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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]. Worldwide 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 1511920072). 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

Table 1: Characteristics of the study sample by ADHD status, N = 2,965, 2017 National Health Interview Survey.

	Total sample		*ADHD*		*No ADHD*		*P-value for ADHD vs No ADHD*
	N	Wt%[1]	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							
Asthma							*0.0004*
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	

Table 1: Continued.

	Total sample		ADHD		No ADHD		P-value for ADHD vs No ADHD
	N	Wt%[1]	N	Wt%	N	Wt%	
	2,965	100	416	13.2	2,549	86.8	
HEALTHCARE UTILITZATION							
Preventive Medical visit within the previous year							0.3106
Yes	2,380	81.1	352	83.3	2,028	80.7	
No	585	18.9	64	16.7	521	19.3	
Dental visit within the previous year							0.8949
Yes	2,639	89.0	374	89.2	2,265	88.9	
Greater than 1 year/never	326	11.0	42	10.8	284	11.1	
Emergency Department visits within the previous year							*<.0001*
Yes	457	14.9	104	24.8	353	13.4	
No	2,508	85.1	312	75.2	2,196	86.6	

Note: based on 2,965 children, ages greater than 11 years to and including 17 years.
wt%, weighted; ADHD, attention-deficit hyperactivity disorder.
∗Cell suppressed due to cell size.
[1] Weighted column percentage.
P-value based upon Rao Scott Chi-square difference between ADHD and no ADHD.

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.

	Emergency Department visit					Preventive medical visit				
	Yes		No			Yes		No		
	N	wt%[1]	N	wt%[1]	*P*-value[2]	N	wt%[1]	N	wt%[1]	*P*-value[3]
ADHD					*<.0001*					*.3106*
Yes	104	22.0	312	11.7		352	13.6	64	11.6	
No	353	78.0	2,196	88.3		2,028	86.4	521	88.4	
Sex					*.0079*					*.7981*
Male	219	44.1	1,342	52.0		1,256	50.9	305	50.2	
Female	238	55.9	1,166	48.0		1,124	49.1	280	49.8	
Race/ethnicity					*.3854*					*.0446*
Non-Hispanic white	273	58.0	1,419	54.2		1,367	55.5	325	51.7	
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					*<.0001*					*.0003*
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					*.0005*					*.0164*
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					*.6141*					*<.0001*
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.

	Emergency Department visit					Preventive medical visit				
	Yes		No			Yes		No		
	N	wt%[1]	N	wt%[1]	*P*-value[2]	N	wt%[1]	N	wt%[1]	*P*-value[3]
Disease/condition excluding ADHD					*<.0001*					*.0293*
0	280	60.0	1,922	77.9		1,746	74.2	456	79.5	
1 or more	177	40.0	586	22.1		634	25.8	120	20.5	
Preventive Medical visit within the previous year					*.0790*					
Yes	380	84.6	2,000	80.4		not applicable				
No	77	15.4	508	19.6		not applicable				
Dental visit within the previous year					*.0420*					*<.0001*
Yes	386	85.6	2,253	89.5		2,182	92.0	457	75.9	
Greater than 1 year/never	71	14.4	255	10.5		198	7.5	128	21.8	
Emergency Department visits within the previous year										*.0790*
Yes	not applicable					380	15.5	77	12.1	
No	not applicable					2,000	84.5	508	87.9	

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.

the adjusted OR was 1.93 (95%CI: 1.35, 2.74; $p = 0.0003$) (Table 3).

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 information 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; $p<.0001$]). There were 13.2% of the children in the sample who had ADHD. The plurality of the children with ADHD was male (70.9%). 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 did not have ADHD.

Consideration of the other factors included in the study, although not the focus of this study, provides insight into utilization patterns. Females were more likely to utilize emergency department services than males; children with 1 or more diseases (excluding ADHD) were more likely to 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				
Yes	*2.08 [1.55, 2.78]*	*<.0001*	*1.93 [1.35, 2.74]*	*0.0003*
No	reference group		reference group	
Sex				
Male			*0.59 [0.46, 0.75]*	*<.0001*
Female			reference group	
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			reference group	
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			reference group	
Family federal ratio of income to poverty				
Less than 2.0			*2.13 [1.60, 2.85]*	*<.0001*
2.0 and above			reference	
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)			reference group	
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

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 identifying 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 representative, 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, children with ADHD were more likely to have emergency department utilization than children who did not have 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. 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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