Research Article

Healthcare Utilization and Morbidity among Adolescents with ADHD in Children Aged 11-17 Years, NHIS, 2017

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Purpose. Children with ADHD have known behaviors of hyperactivity and impulsivity which may result in adverse outcomes. The purpose of this study is to examine the association of serious adverse outcomes (emergency department visits within the previous year) in preadolescents and adolescents with ADHD as compared with preadolescents and adolescents without ADHD. Method. The researchers conducted a cross-sectional, secondary data analysis of National Health Interview Survey (NHIS) 2017 data concerning 2,965 children (>11 to 17 years). The NHIS data resulted from face-to-face interviews of a household member selected from a multistage area probability design representing households in the US. Data analyses for this study included Chi-square bivariate analyses and logistic regression analyses. Results. There were 13.2% of children in the sample who had ADHD. Children with ADHD were more likely to be male and non-Hispanic white. They were also more likely to have one or more additional disease or condition excluding ADHD. In adjusted logistic regression analysis on emergency department utilization by ADHD status, the adjusted odds ratio was 1.93 (95%CI: 1.35, 2.74; p = 0.0003) for preadolescents and adolescents with ADHD as compared with preadolescents and adolescents without ADHD. Conclusion. Children with ADHD were more likely to have emergency department utilization than children without ADHD. Preventive medical visits were similar between preadolescent and adolescent children with and without ADHD. Characteristics associated with ADHD may explain the increased need for emergent care. Developing interventions for children with ADHD may decrease emergency department utilization.

1. Introduction

Over 45% of the US population has one or more chronic diseases with health surveillance disproportionately focused on adults [1, 2]. The prevalence of chronic conditions among children has been increasing over the years. Researchers who conducted a longitudinal study involving three, large, nationally representative cohorts of children showed an increase in chronic conditions from 13% to 27% between each subsequent cohort of children [3]. The epidemiology of chronic conditions among children has shifted temporally with an increase in mental health conditions and behavior/learning problems [3]. Some of the most common, major chronic conditions and diseases of youth in the US are asthma, obesity, hypertension, dental disease, a variety of genetic disorders, and attention-deficit/hyperactivity disorder (ADHD).
The criteria required for ADHD diagnosis are based on the use of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders-5th Edition [4] and/or the International Statistical Classification of Disease and Related Health Problems, Tenth Revision (ICD-10) [5, 6].

A child with ADHD has persistent, interfering symptoms of inattention (often fails to attend to details/makes careless mistakes, loses attention, appears not to be listening, fails to follow through, has difficulty with organization, avoids/dislikes mental tasks, loses things for tasks, and is easily distracted and forgetful) and hyperactivity and impulsivity (often fidgets, taps hands/feet, or squirms, has difficulty remaining seated when expected to remain seated, runs about inappropriately, has difficulty playing in quiet activities, talks excessively, blurts out comments/answers, has difficulty waiting, interrupts, or is “on the go”) [2, 7, 8]. The variety of behaviors and circumstances in which such behaviors are problematic or inappropriate makes it difficult to estimate the prevalence of ADHD [9–13]. The current US prevalence of ADHD is estimated at 6.1 million children, aged 2–17 years (approximately 9.4%) [9]. Worldwidew pooled prevalence of ADHD (which is referred to as hyperkinetic disorder by WHO) is between 5.29% [14] and 7.1% [15]. ADHD has been described as the most commonly diagnosed neurodevelopmental disorder [16, 17].

ADHD has both short-term and long-term adverse outcomes such as academic underachievement [18], unsafe driving behavior and motor vehicle collisions [19], substance use disorders [20], risky sexual behaviors [21], criminal behavior, mortality [22], unintentional physical injuries (UPIs) [16], and poisoning [17]. Researchers of a large systematic review and meta-analysis of UPIs who searched 114 databases concluded that children and adolescents with ADHD were more likely to have UPIs (pooled OR = 1.53, 95%CI: 1.40, 1.67) [16]. They also showed that ADHD medications had a protective effect, at least in the short term as found by pooling the effect from five studies [16]. Included in UPIs is the risk of poisoning, a subtype of physical injury. In a systematic review and meta-analysis of nine studies, ADHD was found to be associated with over three times increased risk of poisoning (risk ratio = 3.14, 95%CI: 2.23–4.42) [17]. The authors also found that the risk ratio of poisoning was significantly more than UPIs when individuals with and without ADHD were compared [17]. Other researchers found similar results when examining the effectiveness of pharmacological treatment for ADHD upon UPIs [18]. They used five studies of ADHD children in which medication and risk of injury were studied [18]. From their meta-analysis, they reported an Adjusted Rate Ratio of 0.76 [95%CI: 0.85, 0.92] [18].

In addition, up to two-thirds of US children and adolescents with ADHD have comorbid mental, emotional, or behavioral disorder(s) [9, 22–25]. Behavior impairments, academic/cognitive difficulties, and aberrant social skills are typically apparent by the age of 7 [26]. It has been recommended that ADHD should not be seen as a childhood disorder alone because studies show persistence of ADHD from childhood to adulthood, with continuation of the symptoms varying from 29%-66% into later life [23, 27, 28]. Although causes and risk factors remain equivocal, genetics is potentially very important as are brain injury, environmental pollutants, maternal alcohol/tobacco use during pregnancy, premature birth, and low birth weight [29].

There are limited studies of preadolescent and adolescent children (aged 11–17) dealing with healthcare utilization, morbidity, and ADHD. In previous meta-analyses of the available studies, many of the potential studies had to be excluded due to duplications, as well as studies not meeting the inclusion criteria (e.g., case reports, animal studies, or not investigating the desired impact) [16–18]. In a large, prospective study of over 2 million US children aged 3-17 years, researchers found that the annual number of visits per child to mental health professionals for behavioral therapy increased between 2007-2009 and 2010-2013 [30]. In very young children with ADHD (aged 3-5 years), it has been reported that there is an increased use of medical services for treatment due to a greater risk of injuries and poisonings resulting from impulsive/overactive behaviors as well as for medical services to provide psychotropic medications as compared with children who do not have ADHD [26]. Researchers found a substantial proportion of children, aged 6-8 years, who were not accessing professional services, mainly due to a lack of case identification and referral [31]. In a study conducted in England, clinical contact for adolescents and young adults decreased by 35% for each year increase in age from baseline [32]. It is unknown if similar circumstances are occurring in the US.

The purpose of this research is to determine the prevalence of ADHD and healthcare utilization, specifically emergency department use, and comorbidity associated with preadolescents and adolescents in regard to ADHD within the US. The rationale is that it is important to understand the changes in morbidity and healthcare utilization in these children for possible interventions to improve both. The primary research hypothesis is that preadolescents and adolescents with ADHD will be more likely to utilize healthcare services, particularly emergency department utilization, than preadolescents and adolescents who do not have ADHD.

The theoretical framework for this research is the adapted Andersen Expanded Behavioral Model [33]. It is a model specifically addressing healthcare utilization and its risk factors. The modified model includes risk factors influencing healthcare utilization as follows: (1) need factors; (2) predisposing factors (generally immutable); (3) enabling factors; (4) personal health/behavioral factors [33]; (5) environmental context [34].

2. Materials and Methods
2.1. Study Design and Data Source. West Virginia University Institutional Review Board provided acknowledgement of this research as nonhuman subject research (protocol 1519200072). It was conducted as a secondary data analysis of a subset of cross-sectional data from the 2017 National Health Interview Survey (NHIS). The NHIS is a face-to-face interview survey of noninstitutionalized civilians in the US conducted through contract by the Census Bureau, as an agent for the National Center for Health Statistics [35]. The purpose of the NHIS is to conduct health surveillance,
collect and analyze health-related topics, and provide timely information to the Department of Health and Human Services to monitor trends [35]. The NHIS researchers use a cross-sectional design of households with a multistage area probability design for representative sampling of households and noninstitutionalized housing (CDC, April, 2018). There is no oversampling of race/ethnicity at the household level, and the annual response rate is 70% of eligible households [35].

For the 2017 survey year, there were 8,845 children files for children aged 0 to ≤18 years. A household adult provided the child’s information available in the Sample Child Core questionnaire [36] at https://www.cdc.gov/nchs/nhis/nhis_2017_data_release.htm.

This original data set has data limitations for the current research. For this current research, the researchers were limited to the specific questions that were presented to the participants and therefore all potential explanatory variables or confounding variables were not available. Sample limitations included a large number of missing responses (98.4%) to questions concerning complementary health visits within the previous year and a large number of missing responses (88.0%) on insurance in the family.

2.2. Study Sample. This study included responses of a household adult about adolescents and preadolescents, ages > 11 to 17 years, from the NHIS Sample Child Core questionnaire. The inclusion criteria were availability of complete data on the adolescent’s or preadolescent’s ADHD status, sex, race/ethnicity, age, body mass index percentile, region, asthma, intellectual disability, congenital heart disease, preventive medical visit within the previous year, preventive dental visit within the previous year, and emergency department use within the previous year. The final study sample was 2,871 adolescents.

2.3. Measures

2.3.1. Key Dependent Variable. The key variable was emergency department utilization within the previous year (yes, no). Information for this variable was gathered from the NHIS 2017 question “During the past 12 months, how many times has [child’s name] gone to a hospital emergency room about his/her health? (This includes emergency room visits that resulted in a hospital admission.)” [35]. The potential responses were “none, 1, 2-3, 4-5, 6-7, 8-9, 10-12, 13-15, 16 or more, refused and don’t know.” [35]. The variable was dichotomized to a yes/no response of emergency department use post hoc as the eligible population had 85.1% with no emergency department utilization, 10.4% with 1 use, and the remaining 4.5% with more than 1 emergency department visit.

Other healthcare utilization was also considered: preventive medical utilization based on whether the participant had a well-child visit within the previous year (yes, no) and dental utilization within the previous year (yes, no).

2.3.2. Key Independent Variable. The key independent variable for the study was ADHD (yes/no). Information for this variable was gathered from the NHIS 2017 question “Has a doctor or health professional ever told you that [child’s name] had Attention-Deficit Hyperactivity Disorder (ADHD) or Attention-Deficit Disorder (ADD)?” [36]. The potential responses were “yes, no, refused, don’t know.” [36].

2.3.3. Other Variables. According to the Andersen model, there are several factors related to access to care and healthcare utilization. The model is an analysis rather than a mathematical model and does not precisely indicate the variables and methods to be used [31]. The following variables were, thus, included as predisposing variables: sex (female/male); race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other); age in years (greater than 11 to and including 14, more than 14 to and including 17); highest education in family members (less than high school, high school graduate, some college/technical education, college/associate degree, and above); family federal ratio of income to poverty (≤2.0, ≥2.0, and missing).

These variables were included as need factors: asthma (yes, no); congenital heart disease/other heart condition (yes, no), disease condition excluding ADHD (0, 1-2, 3, or more). Region of habitation (in this study: Northeast, Midwest, South, and West), as a proxy for availability of services, was recommended by Phillips et al., 1998, as an environmental contextual factor. Body mass index (< 5th percentile or underweight, 5th percentile to <85th percentile or normal weight, 85th percentile to < 95th percentile or overweight, and ≥95th percentile or obese) was included as personal health/behavioral factor.

2.4. Statistical Methodology. Data analyses were conducted for sample descriptive statistics (frequency of the variables and weighted percentages). Additionally, three bivariate analyses were conducted between ever-diagnosed ADHD and the explanatory variables; emergency department utilization and the variables; and preventive medical visits and the variables. The level of significance selected, a priori, was 0.05.

Unadjusted and adjusted logistic regression analyses were performed on emergency department utilization by ADHD status. In the design of the model, due to sample size considerations asthma, intellectual disabilities, autism spectrum disorder, Down syndrome, other, congenital heart disease, and other heart diseases were not considered separately. Instead, disease/condition excluding ADHD was used. The variables included in the model were based on the Andersen model and availability of data in the original NHIS 2017 data set. Although race/ethnicity, age, region, and preventive medical visit within the previous year were not statistically significant in the bivariate analyses, these factors were considered to be epidemiologically important a priori according to the theoretical framework and were included in the final adjusted logistic regression model.

The NHIS 2017 weight variable for the child sample (WTFA_SC), pseudostratum variable (PSTRAT), and Pseudo-PSU variable (PPSU) for public-use files and an eligible population domain variable were incorporated into the analyses to account for the complex design of the NHIS.
|                  | Total sample |   | ADHD |   | No ADHD |   | P-value for ADHD vs No ADHD |
|------------------|--------------|---|------|---|---------|---|-----------------------------|
|                  | N            | Wt% | N    | Wt% | N       | Wt% |                              |
|                  | 2,965        | 100 | 416  | 13.2| 2,549   | 86.8|                              |
| **Sex**          |              |     |      |     |         |     | <.0001                      |
| Male             | 1,561        | 50.8| 292  | 70.8| 1,269   | 47.7|                              |
| Female           | 1,404        | 49.2| 124  | 29.2| 1,280   | 52.3|                              |
| **Race/Ethnicity**|              |     |      |     |         |     | 0.0744                      |
| Non-Hispanic White| 1,692       | 54.8| 266  | 61.7| 1,426   | 53.7|                              |
| Non-Hispanic Black| 321         | 12.8| 47   | 12.4| 274     | 12.9|                              |
| Hispanic         | 628          | 22.5| 72   | 18.0| 556     | 23.2|                              |
| Other            | 324          | 9.9 | 31   | 8.0 | 293     | 10.1|                              |
| **Age in years** |              |     |      |     |         |     | 0.5969                      |
| More than 11 to and including 14 years | 1,358 | 49.7 | 201 | 51.2 | 1,157 | 49.5 |                              |
| More than 14 to and including 17 years | 1,607 | 50.3 | 215 | 48.8 | 1,392 | 50.5 |                              |
| **Highest education in family members** | | | | | | | 0.0160 |
| Less than high school | 176 | 7.4 | 31 | 8.9 | 145 | 7.2 |                              |
| High school graduate | 460 | 15.2 | 85 | 19.4 | 375 | 14.5 |                              |
| Some college/technical education | 461 | 15.7 | 81 | 18.4 | 410 | 15.3 |                              |
| College/associate degree and above | 1,838 | 61.7 | 219 | 53.3 | 1,619 | 63.0 |                              |
| **Family federal ratio of income to poverty** | | | | | | | 0.0236 |
| Less than 2.0 | 897 | 34.4 | 161 | 41.1 | 736 | 33.4 |                              |
| 2.0 and above | 1,948 | 61.3 | 242 | 56.0 | 1,706 | 62.2 |                              |
| Not answered/missing | 120 | 4.2 | 13 | 2.9 | 107 | 4.4 |                              |
| **Body Mass Index Percentile** | | | | | | | 0.0423 |
| Less than 5% (underweight) | 107 | 4.1 | 12 | 3.9 | 95 | 4.1 |                              |
| 5% to less than 85% (normal weight) | 1,880 | 64.0 | 244 | 57.8 | 1,636 | 65.0 |                              |
| 85% to less than 95% (overweight) | 492 | 16.2 | 73 | 17.0 | 419 | 16.0 |                              |
| 95% and above (obese) | 486 | 15.7 | 87 | 21.2 | 399 | 14.9 |                              |
| **Region** | | | | | | | 0.0031 |
| Northeast | 469 | 18.2 | 62 | 14.9 | 407 | 18.7 |                              |
| Midwest | 668 | 22.3 | 104 | 23.9 | 564 | 22.0 |                              |
| South | 1,117 | 36.6 | 187 | 45.0 | 930 | 35.3 |                              |
| West | 711 | 23.0 | 63 | 16.2 | 648 | 24.0 |                              |
| **MORBIDITY** | | | | | | | 0.0004 |
| Asthma | | | | | | | <.0001 |
| Yes | 583 | 19.4 | 114 | 27.5 | 469 | 18.1 |                              |
| No | 2,381 | 80.6 | 302 | 72.5 | 2,079 | 81.9 |                              |
| Intellectual disability, Autism Spectrum disorder, Down syndrome, other | | | | | | | <.0001 |
| Yes | 192 | 6.0 | 82 | 18.8 | 110 | 4.1 |                              |
| No | 2,773 | 94.0 | 334 | 81.2 | 2,439 | 95.9 |                              |
| Congenital heart disease/other heart condition | | | | | | | 0.2589 |
| Yes | 35 | 0.9 | * | * | * | * |                              |
| No | 2,930 | 99.1 | 407 | 98.6 | 2,543 | 99.1 |                              |
| Disease/condition excluding ADHD | | | | | | | <.0001 |
| 0 | 2,202 | 75.2 | 237 | 59.0 | 1,965 | 77.7 |                              |
| 1 or more | 763 | 24.8 | 179 | 41.0 | 584 | 22.3 |                              |
2017. SAS 9.3 (Carey, NC, USA) was used for the analyses. The logistic regression model had all of the independent variables entered in a single step.

3. Results

3.1. Data Availability. Publicly available 2017 National Health Interview Survey data were used for this study and are available at https://www.cdc.gov/nchs/nhis/nhis_2017_data_release.htm [34].

3.2. Study Sample Description. The sample consisted of 2,965 children with ages greater than 11 years to and including 17 years. There were 13.2% who were ever diagnosed with ADHD. A significantly higher proportion of males (70.8%) than females (29.2%) had ADHD (p<.0001). The sample included 54.8% non-Hispanic white children, 12.8% non-Hispanic black children, 22.6% Hispanic children, and 9.9% children from other/mixed races. There was an equal distribution of children with ages greater than 11 years to and including 14 years (49.7%) and children greater than 14 years to and including 17 years. Most of the children were of normal weight (64.0%). Over a third (36.6%) lived in the South, 23.0% lived in the West, 22.3% lived in the Midwest, and 18.2% lived in the Northeast. Most of the children did not have asthma (80.6%), did not have an intellectual disability, autism spectrum disorder, or Down syndrome (94.0%), and did not have a congenital heart disease or other heart condition (99.1%). There were 81.1% who had preventive medical utilization within the previous year, 89.0% who had dental utilization within the previous year, 14.9% who had utilized emergency department services visit within the previous year, and 1.6% who had utilized a complementary health visit within the previous year (this result was not presented in tabular form due to the small cell sizes, as previously noted). Results are presented in Table 1.

3.3. Bivariate Comparisons. Preadolescent and adolescent children with ADHD were more likely to have asthma, intellectual disability, autism spectrum disorder, Down syndrome and others and one or more disease/condition excluding ADHD than preadolescent and adolescent children who do not have ADHD (Table 1). Children with ADHD were more likely to utilize emergency department services within the previous year than children who did not have ADHD (Table 2).

Other significant relationships with utilizing emergency department services were with sex, highest education in family members, family federal poverty ratio of income to poverty, body mass index percentile, asthma, congenital heart disease or other heart condition, intellectual disability/autism spectrum disorder/Down syndrome/other, additional diseases/conditions beyond ADHD, and dental visit within the previous year.

Table 2 also has the likelihood of utilizing preventive medical visits within the previous year. ADHD status failed to reach statistical significance. Statistically significant relationships of ADHD were observed with race/ethnicity, age, highest education in family members, family federal ratio of income to poverty, body mass index percentile, region, disease/condition excluding ADHD, and dental visit within the previous year.

3.4. Logistic Regression. In unadjusted logistic regression analysis on emergency department utilization within the previous year by ADHD status, the unadjusted odds ratio (OR) for ADHD was 2.08 (95% confidence interval [95%CI]: 1.55, 2.78; p<.0001). In adjusted logistic regression analysis,
Table 2: Characteristics of the study sample by healthcare utilization within the previous year, N = 2,965, 2017 National Health Interview Survey.

| Characteristics                        | Emergency Department visit | Preventive medical visit |
|----------------------------------------|-----------------------------|--------------------------|
|                                        | Yes | wt%  | No  | wt% | P-value | Yes | wt%  | No  | wt% | P-value |
| ADHD                                   |     |      |     |      |         |     |      |     |      |         |
| Yes                                    | 104 | 22.0 | 312 | 11.7 | <.0001  | 352 | 13.6 | 64  | 11.6 | .3106   |
| No                                     | 353 | 78.0 | 2,196 | 88.3 |         | 2,028 | 86.4 | 521 | 88.4 |         |
| Sex                                    |     |      |     |      |         |     |      |     |      |         |
| Male                                   | 219 | 44.1 | 1,342 | 52.0 | .0079   | 1,256 | 50.9 | 305 | 50.2 | .7981   |
| Female                                 | 238 | 55.9 | 1,166 | 48.0 |         | 1,124 | 49.1 | 280 | 49.8 |         |
| Race/ethnicity                         |     |      |     |      |         |     |      |     |      |         |
| Non-Hispanic white                     | 273 | 58.0 | 1,419 | 54.2 | .3854   | 1,367 | 55.5 | 325 | 51.7 | .0446   |
| Non-Hispanic black                     | 61  | 14.0 | 260  | 12.6 |         | 277  | 13.5 | 44  | 9.9  |         |
| Hispanic                               | 79  | 19.3 | 549  | 23.1 |         | 489  | 21.6 | 139 | 26.4 |         |
| Other                                  | 44  | 8.7  | 280  | 10.0 |         | 247  | 9.3  | 77  | 12.0 |         |
| Age                                    |     |      |     |      | .6570   |     |      |     |      | .0036   |
| More than 11 to and including 14 years | 205 | 48.6 | 1,153 | 49.9 |         | 1,145 | 51.4 | 213 | 42.2 |         |
| More than 14 to and including 17 years | 252 | 51.4 | 1,355 | 50.1 |         | 1,235 | 48.5 | 372 | 57.8 |         |
| Highest education in family members    |     |      |     |      | .0033   |     |      |     |      | <.0001  |
| Less than high school                  | 35  | 7.1  | 141  | 7.5  |         | 131  | 6.3  | 45  | 12.2 |         |
| High school graduate                   | 90  | 18.6 | 370  | 14.6 |         | 344  | 13.9 | 116 | 20.5 |         |
| Some college/technical education       | 98  | 21.2 | 393  | 14.8 |         | 379  | 15.1 | 112 | 18.4 |         |
| College/associate degree and above     | 234 | 53.1 | 1,604 | 63.2 |         | 1,526 | 64.7 | 312 | 48.9 |         |
| Family federal ratio of income to poverty |     |      |     |      | .0005   |     |      |     |      | .0164   |
| Less than 2.0                          | 197 | 48.9 | 700  | 31.9 |         | 698  | 32.4 | 199 | 43.2 |         |
| 2.0 and above                          | 242 | 46.6 | 1,706 | 63.9 |         | 1,584 | 63.3 | 364 | 53.1 |         |
| Not answered/missing                   | 18  | 4.5  | 102  | 4.2  |         | 98   | 4.3  | 22  | 3.7  |         |
| Body Mass Index Percentile             |     |      |     |      | .6141   |     |      |     |      | <.0001  |
| Less than 5% (underweight)             | 11  | 1.9  | 96   | 4.5  |         | 83   | 3.5  | 24  | 6.7  |         |
| 5% to less than 85% (normal weight)    | 264 | 57.5 | 1,616 | 65.1 |         | 1,500 | 64.2 | 380 | 63.5 |         |
| 85% to less than 95% (overweight)      | 83  | 20.2 | 408  | 15.5 |         | 419  | 17.0 | 73  | 12.6 |         |
| 95% and above (obese)                  | 99  | 20.4 | 387  | 14.9 |         | 378  | 15.4 | 108 | 17.2 |         |
| Region                                 |     |      |     |      | .0025   |     |      |     |      | .0660   |
| Northeast                              | 62  | 16.3 | 407  | 18.5 |         | 427  | 20.2 | 42  | 9.7  |         |
| Midwest                                | 116 | 25.0 | 552  | 21.8 |         | 523  | 22.0 | 145 | 23.7 |         |
| South                                  | 182 | 35.8 | 935  | 36.7 |         | 901  | 36.8 | 216 | 35.4 |         |
| West                                   | 97  | 22.9 | 614  | 23.0 |         | 529  | 21.0 | 182 | 31.2 |         |
| Asthma                                 |     |      |     |      | <.0001  |     |      |     |      | .0756   |
| Yes                                    | 133 | 30.2 | 450  | 17.5 |         | 485  | 20.1 | 98  | 16.1 |         |
| No                                     | 324 | 69.8 | 2,057 | 82.5 |         | 1,894 | 79.9 | 487 | 83.9 |         |
| Intellectual disability, Autism Spectrum disorder, Down syndrome, other |     |      |     |      | .0025   |     |      |     |      | .0660   |
| Yes                                    | 44  | 10.1 | 148  | 5.3  |         | 164  | 6.4  | 28  | 4.1  |         |
| No                                     | 413 | 89.9 | 2,360 | 94.7 |         | 2,216 | 93.6 | 557 | 99.6 |         |
| Congenital heart disease/other heart condition |     |      |     |      | <.0001  |     |      |     |      | .0664   |
| Yes                                    | 16  | 2.8  | 19   | 0.6  |         | *    | 1.1  | *   | 0.4  |         |
| No                                     | 441 | 97.2 | 2,469 | 99.4 |         | 2,350 | 98.9 | 580 | 99.6 |         |
Table 2: Continued.

| Disease/condition excluding ADHD | Emergency Department visit | Preventive medical visit |
|----------------------------------|----------------------------|-------------------------|
|                                  | Yes | wt% | No | wt% | P-value | Yes | wt% | No | wt% | P-value |
| 0                                | 280 | 60.0 | 1,922 | 77.9 | <.0001 | 1,746 | 74.2 | 456 | 79.5 | .0293 |
| 1 or more                        | 177 | 40.0 | 586 | 22.1 | | 634 | 25.8 | 120 | 20.5 | |

Preventive Medical visit within the previous year

| Yes | wt% | No | wt% | P-value |
|-----|-----|----|-----|---------|
| 380 | 84.6 | 2,000 | 80.4 | not applicable |
| 77  | 15.4 | 508 | 19.6 | not applicable |

Dental visit within the previous year

| Yes | wt% | No | wt% | P-value |
|-----|-----|----|-----|---------|
| 386 | 85.6 | 2,253 | 89.5 | .0420 |
| 198 | 14.4 | 255 | 10.5 | |

Emergency Department visits within the previous year

| Yes | P-value |
|-----|---------|
| not applicable |

| No | P-value |
|----|---------|
| 2,000 | 84.5 |

Note: based on 2,965 children, ages greater than 11 years to and including 17 years having or not having the visit within the previous year. wt, weight/weighted; ADHD, attention deficit hyperactivity disorder.

1 Weighted column percentage.

2 P-value based upon Rao Scott Chi-square difference between having an emergency visit within the previous year or not having an emergency visit within the previous year.

3 P-value based upon Rao Scott Chi-square difference between having a preventive medical visit within the previous year or not having a preventive medical visit within the previous year.

4. Discussion

The transition from childhood into the teen years is a period of challenges for most children and it may be particularly difficult for children with ADHD. This study adds to the literature on emergent healthcare utilization of preadolescents and adolescents with and without ADHD. The study results include similar healthcare utilization patterns for children with ADHD and children without ADHD in the use of preventive medical services within the previous year in the bivariate analyses. However, preadolescents and adolescents with ADHD were more likely to utilize an emergency department within the previous year than preadolescents and adolescents who did not have ADHD (adjusted OR= 1.93 [95% CI: 1.35, 2.74; p = 0.0003]) (Table 3).

Utilize emergency department services than children with no diseases, children in families with a less than 2.0 ratio of income to poverty were more likely to utilize emergency department services than children in families with a higher income to poverty ratios, and Hispanic children were less likely to use emergency department services than non-Hispanic white children.

Previous implications of ADHD and injuries through accidents and violence [35] may be important in the explanation of this study’s result of increased utilization of the emergency department by preadolescents and adolescents. Symptoms associated with ADHD (i.e., impulsivity, social inadequacy, and inappropriate risk-taking behaviors) may explain the increased need for emergent care. Future research is needed to determine if efforts to address the factors leading to injuries and violence could decrease emergency use in preadolescents and adolescents with ADHD.

4.1 Similar and Contradictory Studies. Most peer-reviewed articles in the literature about ADHD and children considered all children with ages 0-18 years and did not specifically examine preadolescence and adolescence. One of the peer-reviewed journal articles that was a meta-analysis reported age of injury [16]. One of the studies in the meta-analysis examined children aged 5-10 years, one was 6-19 years, one was 3-17 years, and two were 1-18 years [16]. None of the studies were completed in the US. In a meta-analysis of the risk of poisoning in children and adolescents with ADHD, one of the ages in the studies was 0-19 (one study); 3-17 (one study); 5-9 (one study); 0-15 (one study); 3-18 (one study);
Table 3: Logistic regression of ADHD on emergency department utilization within the previous year, N = 2,965, 2017 National Health Interview Survey.

| ADHD | 2.08 [1.55, 2.78] | <.0001 | 1.93 [1.35, 2.74] | 0.0003 |
|------|------------------|--------|------------------|--------|
| Yes  |                  |        |                  |        |
| No   |                  |        |                  |        |

| Sex                                      |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| Male                                     | 0.59 [0.46, 0.75]   | <.0001|                  |        |
| Female                                   |                     |       |                  |        |

| Race/ethnicity                           |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| Non-Hispanic Black                       | 0.74 [0.49, 1.10]   | 0.1354|                  |        |
| Hispanic                                 | 0.60 [0.41, 0.88]   | 0.0091|                  |        |
| Other                                    | 0.70 [0.44, 1.13]   | 0.1474|                  |        |
| Non-Hispanic White                       |                     |       |                  |        |

| Age in years                             |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| More than 11 to and including 14 years   | reference group     |       |                  |        |
| More than 14 to and including 17 years   | 1.08 [0.84, 1.38]   | 0.5502|                  |        |

| Highest education in family members      |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| Less than high school                    | 0.83 [0.49, 1.41]   | 0.4900|                  |        |
| High school graduate                     | 1.16 [0.80, 1.69]   | 0.4380|                  |        |
| Some college/technical education         | 1.27 [0.90, 1.79]   | 0.1793|                  |        |
| College/associate degree and above       |                     |       |                  |        |

| Family federal ratio of income to poverty|                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| Less than 2.0                            | 2.13 [1.60, 2.85]   | <.0001|                  |        |
| 2.0 and above                            |                     |       |                  |        |
| Not answered/missing                     | 1.52 [0.81, 2.86]   | 0.1910|                  |        |

| Body mass index                          |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| Less than 5% (underweight)               | 0.50 [0.23, 1.08]   | 0.0786|                  |        |
| 5% to less than 85% (normal weight)      |                     |       |                  |        |
| 85% to less than 95% (overweight)        | 1.39 [1.01, 1.90]   | 0.0443|                  |        |
| 95% and above (obese)                    | 1.35 [0.96, 1.89]   | 0.0844|                  |        |

| Disease/condition excluding ADHD         |                     |       |                  |        |
|------------------------------------------|---------------------|-------|------------------|--------|
| 0                                        | reference group     |       |                  |        |
| 1 or more                                | 2.13 [1.64, 2.77]   | <.0001|                  |        |

| Preventive Medical visit within the previous year |                     |       |                  |        |
|----------------------------------|---------------------|-------|------------------|--------|
| Yes                              | reference group     |       |                  |        |
| No                               | 0.68 [0.48, 0.96]   | 0.0283|                  |        |

| Dental visit within the previous year   |                     |       |                  |        |
|----------------------------------------|---------------------|-------|------------------|--------|
| Yes                                    | reference group     |       |                  |        |
| Greater than 1 year/never              | 1.44 [0.98, 2.10]   | 0.0607|                  |        |

Note: based on 2,965 children, ages greater than 11 years to and including 17 years having or not having the visit within the previous year. wt, weight/weighted; ADHD, attention deficit hyperactivity disorder.

3-17 (one study); 5-15 (one study); 0-4 (one study); and any age (one study)[17]. Two of these studies were completed in the US. Such factors make it difficult to compare our study with the results of the meta-analyses; however, our results are supportive of the negative impact of ADHD upon injury as measured by emergency department visits.

Of the peer-reviewed articles in which investigators conducted research on preadolescent/adolescent health, the emphasis was on difference in utilization patterns of medications for ADHD. Researchers for one study set in the UK that followed adolescents, ages 14-24 years, for 3 years found that impairments lessened significantly over that time, but any psychiatric comorbidities remained stable and there was a correlation of health service utilization with younger age rather than need [32]. In a study of children, ages 7 to 18 years, utilizing the Korean National Health and Nutrition Examination Survey, 2007-2015, there was no significant difference in outpatient visits between them and their peers, and the researcher reported that children with ADHD underutilize healthcare services relative to their needs [37].

Medication utilization is an important factor to consider in decreasing the risk of UPIs and subsequent emergency visits.
department utilization in children and adolescents. In meta-
analyses of UPIs, pharmacological treatment reduced the risk
of injuries among children with ADHD as compared with
children with ADHD who were not taking medications [18].

There is a need for increased surveillance for behavioral
and learning problems in children to identify cases which
may be undiagnosed. Often a diagnosis is critical in access
to needed care and conversely diagnosis may be influenced
by pursuit of treatment [3]. Proper diagnosis and identi-
fying the appropriate treatment and support are essential
to help individuals with ADHD improve their lives and
also offset the costs associated with lost productivity and
overall healthcare utilization. These findings have important
implications for the effectiveness of care provided to children.
It should be noted that only a minority of children with
ADHD reach adulthood without serious adverse outcomes,
suggesting that the care of childhood ADHD is far from
optimal.

4.2. Limitations and Strengths. The authors provide several
caveats for the study. First, the data for the children were
reported by their parents/guardians and may be biased
by social desirability bias of the parent/guardian wanting
to please the investigator. Second, all variables that the
researchers desired and which could have made the study
more robust were not adequately available in the original data
set due to the number of missing data points or due to the
original purpose of the source data.

As NHIS uses parental/guardian reports of children’s
ADHD instead of standardized assessments, the reporting
may have resulted in underestimating the disorder. However,
the researchers used data from a recent, nationally repre-
sentative, and high quality study, utilizing the features of
its complex study design. And, although the cross-sectional
study design by nature does not have temporality (and
causality cannot therefore be determined), the study is useful
in providing insight and epidemiological information on
healthcare utilization by preadolescents and adolescents with
ADHD.

5. Conclusion

In this study of 2,965 preadolescents and adolescents, chil-
dren with ADHD were more likely to have emergency depart-
ment utilization than children who did not have ADHD.
Preventive medical visits were similar between preadolescent
and adolescent children with and without ADHD. Character-
istics associated with ADHD may explain the increased need
for emergent care. It is important to develop interventions
for children with ADHD to decrease emergency department
utilization.

Data Availability

Previously reported NHIS, 2017, publicly available data were
used to support this study and are available at https://www
.cdc.gov/nchs/nhis/nhis_2017_data_release.htm [36].

Disclosure

The content is solely the responsibility of the authors and does
not necessarily represent the official views of the National
Institutes of Health. The funders had no role in study design,
data collection, analysis, decision to publish, or preparation of
the manuscript.

Conflicts of Interest

The authors have no conflicts of interest to declare.

Authors’ Contributions

R. Constance Wiener developed the concept, conducted the
data analyses, and wrote the first draft. Christopher Waters,
Ruchi Bhandari, and Alcinda Shockey reviewed the data
analyses, contributed to the writing and editing of the drafts,
and approved the final version of the manuscript.

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References

[1] D. C. Lee, S. S. Yi, H.-F. Fong et al., “Identifying local hot
spots of pediatric chronic diseases using emergency department
surveillance,” Academic Pediatrics, vol. 17, no. 3, pp. 267–274,
2017.
[2] J. H. Price, J. Khubchandani, M. McKinney, and R. Braun,
“Racial/ethnic disparities in chronic diseases of youths and
access to health care in the united states,” BioMed Research
International, vol. 2013, Article ID 787616, 12 pages, 2013.
[3] J. Van Cleave, S. L. Gortmaker, and J. M. Perrin, “Dynamics
of obesity and chronic health conditions among children and
youth,” Journal of the American Medical Association, vol. 303,
no. 7, pp. 623–630, 2010.
[4] Psychiatric Association, Diagnostic And Statistical Manual of
Mental Disorders, American Psychiatric Association, Washing-
ton, DC, USA, 5th edition, 2013.
[5] World Health Organization, The ICD-10 Classification of Mental
And Behavioral Disorders: Clinical Descriptions And Diagnostic
Guidelines, World Health Organization, Geneva, Switzerland,
1992.
[6] World Health Organization, International Classification of Dis-
eses (ICD-11) for Mortality and Morbidity Statistics (ICD-11
MMS) 11th Revision, 2018 version, World Health Organization,
Geneva, Switzerland, 2018.
[7] Centers for Disease Control and Prevention, Attention-
Deficit/Hyperactivity Disorder, Symptoms and Diagnosis, 2017,
https://www.cdc.gov/ncbddd/adhd/diagnosis.html.
[8] R. K. Bailey and D. L. Owens, “Overcoming challenges in
the diagnosis and treatment of attention-deficit/hyperactivity
disorder in African Americans,” Journal of the National Medical
Association, vol. 97, 10 Supplement, pp. 55–105, 2004.
[9] M. L. Danielson, R. H. Bitsko, R. M. Ghandour, J. R. Holbrook, M. D. Kogan, and S. J. Blumberg, "Prevalence of parent-reported ADHD diagnosis and associated treatment among U.S. children and adolescents, 2016," Journal of Clinical Child & Adolescent Psychology, vol. 47, no. 2, pp. 199–212, 2018.

[10] M. B. First, G. M. Reed, S. E. Hyman, and S. Saxena, "WHO report: the development of the ICD-II clinical descriptions and diagnostic guidelines for mental and behavioural disorders," World Psychiatry, vol. 14, no. 1, pp. 82–90, 2015.

[11] G. M. Reed, M. C. Roberts, J. Keeley et al., "Mental health professionals’ natural taxonomies of mental disorders: implications for the clinical utility of the ICD-11 and the DSM-5," Journal of Clinical Psychology, vol. 69, no. 12, pp. 1191–1212, 2013.

[12] G. M. Reed, "Toward ICD-II: improving the clinical utility of WHO’s international classification of mental disorders," Professional Psychology: Research and Practice, vol. 41, pp. 457–464, 2010.

[13] R. D. Todd, H. Huang, and C. A. Henderson, "Poor utility of the age of onset criterion for DSM-IV attention deficit/hyperactivity disorder: Recommendations for DSM-V and ICD-11," Journal of Child Psychology and Psychiatry and Allied Disciplines, vol. 49, no. 9, pp. 942–949, 2008.

[14] G. Polanczyk, M. S. de Lima, B. L. Horta, J. Biederman, and L. A. Rohde, "The worldwide prevalence of ADHD: a systematic review and metaregression analysis," The American Journal of Psychiatry, vol. 164, no. 6, pp. 942–948, 2007.

[15] R. Thomas, S. Sanders, J. Doust, E. Beller, and P. Glasziou, "Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis," Pediatrics, 2015.

[16] M. Ruiz-Goikoetxea, S. Cortese, M. Aznarez-Sanado et al., "Risk of unintentional injuries in children and adolescents with ADHD and the impact of ADHD medications: a systematic review and meta-analysis," Neuroscience & Biobehavioral Reviews, vol. 84, pp. 63–71, 2018.

[17] M. Ruiz-Goikoetxea, S. Cortese, S. Magallón et al., "Risk of poisoning in children and adolescents with ADHD: a systematic review and meta-analysis," Scientific Reports, vol. 8, no. 1, p. 7584, 2018.

[18] K. K. C. Man, P. Ip, E. W. Chan et al., "Effectiveness of pharmacological treatment for attention-deficit/hyperactivity disorder on physical injuries: a systematic review and meta-analysis of observational studies," CNS Drugs, vol. 31, no. 12, pp. 1043–1055, 2017.

[19] L. E. Arnold, P. Hodgkins, J. Kahle, M. Madhoo, and G. Kewley, "Long-term outcomes of ADHD: academic achievement and performance," Journal of Attention Disorders, 2015, https://doi.org/10.1177/1087054714566076.

[20] A. B. M. Fuermaner, L. Tucha, B. L. Evans et al., "Driving and attention deficit hyperactivity disorder," Journal of Neural Transmission, vol. 124, no. 1, pp. 55–67, 2017.

[21] E. Harstad and S. Levy, "Attention-deficit/hyperactivity disorder and substance abuse," Pediatrics, vol. 134, no. 1, pp. e293–e301, 2014.

[22] E. N. Schoenfelder and S. H. Kollins, "Topical review: ADHD and health-risk behaviors: Toward prevention and health promotion," Journal of Pediatric Psychology, vol. 41, no. 7, pp. 735–740, 2016.

[23] W. J. Barbaresi, R. C. Colligan, A. L. Weaver, R. G. Voigt, J. M. Killian, and S. K. Katusic, "Mortality, ADHD, and psychosocial adversity in adults with childhood ADHD: A prospective study," Pediatrics, vol. 131, no. 4, pp. 637–644, 2013.

[24] Centers for Disease Control and Prevention, Attention-Deficit/Hyperactivity Disorder, Articles: Key Findings: National Prevalence of ADHD and Treatment: New statistics for children and adolescents, 2016, 2018, https://www.cdc.gov/nchcdd/ahd/ features/national-prevalence-ahd-and-treatment.html.

[25] J. Meyers, P. Classi, L. Wietecha, and S. Candrilli, "Economic burden and comorbidities of attention-deficit/hyperactivity disorder among pediatric patients hospitalized in the United States," Child and Adolescent Psychiatry and Mental Health, vol. 4, no. 31, 2010.

[26] G. J. DuPaul, K. E. McGoey, T. L. Eckert, and J. VanBrakle, "Preschool children with attention-deficit/hyperactivity disorder: impairments in behavioral, social, and school functioning," Journal of the American Academy of Child and Adolescent Psychiatry, vol. 40, no. 5, pp. 508–515, 2001.

[27] R. A. Barkley, M. Fischer, L. Smallish, and K. Fletcher, "The persistence of attention-deficit/hyperactivity disorder into young adulthood as a function of reporting source and definition of disorder," Journal of Abnormal Psychology, vol. III, no. 2, pp. 279–289, 2002.

[28] F. H. Wender, L. E. Wolf, and J. Wasserstein, "Adults with ADHD: an overview," Annals of the New York Academy of Sciences, vol. 931, no. 1, pp. 1–16, 2001.

[29] The ADHD Molecular Genetics Network, "Meeting report: report from the third international meeting of the attention-deficit hyperactivity disorder molecular genetics network," American Journal of Medical Genetics, vol. 114, no. 3, pp. 272–277, 2002.

[30] A. W. Walter, Y. Yuan, and H. J. Cabral, "Mental health services utilization and expenditures among children enrolled in employer-sponsored health plans," Pediatrics, vol. 139, Supplement 2, pp. S127–S135, 2017.

[31] D. Efron, O. Moisuc, V. McKenzie, and E. Sciberras, "Service use in children aged 6–8 years with attention deficit hyperactivity disorder," Archives of Disease in Childhood, 2015.

[32] H. Eklund, T. Cadman, J. Findon et al., "Clinical service use as people with attention deficit hyperactivity disorder transition into adolescence and adulthood: a prospective longitudinal study," BMC Health Services Research, vol. 16, no. 1, article 248, 2016.

[33] R. M. Andersen, "Revisiting the behavioral model and access to medical care: does it matter?" Journal of Health and Social Behavior, vol. 36, no. 1, pp. 1–10, 1995.

[34] K. A. Phillips, K. R. Morrison, R. Andersen, and L. A. Aday, "Understanding the context of healthcare utilization: assessing environmental and provider-related variables in the behavioral model of utilization," Health Services Research, vol. 33, no. 3, pp. 571–596, 1998.

[35] Centers for Disease Control and Prevention and National Center for Health Statistics, "National Health Interview Survey, About the National Health Interview Survey," 2017, https://www.cdc.gov/nchs/nhis/about_nhis.htm.

[36] Centers for Disease Control and Prevention and National Center for Health Statistics, "National Health Interview Survey, 2017 Data Release 2018 Aug," https://www.cdc.gov/nchs/nhis/nhis_2017_data_release.htm.

[37] S. J. Park, H. Jang, Y. Lee, C. E. Kim, and S. Park, "Health behaviors, physical health, and health care utilization in children With ADHD," Journal of Attention Disorders, 2018.
