety	0 (0)	0 (0)	33,563 (100)	32,712 (100)
Asthma	32,879 (15.4)	2,211 (49.3)	12,834 (38.2)	13,288 (40.6)
Allergies	79,512 (37.6)	2,219 (49.5)	17,549 (52.3)	22,850 (69.9)

Population estimates are depicted as estimate *N*(response %).

Percentages are out of the total number of respondents for that factor.

FPL = federal poverty level.

[†]These estimates are illustrated as mean (standard deviation).

Table 2:

Results of weighted multivariable logistic regressions on depression and anxiety among children with epilepsy.

Category	Factor	Depression		Anxiety	
		OR [CI]	<i>p</i> -value	OR [CI]	<i>p</i> -value
<i>Age</i>	Adolescent	1.58 [0.73–3.40]	0.25	1.07 [0.58–1.97]	0.83
	Child	ref	---	ref	---
<i>Region</i>	West	1.77 [0.60–5.21]	0.30	0.77 [0.34–1.75]	0.53
	Midwest	1.44 [0.54–3.84]	0.47	0.70 [0.30–1.63]	0.41
	Northeast	0.74 [0.24–2.32]	0.61	1.14 [0.50–2.60]	0.76
	South	ref	---	ref	---
<i>Gender</i>	Male	0.59 [0.26–1.32]	0.20	0.66 [0.36–1.20]	0.18
	Female	ref	---	ref	---
<i>Ethnicity</i>	Hispanic	0.91 [0.29–2.92]	0.88	0.60 [0.22–1.65]	0.32
	Non-Hispanic	ref	---	ref	---
<i>Race / Income</i>	Low-income black	5.60 [1.19–26.3]	0.03*	0.04 [0.01–0.46]	0.002**
	High-income black	1.80 [0.42–7.72]	0.52	0.35 [0.11–1.18]	0.09
	Low-income other	7.00 [1.21–40.4]	0.03*	1.47 [0.27–8.14]	0.66
	High-income other	1.22 [0.27–5.44]	0.59	0.54 [0.20–1.45]	0.22
	Low-income white	8.04 [2.56–25.3]	<0.001***	0.75 [0.30–1.85]	0.54
	High-income white	ref	---	ref	---
<i>Highest Parent Education</i>	Less than high school	1.25 [0.34–4.65]	0.74	0.71 [0.25–2.01]	0.52
	High school	1.47 [0.48–4.50]	0.50	0.48 [0.20–1.14]	0.10
	More than high school	ref	---	ref	---
<i>Insurance</i>	Public	0.82 [0.26–2.59]	0.74	1.24 [0.61–2.53]	0.56
	Uninsured	3.54 [0.61–20.7]	0.16	0.42 [0.10–1.76]	0.24
	Private or other comprehensive	ref	---	ref	---
<i>Specialist Needs</i>	No specialist needs	1.38 [0.51–3.68]	0.53	0.96 [0.35–2.61]	0.94
	Specialist needed and needs unmet	3.91 [1.40–10.9]	0.009**	0.88 [0.22–3.53]	0.86
	Specialist needed and needs met	ref	---	ref	---
<i>Epilepsy Severity</i>	Moderate	1.14 [0.43–2.99]	0.80	0.99 [0.51–1.95]	0.99
	Severe	0.95 [0.41–2.24]	0.91	0.82 [0.37–1.81]	0.62
	Mild	ref	---	ref	---
<i>Comorbidity</i>	Behavior disorder	4.57 [1.99–10.5]	<0.001***	6.05 [2.77–13.2]	<0.001***
	ASD	0.86 [0.32–2.28]	0.76	2.60 [1.27–5.35]	0.009**
	ADD/ADHD	3.23 [1.52–6.83]	0.002**	1.40 [0.72–2.75]	0.32
	Depression	---	---	29.1 [11.8–72.0]	<0.001***
	Anxiety	30.5 [11.8–79.0]	<0.001***	---	---
	Migraines/frequent headaches	3.97 [1.65–9.54]	0.002**	1.80 [0.94–3.44]	0.08
	Concussion	0.82 [0.28–2.40]	0.71	0.90 [0.35–2.35]	0.83
	Asthma	0.63 [0.21–1.90]	0.42	2.48 [1.21–5.06]	0.01*
	Allergies	2.24 [0.92–5.43]	0.07	2.74 [1.47–5.11]	0.002**

OR = odds ratio, CI = 95% confidence interval, ref = reference level for that variable. Significance levels of .05, .01, and .001 are indicated by *, **, and *** respectively.