Background: Approximately 1 in 4 children hospitalized with injuries from traffic crashes and their parents experience symptoms of acute stress disorder (ASD). These families represent a minority of those exposed to the trauma of a crash. To date, no studies have explored the prevalence of ASD symptoms in the broader population of children and parents exposed to crashes.

Objective: To describe the prevalence of and risk factors for ASD symptoms in children and their driver parents after vehicle crashes.

Design, Setting, and Participants: Cross-sectional study via telephone survey of parent drivers and children (aged 5-15 years), using an exposure-based crash surveillance system. A probability sample of 1091 crashes involving 1483 children weighted to represent 24,376 children in 18,422 crashes was collected.

Main Outcome Measure(s): Parent-reported ASD symptoms and impairment.

Results: Significant ASD symptoms occurred in 1.6% (95% confidence interval, 0.9%-2.3%) of children in crashes and 4.7% (95% confidence interval, 4.0%-5.5%) of parents. In children, ASD symptoms were independently associated with sustaining an injury and with receiving medical care; in parents, symptoms were independently associated with child injury, child receiving medical care, Hispanic ethnicity, lower income (<$40,000), and higher crash severity.

Conclusions: Sustaining injuries and receiving medical treatment were strong predictors for developing ASD symptoms after crashes but ASD symptoms often occurred in the absence of these risk factors. Health care professionals should consider screening for traumatic stress symptoms in children and their parents when children are involved in traffic crashes, particularly if they sustain injuries.

Arch Pediatr Adolesc Med. 2005;159:1074-1079
than objective ratings of injury or illness severity.\textsuperscript{7,8,15} Thus, it is unclear how applicable the available research findings on traumatic stress in children and parents after MVCs are to the broad population of those exposed to crashes.

This study sought to assess ASD symptoms in children and their parents after an MVC using an exposure-based crash surveillance system in a broad population to establish the prevalence of ASD symptoms and to quantify the role of crash and injury-related variables in symptom development.

**METHODS**

**STUDY POPULATION AND DATA COLLECTION**

Data on ASD symptoms were collected from March 1, 2001, to February 28, 2002, in addition to the main data collection for an ongoing, large-scale, child-specific crash surveillance system; insurance claims from State Farm (Bloomington, Ill) functioned as the source of subjects, with telephone survey and on-site crash investigations serving as the primary sources of data. A description of the study methods has been published previously.\textsuperscript{1,16} Qualifying vehicles were State Farm insured, model year 1990 or newer, and in a crash with at least 1 child occupant 15 years of age or younger. Qualifying crashes represented 3 large regions of the United States (East: New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, Washington, DC; Midwest: Ohio, Michigan, Indiana, Illinois; West: California, Nevada, Arizona). After policyholders consented to participate in the study, limited data (contact information, basic information about the child occupants and their medical treatment) were transferred electronically to researchers at The Children’s Hospital of Philadelphia and University of Pennsylvania (both in Philadelphia) consistent with the protocol approved by the institutional review boards of both institutions.

A stratified cluster sample was designed to select vehicles (the unit of sampling) for a 30-minute telephone survey with the adult driver of the vehicle who was the parent of the involved children. Vehicles containing children who received medical treatment following the crash were oversampled so that the majority of injured children would be selected while maintaining the representativeness of the overall population. All child occupants in a sampled vehicle were included in the survey. Drivers of sampled vehicles were contacted by telephone, consented for completion of the telephone survey, and, if a passenger had received medical treatment, screened via an abbreviated survey to verify the presence of at least 1 child occupant with an injury. All vehicles with at least 1 child who screened positive for injury and a 10% random sample of vehicles in which all child occupants who were reported to receive medical treatment but screened negative for injury were selected for a full interview; a 2.5% sample of crashes where no medical treatment was received was also selected. The median length of time between the date of the crash and the completion of the interview was 6 days.

From December 1998 until the time of this study, 367,020 children riding in 246,245 State Farm–insured vehicles newer than model year 1990 were identified by State Farm. Claim representatives correctly identified 95% of eligible vehicles, and 74% of policyholders consented for participation in this study. Of these, 19% were sampled for interview and an estimated 81% of these were successfully interviewed. Comparing the included sample with known population values from State Farm claims, little difference was observed. In both the sample and the population, 40%, 36%, and 24% of the vehicles were located in the East, Midwest, and West regions, respectively; 58% of the sampled vehicles were model year 1996 or newer. In the sample, 53% were passenger cars; 20%, minivans; 18%, sport utility vehicles; 6%, pickup trucks; and 2%, large passenger/cargo vans compared with 55%, 18%, 18%, 7%, and 2% in the population; 32% were nondriveable after the crash, compared with 30% of the population. The mean age of the child occupants in the sample was 6.9 years, compared with 7.3 years in the population.

For claims reported in a 1-year period (between March 1, 2001, and February 28, 2002), parent drivers reported on their own and their child occupants’ ASD symptoms as part of the overall survey. During this 1-year period, the surveillance system sampled 2319 crashes for complete interview. Of these, 1091 met the study inclusion criteria for the traumatic stress additional questions: crashes involving parent drivers of children 5 years and older who were interviewed within 30 days of the crash. Child occupant age was restricted in response to the difficulty in assessing ASD symptoms in children younger than 5 years. The sample was restricted to the 83.3% of interviews that were completed within 30 days of the crash for consistency with the diagnostic criteria for ASD.\textsuperscript{17}

Four questions assessed key symptoms across the 4 symptom categories for ASD.\textsuperscript{17} A fifth question assessed impairment in function resulting from the psychological symptoms. Response options included categorical frequency responses of never, sometimes, or often. The questions were:

1. (Dissociation): Since the accident, did you feel spacey, “in a daze,” or like things around you weren’t quite real?
2. (Reexperiencing): Since the accident, how often have you had unwanted thoughts, memories, dreams, or pictures in your mind about what happened?
3. (Avoidance): Since the accident, how often have you wanted to or tried to avoid things that remind you of the accident?
4. (Arousal): Since the accident, how often have you felt more restless, on edge, jumpy, or easily startled?
5. (Impairment): Since the accident, how often have your reactions to the accident stopped you from doing things you usually do, such as going to work and getting along with friends or family, or made it harder to do these things even if you managed to do them?

**VARIABLE DEFINITIONS**

Crash severity was determined by driver report of the presence of intrusion into the occupant compartment of the vehicle and whether vehicle damage precluded driving the vehicle from the scene. The validity of survey responses was confirmed previously by comparison with on-site crash investigation reconstructions.\textsuperscript{18} Child occupants’ medical care was categorized as the highest level received (inpatient care, an emergency department visit without admission to the hospital, care in a physician’s office, other care, or no medical care received). Survey questions regarding injuries to children were designed to provide responses that were classified by body region and severity based on the Abbreviated Injury Scale score\textsuperscript{19} and have been previously validated for their ability to distinguish Abbreviated Injury Scale scores of 2 or higher from less severe injuries.\textsuperscript{20,21} In this study, a consequential injury (one likely to require medical attention) was any injury with an Abbreviated Injury Scale score of 2 or higher (concussions and more serious brain injuries, all internal organ injuries, spinal cord injuries, and extremity fractures) or facial lacerations. Minor injuries included all other lacerations, contusions, and abrasions.
Children and parents were classified as having ASD symptoms present when the responses were either “sometimes” or “often” to all of the ASD symptom questions (1-4), which is consistent with the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition diagnostic criteria of “marked” symptoms. Similarly, impairment in function was defined as responses of either “sometimes” or “often” to the impairment question (5).

DATA ANALYSIS

The primary purpose of these analyses was to describe the prevalence of ASD symptoms in children and their driver parents in passenger vehicle crashes. Logistic regression modeling was used to compute the odds ratio (OR) of the presence of ASD symptoms in children and driver parents after adjusting simultaneously for demographic characteristics, crash severity, medical care received, and injury severity.

Because sampling was based on the likelihood of an injury, subjects least likely to be injured were underrepresented in the study sample in a manner potentially associated with the predictors of interest. To account for this potential bias, case weights equal to the inverse of the probability of selection were used to account for the oversampling of crashes in which an injury to a child likely occurred. To adjust inference to account for the disproportional sampling of subjects by medical treatment and clustering of subjects by vehicle, robust $\chi^2$ tests of association and Taylor Series linearization estimates of the logistic regression parameter variances were calculated using SAS-callable SUDAAN Software for the Statistical Analysis of Correlated Data, Version 8.0 (Research Triangle Institute, Research Triangle Park, NC).

RESULTS

This analysis is restricted to the 1091 crashes involving 1483 children aged 5 through 15 years in whom traumatic stress symptoms were assessed, weighted to represent 24 376 children in 18 422 crashes. Study participant characteristics are presented in Table 1. While the study population, insured drivers, varied as expected from the general US population (fewer minorities, higher income, higher education level), the study population nonetheless demonstrates a broad demographic base. Data collection occurred around the terrorist attacks of September 11, 2001, which affected states included in the study population (New York, Pennsylvania, and Washington, DC). Since the prevalence of ASD symptoms did not demonstrate statistically significant differences for crashes occurring before or after these events (children, 1.8% vs 1.5%; parents, 4.4% vs 3.9%), data across the full span of the collection period were analyzed together.

PREVALENCE OF ASD SYMPTOMS

The prevalence of ASD symptoms was 1.6% (95% confidence interval [CI], 0.9%-2.3%) for children and 4.7% (95% CI, 4.0%-5.5%) for parents. Impairment from these symptoms was reported for 81.2% (95% CI, 62.1%-100.0%) of affected children and 75.6% (95% CI, 60.2%-90.8%) of affected parents. Our results suggest that for every 1000 children involved in crashes, 13 children and 35 parent drivers will have functional impairment from ASD symptoms.

The prevalence of ASD symptoms was higher among children who received medical care and their parents (Table 2). For children, prevalence varied across treatment setting: 15.9% for inpatient care, 6.3% for an emergency department visit without inpatient care, 10.4% for care in a physician’s office, and 0.5% for other care as compared with 0.6% for no medical care received. In parents, different variability was observed: 15.9% for inpatient care, 22.6% for an emergency department visit without inpatient care, 7.7% for care in a physician’s office, and 11.6% for other care as compared with 2.2% for no medical care received. Additionally, the prevalence of ASD symptoms was higher among children with any injury and their parents. While injury severity and receiving medical care were important predictors of ASD symptoms, among children with ASD symptoms present, 32.0% of children had not sought any medical care as a result of the crash and 26.3% of symptomatic children did not sustain any injuries.

With respect to crash severity, the prevalence of ASD symptoms was higher in crashes with vehicular intru-
sion or with sufficient damage to preclude driving from the scene for both children and their parents.

No statistically significant differences in the prevalence of ASD symptoms were observed based on the child’s age or sex or for the parent driver’s race/ethnicity or education level. Parents with an annual household income less than $40,000 were more likely to have ASD symptoms present than those with an annual income of $40,000 or greater, but this was not a statistically significant difference for children.

MULTIVARIATE MODELS PREDICTING ASD SYMPTOM PRESENCE

A multivariate model for predicting the risk of developing ASD symptoms in both children and parents is presented in Table 3. For children, injury severity and having received medical care both provide independent contributions to the presence of ASD symptoms. Children with consequential injuries had 6.95 times the odds of experiencing ASD symptoms than children without injuries (95% CI, 0.93-52.14), while children with minor injuries had 2.92 times the odds of experiencing ASD symptoms than children without injuries (95% CI, 0.42-20.54) (omnibus test: $\chi^2=7.1; P = .03$). Similarly, children who received medical care were at greater risk of ASD than children who did not (OR, 4.05 [95% CI, 1.05-15.65]). For parents, the following characteristics were independently related to the presence of ASD symptoms: their child receiving medical care (OR, 3.72 [95% CI, 1.41-9.76]), their child being injured (OR for consequential injury vs uninjured, 4.18 [95% CI, 1.37-12.77]; OR for minor injury vs uninjured, 3.97 [95% CI, 1.44-10.90]), Hispanic ethnicity (OR vs white, 3.80 [95% CI, 1.38-10.44]), having lower household income (OR, 5.68 [95% CI, 2.38-13.56]), and having a nondriveable vehicle after the crash (OR, 3.97 [95% CI, 1.54-10.26]).

**COMMENT**

This study provides initial evidence about the prevalence of acute traumatic stress reactions in children and their parent drivers after traffic crashes from a general population sample. Results suggest that most children and parents demonstrate resilience and minimal acute traumatic stress reactions after being exposed to the trauma of a traffic crash. While prevalence of significant

### Table 2. Prevalence of ASD Symptoms by Demographic Characteristics, Crash Severity, Medical Care Received, and Injury Severity

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Children With ASD Symptoms Present, Weighted % (95% CI)</th>
<th>P Value</th>
<th>Parents With ASD Symptoms Present, Weighted % (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2.0 (1.0-3.7) [57]</td>
<td>.36</td>
<td>4.3 (2.7-6.9) [107]</td>
<td>.60</td>
</tr>
<tr>
<td>Female</td>
<td>1.3 (0.7-2.3) [52]</td>
<td></td>
<td>5.0 (3.4-7.3) [133]</td>
<td></td>
</tr>
<tr>
<td>Child age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-8</td>
<td>0.9 (0.5-1.6) [33]</td>
<td>.18</td>
<td>5.5 (3.7-8.2) [97]</td>
<td>.50</td>
</tr>
<tr>
<td>9-12</td>
<td>1.9 (1.0-3.9) [55]</td>
<td></td>
<td>3.9 (2.5-6.3) [90]</td>
<td></td>
</tr>
<tr>
<td>13-15</td>
<td>2.5 (1.0-6.1) [21]</td>
<td></td>
<td>4.4 (2.3-8.3) [53]</td>
<td></td>
</tr>
<tr>
<td>Driver race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>3.6 (1.2-10.5) [13]</td>
<td>.65</td>
<td>9.9 (4.7-19.9) [27]</td>
<td>.46</td>
</tr>
<tr>
<td>White*</td>
<td>1.4 (0.8-2.5) [61]</td>
<td></td>
<td>4.2 (2.6-6.3) [156]</td>
<td></td>
</tr>
<tr>
<td>African American*</td>
<td></td>
<td></td>
<td>4.3 (2.3-7.8) [42]</td>
<td></td>
</tr>
<tr>
<td>Other*</td>
<td>1.3 (0.4-4.0) [8]</td>
<td></td>
<td>5.5 (1.9-15.0) [13]</td>
<td></td>
</tr>
<tr>
<td>Driver annual household income, $</td>
<td></td>
<td>.91</td>
<td>11.8 (7.7-17.8) [118]</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;40,000</td>
<td>1.6 (1.0-2.6) [55]</td>
<td></td>
<td>2.4 (1.6-3.8) [104]</td>
<td></td>
</tr>
<tr>
<td>≥40,000</td>
<td>1.7 (0.9-3.1) [44]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver education level</td>
<td></td>
<td>.59</td>
<td></td>
<td>.25</td>
</tr>
<tr>
<td>≤High school</td>
<td>1.9 (0.9-3.9) [46]</td>
<td></td>
<td>5.0 (3.1-8.0) [90]</td>
<td></td>
</tr>
<tr>
<td>Bachelor degree/some college</td>
<td></td>
<td></td>
<td>5.2 (3.3-8.0) [128]</td>
<td></td>
</tr>
<tr>
<td>Advanced degree</td>
<td></td>
<td></td>
<td>2.4 (0.8-6.7) [17]</td>
<td></td>
</tr>
<tr>
<td>Crash severity</td>
<td></td>
<td>.01</td>
<td>11.1 (6.8-17.7) [96]</td>
<td>.005</td>
</tr>
<tr>
<td>Intrusion present</td>
<td></td>
<td></td>
<td>4.1 (2.6-6.0) [144]</td>
<td></td>
</tr>
<tr>
<td>Intrusion absent</td>
<td></td>
<td>.008</td>
<td>10.5 (7.4-14.6) [230]</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vehicle nondriveable from scene</td>
<td></td>
<td></td>
<td>1.6 (0.8-3.4) [10]</td>
<td></td>
</tr>
<tr>
<td>Vehicle driveable from scene</td>
<td></td>
<td>.001</td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medical care received by child</td>
<td></td>
<td>&lt;.001</td>
<td>18.2 (13.4-24.2) [209]</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Any medical care</td>
<td>6.8 (4.2-10.8) [99]</td>
<td></td>
<td>2.2 (1.1-4.1) [31]</td>
<td></td>
</tr>
<tr>
<td>No medical care</td>
<td>0.6 (0.2-1.6) [10]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child injury severity</td>
<td></td>
<td>&lt;.001</td>
<td>25.1 (17.0-35.3) [90]</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Any consequential injury</td>
<td></td>
<td></td>
<td>15.7 (11.0-21.9) [124]</td>
<td></td>
</tr>
<tr>
<td>Any minor injury</td>
<td>4.8 (2.7-8.4) [46]</td>
<td></td>
<td>1.8 (0.9-3.4) [26]</td>
<td></td>
</tr>
<tr>
<td>No injury</td>
<td>0.5 (0.2-1.6) [6]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: ASD, acute stress disorder; CI, confidence interval.
*Non-Hispanic.
ADHD symptoms appears low (1.6% and 4.7% for children and parents, respectively), there are approximately 1.5 million children involved in traffic crashes annually. As such, more than 25 000 children annually may demonstrate ASD symptoms in response to traffic crashes and may be at risk for developing later PTSD.8,12,13

Prevalence of ASD symptoms varied by the type of medical care received by children, with the highest prevalence observed for more intensive medical care. Prevalence among the hospitalized children in the current study was somewhat lower than what has been reported in previous research. In the current sample, 15.9% of children who received inpatient hospital care for their injuries and 15.9% of their parents demonstrated significant acute traumatic stress reactions. Previous research observed 28% of traffic-injured children (pedestrians and bicyclists in addition to passengers) who were hospitalized and 23% of their parents developed similar ASD symptoms.11 An-other study observed that 29.6% of children who were hospitalized for an injury (about half of whom sustained traffic-related injuries) developed significant ASD symptoms.23 The difference in prevalence may be explained by methodological differences; the current study used a brief assessment in a population-based sample of motor vehicle occupants with a wide range of injury severity while the previous studies used more in-depth assessment and derived samples from inpatient settings exclusively. Risk factors for the development of ASD symptoms varied somewhat for children and parents. Injury severity and medical care provided significant contributions when controlling for other factors in children. For parents, crash severity, parent race/ethnicity, and household income were predictive in addition to those factors for children. Factors most likely to cause direct life disruption seemed to have the greatest contribution to the development of acute traumatic stress. For children, having an injury, a likely painful experience that requires a period of recuperation, and the associated medical attention was most predictive. For parents, the life disruption associated with a vehicle that is non-drive-able, a child who is injured and requires medical care, and the financial repercussions of an MVC may increase the likelihood of the development of ASD symptoms. While injury severity and receiving medical care were important predictors of ASD symptoms, 1 in 3 symptom-atic children did not seek medical care as a result of the crash and 1 in 4 symptomatic children did not sustain any injuries. As such, if screening is relegated to the acute care setting, many affected families will not be identified. With the high prevalence of MVCs in childhood and associated injury, it may be beneficial for primary care professionals to inquire about traumatic stress reactions in crash-exposed families.

### LIMITATIONS

Our study does not include uninsured drivers, who may be expected to have lower income than insured drivers, as evidenced by the proportion of study households with incomes less than $40 000 per year (28%) vs the 2000 census (47%).24 Given that this level of income was an independent predictor of symptoms for parents, the reported estimates of ASD symptoms may underrepresent postcrash ASD prevalence in the US population. Other limitations include the use of a brief parent-reported assessment of acute traumatic stress reactions without child self-report. Previous research has indicated that discrepancies are common in parental reports of child symptoms.25 Future studies should assess ASD symptoms more comprehensively, investigate the development of other psychological symptoms or disorders (eg, depression, phobias), and involve child self-assessment of symptoms. Information regarding parent injuries and medical care should also be collected.

### CONCLUSIONS

While most demonstrate resilience, a significant minority of both injured and uninjured children and their par-
ents demonstrate impairing acute psychological responses to the trauma of passenger-vehicle crashes. Severity of injury and the experience of receiving medical care are predictive of ASD symptoms in children; these factors, together with vehicular damage, low income, and Hispanic ethnicity, are predictive of ASD symptoms in their parent drivers. Because of the high exposure of children to traffic crashes, health care professionals should consider screening children and their parents for traumatic stress symptoms when exposure has occurred.

Accepted for Publication: May 6, 2005.
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Disclaimer: The results presented in this report are the interpretation solely of the author(s) and are not necessarily the views of State Farm Insurance, Bloomington, Ill.

Acknowledgment: We would like to acknowledge the commitment and financial support of State Farm Mutual Automobile Insurance Company for the creation and ongoing maintenance of the Partners for Child Passenger Safety (PCPS) program, the source of data for this study. We also thank the many State Farm policyholders who consented to participate in PCPS.

REFERENCES


A three-year-old child is a being who gets almost as much fun out of a fifty-six dollar set of swings as it does out of finding a small green worm.
—Bill Baughan