J Autism Dev Disord (2015) 45:2382–2391
DOI 10.1007/s10803-015-2405-x

ORIGINAL PAPER

# Age Differences in Emergency Department Visits and Inpatient Hospitalizations in Preadolescent and Adolescent Youth with Autism Spectrum Disorders

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Published online: 5 March 2015


**Abstract** This paper evaluated age differences in emergency department care and inpatient hospitalizations in 252 preadolescent and adolescent youth with autism spectrum disorders (ASDs; ages 9–18). Records from youth with ASDs were linked to acute care utilization records and were compared to a demographically similar comparison group of youth without ASDs ($N = 1260$). A particular focus was placed on utilization for psychiatric concerns and injuries or accidents. Results suggested that psychiatric care was more likely for youth with ASDs in both the preadolescent and adolescent cohorts versus comparison youth, with no significant differences between age cohorts. In contrast, results for the accident and injury categories suggested age-specific findings. Results suggest opportunities for prevention efforts for youth with ASDs.

**Keywords** Autism spectrum disorders · Youth · Age · Acute care utilization

## Introduction

Autism spectrum disorders (ASDs) represent a continuum of impairments characterized by social communication deficits and restrictive and repetitive interests (American Psychiatric Association 2013). In addition to these core psychiatric features, youth with ASDs may have co-occurring medical and psychiatric conditions (e.g., epilepsy, affective disorders) that place them at greater risk for problems that require medical attention (Croen et al. 2006). An increasing body of literature has been devoted to understanding the circumstances under which youth with ASDs present to medical professionals, in order to provide optimal care for youth and their families (Cidav et al. 2013; Croen et al. 2006; Liptak et al. 2006; Mandell 2008; Mandell et al. 2006; McDermott et al. 2008). This work has also presented an opportunity to better understand how to prevent certain kinds of usage, such as emergency department (ED) care or inpatient hospitalization, through education and resources (Cidav et al. 2013; Mandell 2008; Nayfack et al. 2014). The current paper adds to this literature by focusing on age differences in ED care and inpatient hospitalizations in preadolescent and adolescent youth with ASDs. The overall goal of this investigation was to provide information for service providers and families that can be used to anticipate the services and resources that families will require during these developmental periods, in order to prevent or mitigate the circumstances that lead to ED care and inpatient hospitalization.

Several studies have documented increased acute care utilization for youth with ASDs compared to youth without ASDs, including higher rates of ED visits and both psychiatric and general inpatient hospitalizations (Croen et al. 2006; Kalb et al. 2012; Lokhandwala et al. 2012; Mandell 2008; Mandell et al. 2006; McDermott et al. 2008; Nayfack et al. 2014). Mortality risk is also higher for youth with ASDs (Shavelle et al. 2001). Higher rates of utilization in youth with ASDs have been linked to certain forms of injuries and accidents, including poisoning, head/neck injuries, and self-injurious behaviors (Croen et al. 2006; McDermott et al. 2008). The higher injury risk in youth with ASDs may be explained by a combination of factors,

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including impulsivity, difficulty understanding issues of safety, and high rates of elopement in youth with ASDs (Anderson et al. 2012; McDermott et al. 2008). Inpatient psychiatric hospitalizations and emergency psychiatric care have been linked to the presence of co-occurring psychiatric concerns in youth with ASDs, including aggression, mood disorders, and psychosis (Croen et al. 2006; Kalb et al. 2012; Mandell 2008).

A few studies have also begun to document age differences in ED usage and hospitalizations for youth with ASDs, with the most consistent findings emerging for psychiatric care. Previous studies have specifically noted that inpatient psychiatric care is highest in adolescence and appears to increase with age (Cidav et al. 2013; Croen et al. 2006; Nayfack et al. 2014). In the general population, adolescents (along with very young children) also tend to have the highest rates of accidents and injuries (Dowd et al. 2002); however, this age effect has not been examined specifically in youth with ASDs. One prior study of mortality risk suggested that adolescents with ASDs may actually be less likely to have utilization for accidents and injuries due to fewer opportunities for risky behavior (Shavelle et al. 2001). Apart from these findings, there are few studies that have examined age differences in acute care utilization for youth with ASDs, particularly in terms of understanding reasons for utilization that can be used to inform service providers and families of youth with ASDs.

The present study aims were to: (a) identify specific age differences for ED care and inpatient hospitalizations in preadolescent and adolescent youth with ASDs, including reasons for utilization, and (b) compare utilization in youth with ASDs to a demographically similar comparison group. The latter aim was intended to demonstrate whether age differences were specific to youth with ASDs or instead represented broader age differences in the general population. We focused on two primary areas, psychiatric concerns and injury/accident risk, as these forms of utilization are more likely to be prevented or mitigated compared to usage for other medical reasons. We also focused on preadolescent and adolescent youth due to increased psychiatric care observed in adolescents with ASDs as well as the increased risk of accidents and injuries observed for adolescents in the general population (Croen et al. 2006; Dowd et al. 2002). We were particularly interested in understanding utilization in the period just prior to adolescence up to age 18. Consistent with prior research, we hypothesized that adolescents with ASDs would be more likely to have inpatient psychiatric hospitalizations and health care utilization for psychiatric concerns compared to preadolescent youth with ASDs. We made no specific hypotheses for injuries and accidents due to the absence of prior research examining age differences in this area for youth with ASDs.

## Methods

### Overview

The present study used a data linkage approach to link epidemiological surveillance data from a sample of youth with ASDs to ED and inpatient hospitalization records in the state of South Carolina. As described below, youth with ASDs were identified using existing data from the South Carolina Autism and Developmental Disabilities Monitoring (SC ADDM) Network. SC ADDM is part of the Centers for Disease Control and Prevention's Autism and Developmental Disabilities Monitoring (ADDM) Network. SC ADDM uses an active population-based surveillance approach to identify the prevalence of ASDs among 8 year-old youth in multiple communities in the United States. Data from youth meeting surveillance criteria for ASD according to SC ADDM procedures were linked to ED and inpatient hospitalization records provided by the South Carolina Office of Research and Statistics (SC ORS). SC ORS also provided a master database of inpatient and ED visits for same-aged youth, regardless of diagnosis, from which we selected a demographically similar comparison group.

### Case Ascertainment

The methodology of SC ADDM has been described in detail in a previous publication (Nicholas et al. 2008) and is briefly described here. Youth were identified in SC ADDM through screening and abstraction of medical and education records of youth with a range of behaviors and classifications associated with ASD. Surveillance data were obtained from area public schools, the South Carolina Department of Disabilities and Special Needs boards, the University of South Carolina, and the Medical University of South Carolina. Case status was determined through systematic review of abstracted records by a trained clinician using an objective coding scheme based on the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition Text Revision* (*DSM-IV-TR*®) criteria for autistic disorder, Asperger's disorder, or pervasive developmental disorder, not otherwise specified (American Psychiatric Association 2000). This approach allowed for consistent identification of youth who met ASD criteria, even in the absence of a formally documented diagnosis in health and education records. Records on youth in SC ADDM were available for study years 2000 through 2008 (birth years 1992, 1994, 1996, 1998, and 2000).

### Data Linkage

The SC ORS Health and Demographics Section, a component of the South Carolina Budget and Comparison

Board, is responsible for overseeing demographic, health, and census information in the state. This information includes uniformed billing data on all inpatient discharges and ED visits. A data request was made to the SC ORS Data Oversight Council for cases in the SC ADDM data set to be linked to ED and inpatient hospitalization records. Information was requested on basic demographics and diagnostic codes, including International Classification of Diseases, Ninth Revision (ICD-9) diagnoses (primary and secondary) and E-codes. The application was reviewed to ensure appropriate patient confidentiality procedures. Once the linkage was completed, SC ORS provided a de-identified data set.

For each youth, we chose to use two consecutive years of utilization data (January 1, 2009–December 31, 2010). This approach allowed for utilization data for youth ages 9–18 based on study years 2000–2008. Youth were divided into two broad age cohorts: a preadolescent cohort (utilization during ages 9–12) and an adolescent cohort (utilization during ages 13–18).

## Comparison Group

A comparison group of demographically similar youth was selected from the master ED and inpatient database at a 5:1 ratio of comparison youth to youth with ASD. Youth with an ICD-9 code for ASDs or ID who had not been identified through SC ADDM were removed from the master database prior to selecting cases in the comparison group. Comparison youth were selected based on age, sex, race/ethnicity, and rural/urban status. Race/ethnicity and urban/rural status were used as proxies for socioeconomic status, which is considered to be an important predictor of injuries and accidents (Dowd et al. 2002; Dowswell et al. 1996; Laflamme and Diderichsen 2000). For race/ethnicity, youth in the comparison group were selected based on three categories: White American, African American, and Other. The "Other" category represented a small number of youth who identified as Hispanic/Latino, Native American, or Pacific Islander. Due to low frequencies of these youth, we were not able to select youth with these specific race/ethnicity categories at a 5:1 ratio; thus, these groups were combined within the "Other" category. We chose not to use insurance status as a proxy for income in our selection criteria, as youth with ASDs in South Carolina may qualify for Medicaid based on their diagnosis rather than income.

## Variables

### *Broad Categories of Utilization and Psychiatric Concerns*

Preadolescent and adolescent youth were compared in terms of overall ED visits and inpatient hospitalizations. For psychiatric care, we evaluated age differences using multiple variables. For inpatient visits, we separated psychiatric versus non-psychiatric visits based on the youth's primary diagnosis upon admission. If the youth's primary diagnosis fell within the ICD-9 codes for mental disorders (i.e., codes 290–319), the visit was classified as psychiatric. We also evaluated psychiatric admissions to a designated psychiatric unit. Next, we evaluated a combined ED and inpatient variable that included any visit with a primary ICD-9 mental disorder code. We conducted this analysis first using all of the codes for mental disorders and then again removing the codes for ASD and intellectual disability (ID). The latter analysis was done to determine whether the visits were predominantly classified under ASD/ID or under a separate comorbid psychiatric diagnosis. Information on psychiatric diagnoses based on age group and ASD/ID versus the general population was also examined and is provided descriptively in the text. To simplify this information, oppositional defiant disorder and conduct disorders were listed together. Similarly, for psychosis, any mental health code with a psychosis specifier was grouped into this category (e.g., depressive disorder with psychosis, schizoaffective disorder). Finally, the adjustment and acute stress reaction diagnoses were listed together.

### *Injury and Accident Categories*

All primary and secondary ICD-9 codes were used for the injury/accident classification. ICD-9 has two areas in which injuries and accidents are classified. The first is a general ICD-9 code given for injuries and poisoning (codes 800–999). The second is an E-code used to further specify the cause of injury/accident (codes E000–E999). Youth were compared using the broad injury code classification and then again for specific causes of injury/accident. For specific injury/accident categories, the E-codes were grouped together based on their broad classifications. For example, the codes for different kinds of motor vehicle accidents were grouped together. Some of the low-frequency categories were also combined. Specifically, the poisoning and ingesting or inserting foreign objects categories were combined and the categories representing wounds (i.e., cutting, piercing, and burns) were combined.

This process resulted in a broad category for any injury, as well as nine sub-categories based on the E-codes, noted here in order of frequency for youth with ASDs: (1) other accidents; (2) falls; (3) vehicle/bicycle accidents; (4) struck by, against, or between objects; (5) wounds (cutting, piercing, or burns); (6) poisoning, ingesting, or inserting foreign objects; (7) injuries from animals; (8) homicidal injury; and (9) self-inflicted injury. "Other accidents" included all injuries and accidents in which "other" was

noted, but no additional information was provided to determine the cause. "Homicidal injury" represented any form of assault, including child maltreatment or assault by another child. "Self-inflicted injury" included both self-injurious behavior and suicide attempts.

### Statistical Analysis

All analyses were conducted using SAS, V9.4 (SAS Institute, Inc.), with alpha set to .05. For all analyses, utilization data was dichotomized into a yes/no format that represented any utilization for a specified category during the 2-year period for each youth. Count data was not used as youth tended to have only one visit for a specific category within the 2-year period (e.g., one visit for a burn injury rather than multiple visits). Two separate analyses were conducted to evaluate age differences in utilization. First, logistic regression was used to determine whether the preadolescent and adolescent age cohorts for youth with ASDs differed in the categories of utilization, controlling for sex and ID. Second, each category of utilization within the age cohorts was compared to the demographically similar comparison group, controlling for sex and ID. Sex was used as a control variable as previous research suggests that boys may be more likely to experience injuries and accidents versus girls in the general population (Alonge and Hyder 2014; Dowd et al. 2002; He et al. 2014). ID was used as a control variable in order to ensure that the results were specific to youth with ASDs, independent of cognitive functioning.

## Results

### Descriptive Information on Study Sample

Descriptive information for youth with ASDs and the comparison group can be found in Table 1. The data linkage resulted in a sample of 252 youth with ASDs who had an ED or inpatient hospitalization encounter during the 2-year period selected, which represents 29 % of all youth identified in SC ADDM for those study years. A demographically similar comparison group was selected from the master ED and inpatient database at a 5:1 ratio, resulting in 1260 youth. For youth with ASDs, boys outnumbered girls at a ratio of 5:1, and approximately half of these youth had a co-occurring diagnosis of ID. Youth were predominantly White and African American, with approximately two-thirds of the sample living in urban areas of South Carolina. As expected, Medicaid insurance was higher for youth with ASDs versus the comparison population. Of note is that the sample size in the preadolescent cohort was larger than the adolescent cohort, despite representing a smaller age range. This discrepancy is the result of increasing prevalence of ASD diagnoses over the study years.

### Age Differences for Youth with Autism Spectrum Disorders

Results comparing preadolescent and adolescent youth with ASDs are provided in Table 2. There were no statistically significant differences between groups for any form of utilization, including general ED visits and inpatient hospitalizations, utilization for psychiatric reasons, or utilization based on injury/accident categories. We did observe a trend for psychiatric utilization (combined ED and inpatient visits), such that adolescent youth were 2.14 times more likely to have utilization with a primary psychiatric diagnosis (including ASD and ID) compared to preadolescent youth. Psychiatric diagnoses between age groups were also similar; however, psychosis and adjustment/acute stress reaction were only present in the adolescent group. Preadolescent youth with ASD received the following diagnoses in order of frequency: oppositional defiant disorder/conduct problems, depressive disorders, attention deficit/hyperactivity disorder (ADHD), unspecified mental disorders, ASD, and tic disorder. Adolescent youth with ASD received the following diagnoses: oppositional defiant disorder/conduct problems, unspecified mental disorders, depressive disorders, ASD, psychosis, ADHD, and adjustment/acute stress reaction.

### Youth with Autism Spectrum Disorders Versus Comparison Youth

#### *Preadolescent Cohort*

Results comparing preadolescent youth with ASDs with comparison youth can be found in Table 3. Preadolescent youth with ASDs were more likely to have utilization for psychiatric concerns versus comparison youth across multiple outcomes, including for any utilization with a primary psychiatric diagnosis, inpatient visits with a psychiatric diagnosis, and inpatient visits on a psychiatric unit. Specifically, youth with ASDs were 5.63 times more likely to have any ED visit or inpatient hospitalization with a primary psychiatric diagnosis ($RR = 5.62$ if ASD and ID diagnoses are excluded). In addition, youth with ASDs were 10.32 times more likely to have an inpatient stay with a primary psychiatric diagnosis and were 9.05 times more likely to have an inpatient admission on a psychiatric unit. Youth with ASDs were also 2.39 times more likely to have a general inpatient hospitalization; however, this effect was largely driven by psychiatric visits as there was not a statistically significant difference for non-psychiatric inpatient

**Table 1** Characteristics of youth with autism spectrum disorders and comparison youth

| | ASD | | | Comparison youth |
|---|---|---|---|---|
| | 9–12 ($n = 145$) | 13–18 ($n = 107$) | Total ($N = 252$) | ($N = 1260$) |
| Sex | | | | |
| Male | 124 (85.52 %) | 86 (80.37 %) | 210 (83.33 %) | 1050 (83.33 %) |
| Female | 21 (14.48 %) | 21 (19.63 %) | 42 (16.67 %) | 210 (16.67 %) |
| Race/ethnicity | | | | |
| White American | 68 (46.90 %) | 60 (56.07 %) | 128 (50.79 %) | 640 (50.79 %) |
| African American | 69 (47.59 %) | 44 (41.14 %) | 113 (44.84 %) | 565 (44.84 %) |
| Other | 8 (5.52 %) | 3 (2.80 %) | 11 (4.37 %) | 55 (4.37 %) |
| Intellectual disability | 79 (54.48 %) | 43 (40.19 %) | 122 (48.41 %) | – |
| Insurance status | | | | |
| Medicaid | 85 (56.62 %) | 57 (53.27 %) | 142 (56.35 %) | 476 (33.78 %) |
| Private insurance | 57 (39.31 %) | 45 (42.06 %) | 102 (55.40 %) | 607 (48.17 %) |
| Uninsured/self-pay | 3 (2.07 %) | 5 (4.67 %) | 8 (3.17 %) | 177 (14.05 %) |
| Urban status | | | | |
| Urban | 107 (73.79 %) | 73 (68.22 %) | 180 (71.43 %) | 900 (71.43 %) |
| Rural | 38 (26.21 %) | 34 (31.78 %) | 72 (28.57 %) | 360 (28.57 %) |

*ASD* autism spectrum disorders

**Table 2** Results for encounter type by age cohort for youth with autism spectrum disorders

| Encounter type | Total ($N = 252$) | Age cohort | | | |
|---|---|---|---|---|---|
| | | 9–12 ($n = 145$) | 13–18 ($n = 107$) | RR (95 % CI) | $p$ value |
| Emergency department visit | 238 (94.44 %) | 137 (94.48 %) | 101 (94.39 %) | 1.03 (0.34, 3.10) | .957 |
| Inpatient visit | 51 (20.24 %) | 24 (16.55 %) | 27 (25.23 %) | 1.62 (0.97, 3.03) | .130 |
| Psychiatric inpatient visit | 16 (6.35 %) | 6 (4.14 %) | 10 (9.35 %) | 1.97 (0.68, 5.72) | .212 |
| Non-psychiatric inpatient visit | 35 (13.89 %) | 18 (12.41 %) | 17 (15.89 %) | 1.39 (0.67, 2.88) | .370 |
| Psychiatric inpatient unit | 14 (5.56 %) | 6 (4.14 %) | 8 (7.48 %) | 1.49 (0.49, 4.55) | .483 |
| Psychiatric visit (ED or inpatient) | 31 (12.30 %) | 12 (8.28 %) | 19 (17.76 %) | 2.14 (0.98, 4.69) | .056 |
| Psychiatric visit (ED or inpatient; non-ASD/ID) | 27 (10.71 %) | 11 (7.59 %) | 16 (14.95 %) | 1.85 (0.81, 4.24) | .145 |
| Injury (general) | 106 (42.06 %) | 58 (40.00 %) | 48 (44.86 %) | 1.23 (0.74, 2.06) | .228 |
| Other accidents | 32 (12.70 %) | 20 (13.79 %) | 12 (11.21 %) | 0.76 (0.35, 1.67) | .495 |
| Falls | 20 (7.94 %) | 11 (7.59 %) | 9 (8.41 %) | 1.26 (0.49, 3.21) | .633 |
| Vehicle/bicycle accidents | 19 (7.54 %) | 11 (7.59 %) | 8 (7.48 %) | 1.19 (0.45, 3.14) | .726 |
| Struck by, against, or between objects | 14 (5.56 %) | 8 (5.52 %) | 6 (5.61 %) | 1.00 (0.30, 2.70) | .843 |
| Wounds (cutting, piercing, or burns) | 9 (3.57 %) | 6 (4.14 %) | 3 (2.80 %) | 0.76 (0.18, 3.16) | .702 |
| Poisoning or ingesting/inserting foreign objects | 6 (2.38 %) | 4 (2.76 %) | 2 (1.87 %) | 0.81 (0.14, 4.65) | .813 |
| Injuries from animals | 6 (2.38 %) | 3 (2.07 %) | 3 (2.80 %) | 1.39 (0.27, 7.17) | .695 |
| Homicidal injury | 6 (2.38 %) | 2 (1.38 %) | 4 (3.74 %) | 2.16 (0.38, 12.32) | .385 |
| Self-inflicted injury | 4 (1.59 %) | 1 (0.69 %) | 3 (2.80 %) | 3.34 (0.33, 33.61) | .307 |

Some models did not meet expected counts and should be interpreted with caution

*ED* emergency department, *ASD* autism spectrum disorders, *ID* intellectual disability

visits. Psychiatric diagnoses between preadolescent youth with ASD (described above) and comparison youth were similar, with the exception of bipolar disorder and anxiety, which were only present in the comparison group. Preadolescent comparison youth received the following diagnoses in order of frequency: oppositional disorder/conduct problems, depressive disorders, bipolar disorder, ADHD, unspecified mental disorders, and anxiety.

For the injury/accident categories, youth with ASDs were 2.05 times more likely to have utilization for accidents of unknown cause. Youth with ASDs were also 7.42

**Table 3** Results for preadolescent youth with autism spectrum disorders versus comparison youth

| Encounter type | Total ($N = 870$) | ASD ($n = 145$) | Comparison youth ($n = 725$) | RR (95 % CI) | $p$ value |
|---|---|---|---|---|---|
| Emergency department visit | 836 (96.09 %) | 137 (94.48 %) | 699 (96.41 %) | 0.45 (0.17, 1.22) | .119 |
| Inpatient visit | 91 (10.46 %) | 24 (16.55 %) | 67 (9.24 %) | 2.39 (1.24, 4.61) | .009 |
| Psychiatric inpatient visit | 13 (1.49 %) | 6 (4.14 %) | 7 (0.97 %) | 10.32 (3.35, 31.78) | <.001 |
| Non-psychiatric inpatient visit | 78 (8.97 %) | 18 (12.41 %) | 60 (8.28 %) | 1.30 (0.57, 2.98) | .533 |
| Psychiatric inpatient unit | 14 (1.61 %) | 6 (4.14 %) | 8 (1.10 %) | 9.05 (3.03, 27.02) | .001 |
| Psychiatric visit (ED or inpatient) | 29 (3.33 %) | 12 (8.28 %) | 17 (2.34 %) | 5.63 (2.33, 13.63) | .001 |
| Psychiatric visit (ED or inpatient; non-ASD/ID) | 28 (3.22 %) | 11 (7.59 %) | 17 (2.34 %) | 5.62 (2.32, 13.61) | <.001 |
| Injury (general) | 404 (46.44 %) | 58 (40.00 %) | 346 (47.72 %) | 0.73 (0.43, 1.22) | .226 |
| Other accidents | 85 (9.77 %) | 20 (13.79 %) | 65 (8.97 %) | 2.05 (1.02, 4.11) | .044 |
| Falls | 115 (13.22 %) | 11 (7.59 %) | 104 (14.34 %) | 0.19 (0.05, 0.77) | .020 |
| Vehicle/bicycle accidents | 74 (8.51 %) | 11 (7.59 %) | 63 (8.69 %) | 0.51 (0.15, 1.66) | .260 |
| Struck by, against, or between objects | 103 (11.84 %) | 8 (5.52 %) | 95 (13.10 %) | 0.68 (0.29, 1.62) | .381 |
| Wounds (cutting, piercing, or burns) | 34 (3.91 %) | 6 (4.14 %) | 28 (3.86 %) | 0.39 (0.05, 2.89) | .355 |
| Poisoning or ingesting/inserting foreign objects | 6 (2.38 %) | 4 (2.76 %) | 2 (0.28 %) | – | – |
| Injuries from animals | 28 (3.22 %) | 3 (2.07 %) | 25 (3.45 %) | 0.44 (0.06, 3.30) | .422 |
| Homicidal injury | 5 (0.57 %) | 2 (1.38 %) | 3 (0.41 %) | 7.42 (1.21, 45.46) | .030 |
| Self-inflicted injury | 1 (0.11 %) | 1 (0.69 %) | 0 (0.00 %) | – | – |

Some models did not meet expected counts and should be interpreted with caution

*ED* emergency department, *ASD* autism spectrum disorders, *ID* intellectual disability

times more likely to have utilization for homicidal injury versus comparison youth; however, this result is based on low frequencies and should be interpreted with caution given the large confidence interval around this estimate. Youth with ASDs were also *less likely* to have utilization for falls versus comparison youth. Of note is that the logistic regression models could not be analyzed for the categories of poisoning or ingesting/inserting foreign objects or self-inflicted injury due to very low frequencies for these forms of utilization.

### *Adolescent Cohort*

Results comparing adolescent youth with comparison youth can be found in Table 4. For the adolescent cohort, the results were similar to the preadolescent group in terms of utilization for psychiatric concerns versus comparison youth. Specifically, youth with ASDs were 5.72 times more likely to have an ED visit or inpatient hospitalization with a primary psychiatric diagnosis ($RR = 5.20$ if ASD and ID diagnoses are excluded). In addition, youth with ASDs were also 9.51 times more likely to have an inpatient stay with a primary psychiatric diagnosis and were 11.15 times more likely to have an inpatient admission on a psychiatric unit. Youth with ASDs were also 3.44 times more likely to have a general inpatient hospitalization; however, similar to preadolescent youth, this effect was largely driven by psychiatric visits and there was not a statistically significant difference for non-psychiatric inpatient visits. Psychiatric diagnoses were similar between adolescent youth with ASDs and comparison youth, with the exception of bipolar disorder and anxiety, which were only present in the comparison group. In addition, drug use concerns were only present in the comparison group. Adolescent comparison youth received the following diagnoses in order of frequency: oppositional defiant disorder/conduct problems, depressive disorders, anxiety, drug use concerns, psychosis, adjustment/acute stress reaction, unspecified mental disorders, and bipolar disorder.

For the injury categories, youth with ASDs were 9.59 times more likely to have utilization for self-inflicted injury versus comparison youth. Similar to the finding noted for homicidal injury in the preadolescent cohort, this result should be interpreted with caution due to the low frequency of self-inflicted injury in the sample and the large confidence interval around this estimate. Youth with ASDs were also *less likely* to have utilization for injuries based on the general injury category as well as for vehicle/bicycle accidents.

**Table 4** Results for adolescent youth with autism spectrum disorders versus comparison youth

| Encounter type | Total ($N = 642$) | ASD ($n = 107$) | Comparison youth ($n = 535$) | RR (95 % CI) | $p$ value |
|---|---|---|---|---|---|
| Emergency department visit | 618 (96.26 %) | 101 (94.39 %) | 517 (96.64 %) | 0.71 (0.20, 2.47) | .588 |
| Inpatient visit | 79 (12.31 %) | 27 (25.23 %) | 52 (9.72 %) | 3.44 (1.83, 6.46) | .001 |
| Psychiatric inpatient visit | 18 (2.80 %) | 10 (9.35 %) | 8 (1.50 %) | 9.51 (3.53, 26.39) | <.001 |
| Non-psychiatric inpatient visit | 61 (9.50 %) | 17 (15.89 %) | 44 (8.22 %) | 1.85 (0.85, 4.01) | .119 |
| Psychiatric inpatient unit | 14 (5.56 %) | 8 (7.48 %) | 6 (1.12 %) | 11.15 (3.59, 34.59) | <.001 |
| Psychiatric visit (ED or inpatient) | 44 (12.30 %) | 19 (17.76 %) | 25 (4.67 %) | 5.72 (2.79, 11.70) | <.001 |
| Psychiatric visit (ED or inpatient; non-ASD/ID) | 41 (10.71 %) | 16 (14.95 %) | 25 (4.67 %) | 5.20 (2.51, 10.79) | <.001 |
| Injury (general) | 353 (54.98 %) | 48 (44.86 %) | 305 (57.01 %) | 0.58 (0.34, 0.98) | .041 |
| Other accidents | 80 (12.46 %) | 12 (11.21 %) | 68 (12.71 %) | 0.84 (0.37, 1.92) | .679 |
| Falls | 64 (9.97 %) | 9 (8.41 %) | 55 (10.28 %) | 0.74 (0.30, 1.93) | .540 |
| Vehicle/bicycle accidents | 86 (13.40 %) | 8 (7.48 %) | 78 (14.58 %) | 0.29 (0.09, 0.94) | .039 |
| Struck by, against, or between objects | 88 (13.71 %) | 6 (5.61 %) | 82 (15.33 %) | 0.36 (0.13, 1.03) | .057 |
| Wounds (cutting, piercing, or burns) | 24 (3.74 %) | 3 (2.80 %) | 21 (3.93 %) | 0.80 (0.18, 3.44) | .749 |
| Poisoning or ingesting/inserting foreign objects | 3 (2.38 %) | 2 (1.87 %) | 1 (0.19 %) | 8.56 (0.53, 138.71) | .131 |
| Injuries from animals | 13 (2.02 %) | 3 (2.80 %) | 10 (1.87 %) | 1.71 (0.37, 7.98) | .497 |
| Homicidal injury | 19 (2.96 %) | 4 (3.74 %) | 15 (2.80 %) | 2.34 (0.75, 7.30) | .144 |
| Self-inflicted injury | 6 (1.59 %) | 3 (2.80 %) | 3 (0.56 %) | 9.59 (1.82, 50.45) | .008 |

Some models did not meet expected counts and should be interpreted with caution

*ED* emergency department, *ASD* autism spectrum disorders, *ID* intellectual disability

## Discussion

The present study examined age differences in ED care and inpatient hospitalizations in youth with ASDs, with the goal of providing specific information about utilization in preadolescent and adolescent youth that can be used to inform service providers and families. The most consistent finding observed was for psychiatric concerns, with both the preadolescent and adolescent cohorts demonstrating a higher likelihood of utilization for psychiatric concerns versus comparison youth. Additional findings were also observed for injury/accident risk for youth with ASDs versus comparison youth, some of which were specific to the preadolescent or adolescent cohorts. These findings as well as limitations and clinical implications of the study are described below.

We did not find support for our primary hypothesis, which assumed that adolescent youth would be more likely to have utilization for psychiatric concerns versus preadolescent youth, though we did observe a trend in this direction for ED and inpatient visits with a primary psychiatric diagnosis. The absence of an age effect stands in contrast to previous studies that have found that utilization for psychiatric concerns is highest in adolescence and increases with age (Cidav et al. 2013; Croen et al. 2006; Nayfack et al. 2014). One explanation for the discrepancy in findings is that prior studies have used large age ranges (i.e., early childhood through adolescence) whereas our study specifically targeted preadolescent and adolescent youth. It is likely that age differences in psychiatric utilization are more pronounced when comparing young children to adolescents. The findings are consistent with a prior study by Cidav et al. (2013), who found that the largest shift in utilization for services that often involve psychiatric concerns (e.g., long-term care, psychiatric medication, day treatment/partial hospitalization) occurred between the ages of 3–6 and 7–11. This finding along with the present study suggests that preadolescence may be an important time period for screening of psychiatric symptoms and that youth across a wide age range would benefit from services targeting psychiatric symptoms. The present results along with those from previous studies also suggest that children may present with a wide range of psychiatric concerns, including disruptive behavior concerns, affective disorders, anxiety disorders, psychosis, and self-injurious behavior (Cidav et al. 2013; Croen et al. 2006; Mandell 2008).

In contrast, there were statistically significant results specific to the preadolescent and adolescent cohorts versus comparison youth, which may indicate age-specific effects.

In the preadolescent cohort, utilization for accidents of unknown cause was more likely for youth with ASDs versus comparison youth, though the reason for this finding is unclear as the codes were not specific as to the origin of the accident. It is possible that youth with ASDs are more likely to receive this ambiguous diagnosis for injuries or accidents due to the complexity of symptoms in ASDs, which may result in difficulty identifying a specific cause of injury; however, additional research would be needed to support this hypothesis.

We also found that utilization for homicidal injury, which includes child maltreatment or assault by other children, was more likely in youth with ASDs versus comparison youth; however, this result was based on low frequencies and further replication is needed. As noted by previous authors, youth with ASDs and other forms of disability may be at increased risk for child maltreatment and peer victimization (Sullivan and Knutson 2000; Van Cleave and Davis 2006). This preliminary finding may suggest that preadolescent youth with ASDs may be more vulnerable to these forms of abuse when compared to their same-aged peers. Only one prior study specifically examined utilization for homicidal injury in ASDs and did not find a greater risk for this outcome for children with ASDs versus comparison youth; however, this prior study also controlled for age (McDermott et al. 2008). Future research would be beneficial in this area, particularly in terms of understanding when youth with ASDs may be most vulnerable to child maltreatment or other forms of abuse.

In addition to the above findings, we also found that preadolescent youth with ASDs were *less likely* to have utilization for falls versus comparison youth. Previous researchers have noted that youth with ASDs may be less active and less likely to participate in organized sports than their peers, which may explain this finding (Mangerud et al. 2014; McDermott et al. 2008). Youth with ASDs may be less likely to participate in sports due to social deficits or co-occurring motor difficulties (Jansiewicz et al. 2006). One prior study also suggested greater injury risk for youth with ASDs who are involved in sports (Ramirez et al. 2009); thus, it is possible that parents are aware of the risk of injury and that they therefore restrict participation in sports or other activities that might precipitate a fall.

For the adolescent cohort, utilization for self-inflicted injury was more likely for youth with ASDs versus comparison youth. Similar to the result noted above for homicidal injury, this result was based on low frequencies and further replication of this finding would be beneficial. It is also important to note that we were unable to examine self-injury in the preadolescent cohort because there were no preadolescent youth in the comparison sample who fell in this category. Self-injurious behaviors are considered to be a common feature of ASDs; however, there is not consensus as to whether younger versus older children with ASDs are at greater risk for these behaviors and studies have varied widely in terms of the age ranges evaluated (Duerden et al. 2012). Of note is that the current study focused on ED care and inpatient hospitalizations for self-injury rather than measuring the actual frequency of these behaviors. It is possible that adolescent youth differ in terms of the *severity* of self-injury, with adolescents being more likely to engage in behaviors that could be life-threatening and that would require urgent medical attention. Future research examining both quantitative and qualitative aspects of self-injury across development may help to clarify this question.

Utilization was also *less likely* for the general injury category and for vehicle/bicycle accidents in the adolescent cohort. The finding for the general injury category is consistent with a previous study by Shavelle et al. (2001), who suspected that differences in mortality risk between youth with ASDs and the general population were the result of fewer risky behaviors in adolescents with ASDs. As noted previously, youth with ASDs may also be less likely to be active or participate in sports, which may place them at lower risk for injury. The lower risk of utilization for vehicle/bicycle accidents may be explained by fewer youth with ASDs driving vehicles in adolescence compared to their same-aged peers. Similar to sports participation, it is possible that cognitive, motor, social, or adaptive skills deficits interfere with the development of driving ability or that youth are less likely to be active community participants and therefore spend less time in vehicles versus their peers (Jansiewicz et al. 2006; Shattuck et al. 2011). Alternatively, although no previous studies have examined the prevalence of driving in adolescents with ASD versus the general population, there have been several publications focused on increased risk of driving accidents in adolescents with ASDs and the need for specific educational programming targeting driving skills (Classen and Monahan 2013; Classen et al. 2013; Huang et al. 2012). It is possible that parents understand these risks and intentionally limit driving or provide additional driving training, resulting in fewer motor vehicle accidents in adolescence.

The present study should be viewed in the context of limitations. First, although we had a moderate sample size of youth with ASDs, the frequencies of certain types of utilization were quite low, which likely reduced our power to detect significant effects and which limited our findings for certain forms of utilization. In addition, we conducted many analyses in our efforts to examine multiple categories of risk, which increases the likelihood of Type I error. The use of an administrative data set also did not allow us to capture family and provider perspectives of the ED and inpatient hospitalization. This type of information would be particularly helpful in understanding family preferences for

treatment of urgent medical and psychiatric concerns and the types of information and resources that would be helpful for families and providers. This information may also help to elucidate whether the higher rate of psychiatric utilization in children with ASD is the result of comorbid psychiatric conditions or a combination of ASD symptomatology and comorbid concerns. Finally, we used a cross-sectional, cohort design that was focused on preadolescent and adolescent youth. As noted in previous publications, cohort effects (rather than developmental effects) may explain differences in utilization by age (Mandell 2008; Nayfack et al. 2014). For example, in the present study, it is possible that age differences between the cohorts were attenuated by increased service utilization over time. Our work was also focused on preadolescent and adolescent youth; however, additional research with younger children would be beneficial in terms of understanding risks for acute care utilization across childhood.

Strengths of the current study include the use of SC ADDM to identify cases of ASD as well as the diversity of the sample. The methods of the present and previous studies have their strengths and limitations in terms of case identification and data sources. A particular strength of the current study is that it provides information on service utilization using an alternative case identification approach to ICD-9. The methods of ADDM have been recently critiqued for potentially being overly liberal (Mandell and Lecavalier 2014), and it is important to acknowledge that there was not an independent verification of case status by an outside clinician. However, it is likely that our sample captured many true cases of ASD that would have been missed using ICD-9. For example, only 34 % of youth with ASD in this study had a matching ICD-9 code for ASD listed as an admission diagnosis. In addition, we were able to capture youth with a range of insurance providers by relying on data collected through SC ORS. This combination of factors resulted in a fairly diverse sample in terms of race/ethnicity, urban/rural status, and range of intellectual functioning.

The present study poses important clinical implications for service providers for youth with ASDs and their families. A particularly notable finding was the greater likelihood of utilization for ED care and inpatient hospitalizations for psychiatric concerns in both the preadolescent and adolescent cohorts. This finding contributes to the growing literature on the need for improved prevention efforts in youth with ASDs and suggests that youth across a wide age range may benefit from screening, education, and family supports that address psychiatric concerns (Croen et al. 2006; Kalb et al. 2012; Mandell et al. 2006; Seltzer et al. 2004). As described in Mandell (2008), the following specific supports may be particularly beneficial: early identification of ASD and co-occurring psychiatric issues, early intervention using evidence-based therapies (e.g., behavioral interventions for aggression), crisis intervention strategies, and respite care for caregivers. It is also important to acknowledge that, in the absence of these supports or when these supports are not effective, emergency care is a critical option for families in crisis. In addition, the present study found specific effects within the age cohorts that deserve greater attention. In particular, our study found that preadolescent youth may be at greater risk for homicidal injury compared to their same-aged peers without ASDs. Also, our study found that adolescents with ASDs may be at greater risk for self-injury requiring ED care or inpatient hospitalization. These preliminary findings suggest that additional information and resources on these topic areas and specific intervention planning (e.g., safety planning to reduce self-injury) may be beneficial for families of youth with ASDs.

Finally, it is important to note that youth with ASDs were also *less likely* to experience certain forms of injuries and accidents. The findings for lower risk of falls in the preadolescent cohort and general injuries and motor vehicle accidents in the adolescent cohort, in particular, may reflect general lack of sports/physical activity and community engagement for youth with ASD or may suggest that parents and other professionals working with youth are already acting to prevent certain injuries and accidents. Future work may focus not only on risk factors for ED care and inpatient hospitalizations, but also on protective factors and existing prevention efforts that reduce the circumstances that lead to these forms of utilization. In particular, identifying interventions that retain youth engagement in activities while also reducing the risk for injuries and accidents would be beneficial.

**Acknowledgments** This work was supported by a Grant from the Centers for Disease Control and Prevention (CDC-RFA-DD10-1002).

**Conflict of interest** The authors declare that they have no conflict of interest.

## References

Alonge, O., & Hyder, A. A. (2014). Reducing the global burden of childhood unintentional injuries. *Archives of Disease in Childhood, 99*(1), 62–69.

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders: DSM-IV-TR® American Psychiatric Publication.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders: DSM-5® American Psychiatric Publication.

Anderson, C., Law, J. K., Daniels, A., Rice, C., Mandell, D. S., Hagopian, L., et al. (2012). Occurrence and family impact of elopement in children with autism spectrum disorders. *Pediatrics, 130*(5), 870–877.

Cidav, Z., Lawer, L., Marcus, S. C., & Mandell, D. S. (2013). Age-related variation in health service use and associated expenditures among children with autism. *Journal of Autism and Developmental Disorders, 43*(4), 924–931.

Classen, S., & Monahan, M. (2013). Evidence-based review on interventions and determinants of driving performance in teens with attention deficit hyperactivity disorder or autism spectrum disorder. *Traffic Injury Prevention, 14*(2), 188–193.

Classen, S., Monahan, M., & Wang, Y. (2013). Driving characteristics of teens with attention deficit hyperactivity and autism spectrum disorder. *The American Journal of Occupational Therapy, 67*(6), 664–673.

Croen, L. A., Najjar, D. V., Ray, G. T., Lotspeich, L., & Bernal, P. (2006). A comparison of health care utilization and costs of children with and without autism spectrum disorders in a large group-model health plan. *Pediatrics, 118*(4), e1203–e1211.

Dowd, M. D., Keenan, H. T., & Bratton, S. L. (2002). Epidemiology and prevention of childhood injuries. *Critical Care Medicine, 30*(11 Suppl), S385–S392.

Dowswell, T., Towner, E. M., Simpson, G., & Jarvis, S. N. (1996). Preventing childhood unintentional injuries—What works? A literature review. *Injury Prevention, 2*(2), 140–149.

Duerden, E. G., Oatley, H. K., Mak-Fan, K. M., McGrath, P. A., Taylor, M. J., Szatmari, P., et al. (2012). Risk factors associated with self-injurious behaviors in children and adolescents with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*(11), 2460–2470.

He, S., Lunnen, J. C., Puvanachandra, P., Amar, S., Zia, N., & Hyder, A. A. (2014). Global childhood unintentional injury study: Multisite surveillance data. *American Journal of Public Health, 104*(3), e79–e84.

Huang, P., Kao, T., Curry, A. E., & Durbin, D. R. (2012). Factors associated with driving in teens with autism spectrum disorders. *Journal of Developmental and Behavioral Pediatrics, 33*(1), 70–74.

Jansiewicz, E. M., Goldberg, M. C., Newschaffer, C. J., Denckla, M. B., Landa, R., & Mostofsky, S. H. (2006). Motor signs distinguish children with high functioning autism and asperger's syndrome from controls. *Journal of Autism and Developmental Disorders, 36*(5), 613–621.

Kalb, L. G., Stuart, E. A., Freedman, B., Zablotsky, B., & Vasa, R. (2012). Psychiatric-related emergency department visits among children with an autism spectrum disorder. *Pediatric Emergency Care, 28*(12), 1269–1276.

Laflamme, L., & Diderichsen, F. (2000). Social differences in traffic injury risks in childhood and youth—A literature review and a research agenda. *Injury Prevention, 6*(4), 293–298.

Liptak, G. S., Stuart, T., & Auinger, P. (2006). Health care utilization and expenditures for children with autism: Data from U.S. National samples. *Journal of Autism and Developmental Disorders, 36*(7), 871–879.

Lokhandwala, T., Khanna, R., & West-Strum, D. (2012). Hospitalization burden among individuals with autism. *Journal of Autism Developmental Disorders, 42*(1), 95–104.

Mandell, D. S. (2008). Psychiatric hospitalization among children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38*(6), 1059–1065.

Mandell, D. S., Cao, J., Ittenbach, R., & Pinto-Martin, J. (2006). Medicaid expenditures for children with autistic spectrum disorders: 1994 to 1999. *Journal of Autism and Developmental Disorders, 36*(4), 475–485.

Mandell, D., & Lecavalier, L. (2014). Should we believe the center for disease control and prevention's autism spectrum disorder prevalence estimates? *Autism, 18*, 482–484.

Mangerud, W. L., Bjerkeset, O., Lydersen, S., & Indredavik, M. S. (2014). Physical activity in adolescents with psychiatric disorders and in the general population. *Child and Adolescent Psychiatry and Mental Health, 8*(1), 2.

McDermott, S., Zhou, L., & Mann, J. (2008). Injury treatment among children with autism or pervasive developmental disorder. *Journal of Autism and Developmental Disorders, 38*(4), 626–633.

Nayfack, A. M., Huffman, L. C., Feldman, H. M., Chan, J., Saynina, O., & Wise, P. H. (2014). Hospitalizations of children with autism increased from 1999 to 2009. *Journal of Autism and Developmental Disorders, 44*(5), 1087–1094.

Nicholas, J. S., Charles, J. M., Carpenter, L. A., King, L. B., Jenner, W., & Spratt, E. G. (2008). Prevalence and characteristics of children with autism-spectrum disorders. *Annals of Epidemiology, 18*(2), 130–136.

Ramirez, M., Yang, J., Bourque, L., Javien, J., Kashani, S., Limbos, M. A., et al. (2009). Sports injuries to high school athletes with disabilities. *Pediatrics, 123*(2), 690–696.

Seltzer, M. M., Shattuck, P., Abbeduto, L., & Greenberg, J. S. (2004). Trajectory of development in adolescents and adults with autism. *Mental Retardation and Developmental Disabilities Research Reviews, 10*(4), 234–247.

Shattuck, P. T., Orsmond, G. I., Wagner, M., & Cooper, B. P. (2011). Participation in social activities among adolescents with an autism spectrum disorder. *PLoS One, 6*(11), e27176.

Shavelle, R. M., Strauss, D. J., & Pickett, J. (2001). Causes of death in autism. *Journal of Autism and Developmental Disorders, 31*(6), 569–576.

Sullivan, P. M., & Knutson, J. F. (2000). Maltreatment and disabilities: A population-based epidemiological study. *Child Abuse and Neglect, 24*(10), 1257–1273.

Van Cleave, J., & Davis, M. M. (2006). Bullying and peer victimization among children with special health care needs. *Pediatrics, 118*(4), e1212–e1219.