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Association between childhood allergic disease, psychological comorbidity, and injury requiring medical attention

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ABSTRACT

Background: Children with allergic disease have multiple risk factors for accidental injuries.

Objective: To determine the prevalence of injuries requiring medical treatment in US children with allergic disease.

Methods: The authors analyzed data from the 2007 to 2008 National Survey of Children's Health, including a nationally representative sample of 27,556 children 0 to 5 years old.

Results: The prevalence (95% confidence interval [CI]) of at least 1 allergic disease was 29.4% (28.0–30.8); 6.6% (5.8–7.4) were diagnosed with asthma, 15.0% (14.0–16.0) with eczema, 11.6% (10.6–12.6) with hay fever, and 6.1% (5.4–6.9) with food allergy. Children with allergic disorders had higher odds of at least 1 comorbid psychiatric and behavioral disorder (PBD; survey logistic regression; odds ratio 2.93, 95% CI 2.13–4.03), including attention-deficit/hyperactivity disorder (4.75, 2.89–7.80), depression (6.03, 1.29–28.27), anxiety (5.54, 2.70–11.37), conduct/oppositional defiant disorder (2.97, 1.88–4.70), and learning delay (2.49, 1.70–3.66), but not autism/Asperger disorder (1.89, 0.98–3.64). The prevalence of injury in the past year requiring medical attention was 10.5% (95% CI 9.5–11.4). The association between allergic disease and injury requiring medical attention was mediated in part by a PBD (Sobel test 0.0021, 95% CI 0.0014–0.0029, $P < .0001$; bootstrapping approach, indirect effects, odds ratio 1.005, 95% CI 1.003–1.007; Baron–Kenny $\beta(yx,m) = 0.04$, $P < .0001$, $R^2 = 0.002$). However, children with at least 1 allergic disorder (1.74, 1.23–2.46), including eczema (1.59, 1.01–2.50), asthma (1.91, 1.10–3.31), hay fever (2.05, 1.24–3.39), and food allergies (2.00, 1.10–3.67), had higher odds of sustaining injuries even after controlling for comorbid PBDs and medical disorders.

Conclusion: The results suggest that the association between allergic disease and injury is multifactorial, including being secondary to PBD.

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Introduction

Allergic disorders have become a significant global public health burden, and their prevalence has steadily increased over time.^{1–3} These disorders, such as asthma and eczema, are associated with significant morbidity, sleep impairment, and quality-of-life impairment.^{4,5} Often these are treated with prescription and over-the-counter sedating antihistamines. Further, recent studies have found that allergic disorders are associated with increased mental health comorbidity.^{6,7} Impaired sleep,^{8,9} sedating antihistamines,^{10,11} and mental health disorders^{12–19} have been associated with unintentional injury. Therefore, it is logical that patients with allergic disorders are at increased risk for unintentional injury. This is of particular concern in children and young adults because the

leading cause of mortality in those age groups is secondary to accidents or unintentional injury.²⁰

Indeed, recent Australian population-based studies and smaller retrospective studies in the United States have shown that children with asthma and hay fever carry a multifactorial increased risk of accidental injury.^{13,21–24} However, US population-based estimates of the burden of accidental injury in children with asthma are lacking. Further, no studies have examined the burden of accidental injury in eczema and food allergies. Increased prevalences of accidental injury in children with allergic disease may warrant the development of clinical and public health interventions for this potentially high-risk group.

These studies of asthma and accidental injury did not consider psychiatric and behavioral disorders (PBDs) as a risk factor. Considerable research has shown an association between atopic disorders and PBDs in children and adolescents.²⁵ Children with PBDs, including attention-deficit disorder (ADD) or attention-deficit hyperactivity disorder (ADHD), oppositional defiant disorder, depression, and anxiety, have an increased risk of accidental

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injury.^{12–19} It stands to reason that PBDs in children with allergic disease contribute toward an increased risk of accidental injury. The authors hypothesized that children with allergic disease would have an increased risk of injury requiring medical attention and that this association would be accounted for by psychiatric comorbidities. In the present study, data from a US population-based study were analyzed to assess the burden of accidental injury in allergic disease.

Methods

National Survey of Children's Health

The authors used data from the 2007 to 2008 National Survey of Children's Health (NSCH) of 91,642 households, which was designed to estimate the prevalence of various child health issues, including physical, emotional, and behavioral factors. The NSCH was sponsored by the Maternal and Child Health Bureau and the US Department of Health and Human Services. Telephone numbers were chosen at random followed by the identification of households with at least 1 child younger than 18 years and by parental interviews. Subsequently, 1 child was randomly selected for interview. Interviews were conducted in English, Spanish, and 4 Asian languages. Survey results were weighted to represent the population of noninstitutionalized children nationally and in each state. Using data from the US Bureau of the Census, weights were adjusted for age, sex, race/ethnicity, household size, and educational attainment of the most educated household member to provide a dataset that was more representative of each state's population of noninstitutionalized children younger than 18 years. The National Center for Health Statistics of the Center for Diseases Control and Prevention oversaw sampling and telephone interviews. This study was approved by the institutional review board at Northwestern University.

Prevalence of Allergic Disorders

History of allergic disorders was determined by the following questions:

1. During the past 12 months, have you been told by a doctor or other health professional that (child) had asthma?
2. During the past 12 months, have you been told by a doctor or other health professional that (child) had eczema or any kind of skin allergy?
3. During the past 12 months, have you been told by a doctor or other health professional that (child) had hay fever or any kind of respiratory allergy?
4. During the past 12 months, have you been told by a doctor or other health professional that (child) had any kind of food or digestive allergy?

A composite binary variable was created for at least 1 atopic disorder using the responses to these 4 questions.

Because these questions assessed health care provider diagnosis of allergic disorders in the past year, excluded were all patients who responded "no" to the question, "During the past 12 months, did (child) see a doctor, nurse, or other health care professional for any kind of medical care, including sick-child care, well-child checkups, physical examinations, and hospitalizations?"

Prevalence of Mental Health Comorbidities and Injury

The prevalence of health care provider diagnosis of ADD/ADHD, depression, anxiety, oppositional defiant or conduct disorder, autism or Asperger disorder or pervasive developmental disorder or other autism spectrum disorder, or developmental delay that affects a child's ability to learn was determined by survey

responses. Nonresponses or "not known" responses were considered missing data. A composite variable was created for having at least 1 of these PBDs.

History of injury in the past year was determined by the question, "During the past 12 months, has (child) been injured and required medical attention?" Location of the injury was determined by the question, "Did the injury occur at home, at child care, or some other place?"

Data Processing and Statistical Methods

All data processing and statistical analyses were performed in SAS 9.2 (SAS Institute, Cary, North Carolina). Analyses of survey responses were performed using survey procedures that incorporated the complex population-based survey weighting. Bivariate associations were tested by Rao–Scott χ^2 tests. Binary logistic regression models were constructed that examined the effects of having at least 1 allergic disease and/or specific types of allergic disease (predictors) on having at least 1 PBD and/or specific types of PBD (outcomes). Logistic regression models also were constructed to determine the effects of having at least 1 allergic disease and/or specific types of allergic disease and at least 1 PBD and/or specific types of PBD (predictors) on having an injury requiring medical attention and the place where the injury occurred (outcomes). Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated. Multivariate models included some potential confounding variables (age, continuous; sex, binary; race/ethnicity; household income; family structure; and level of parental education, categorical) as identified in bivariate analyses and other nonallergic and non-neurologic medical (diabetes, muscle/joint problems, and recurrent ear infections) and dental disorders. In models of injury requiring medical attention, having at least 1 PBD (binary) was included as a covariate in the models. Adjusted ORs (aORs) and 95% CIs were estimated in multivariate models while simultaneously controlling for the abovementioned covariates. To determine whether the associations among allergic disease, PBD, and injury requiring medical attention occurred in a particular sociodemographic group, 2- and 3-way interactions were tested in regression models for sex, race/ethnicity, and household income and were included in the final models if the *P* value was less than .05 and the effect modification was greater than 10%. To test whether any associations between atopic disease and injuries requiring medical attention was mediated by PBDs, mediation was tested using the Baron–Kenny approach, the Sobel test, and the bootstrap method described by Preacher and Hayes²⁶ (*n* = 5,000 bootstrapping samples). Complete data analysis was performed.

A 2-sided *P* value less than .05 was taken to indicate statistical significance for all estimates. However, the multiple dependent tests performed in this study increased the risk of falsely rejecting the null hypothesis. Therefore, *P* values near .05 should be interpreted with caution.

Results

Determinants of Allergic Disease

In total, 91,642 children and adolescents 0 to 17 years old were represented in the survey, of which 27,556 children (0–5 years old) were included in the analysis. The prevalence of at least 1 allergic disease was 29.4% (95% CI 28.0–30.8), with 6.6% (5.8–7.4) being diagnosed with asthma, 15.0% (14.0–16.0) with eczema, 11.6% (10.6–12.6) with hay fever, and 6.1% (5.4–6.9) with food allergy in the past year.

The prevalence of at least 1 allergic disease was associated with age, race/ethnicity, sex, and family structure but not with household income, level of parental education, health insurance

Table 1Determinants of injury requiring medical attention and of allergic disease in children 0 to 5 years old (n = 27,566)^a

Variable	Injury in past year			≥1 Allergic disease		
	No (n = 23,237)	Yes (n = 2,706)	P value	No (n = 17,948)	Yes (n = 7,846)	P value
Age (y), mean (95% CI)	2.4 (2.4–2.5)	2.9 (2.9–3.0)	<.0001 ^b	2.4 (2.3–2.4)	2.6 (2.5–2.6)	<.0001 ^b
Race/ethnicity, n (%)			.001 ^c			<.0001 ^c
African American	2,109 (91.6)	180 (8.4)		1,339 (59.0)	934 (41.0)	
Hispanic	3,492 (92.2)	338 (7.8)		2,811 (78.4)	994 (21.6)	
White	14,776 (87.8)	1,874 (12.2)		1,100 (70.2)	4,865 (29.8)	
Other/mixed	2,481 (90.9)	274 (9.1)		1,801 (70.7)	933 (29.3)	
Sex, n (%)			.001			.003
Male	11,862 (88.0)	1,530 (12.0)		8,937 (68.6)	4,371 (31.4)	
Female	11,361 (91.1)	1,174 (8.9)		9,001 (72.7)	3,469 (27.3)	
Household income—poverty level, n (%)			.04			.58
0–99	3,222 (91.1)	341 (8.9)		2,498 (72.5)	1,042 (27.5)	
100–199	4,100 (88.1)	463 (9.8)		3,134 (70.2)	1,399 (29.8)	
200–399	7,513 (89.8)	890 (10.2)		5,812 (70.6)	2,542 (29.4)	
≥400	8,402 (87.6)	1,012 (12.4)		6,504 (69.7)	2,863 (30.3)	
Family structure, n (%)			.24			<.0001
2 parents—biological or adopted	18,659 (90.1)	2,157 (9.9)		14,767 (73.1)	5,919 (26.9)	
2 parents—step family	376 (84.1)	51 (15.9)		240 (56.0)	185 (44.0)	
Single mother/no father present	3,172 (88.2)	379 (11.8)		2,204 (61.7)	1,323 (38.3)	
Other family type	907 (90.7)	379 (9.3)		628 (64.5)	374 (35.5)	
Highest level of parental education, n (%)			.02			.84
<High school graduate	681 (92.0)	64 (8.0)		512 (69.4)	230 (30.6)	
High school graduate or GED	1,671 (91.0)	189 (9.0)		1,245 (67.8)	601 (32.2)	
>High school	5,462 (87.1)	686 (12.9)		4,090 (66.8)	2,012 (33.2)	
Health insurance coverage, n (%)			.54			.93
No	1,385 (90.8)	145 (9.1)		1,124 (70.9)	398 (29.1)	
Yes	21,815 (89.4)	2,557 (10.6)		16,789 (70.5)	7,442 (29.5)	
Residence in metropolitan area, n (%)			.78			.56
No	12,884 (89.6)	1,566 (10.4)		9,928 (70.9)	4,427 (29.1)	
Yes	3,320 (89.9)	360 (10.1)		2,476 (69.9)	1,181 (30.1)	
Smoking in home, n (%)			.83			.47
No	4,263 (89.0)	579 (11.0)		3,205 (65.6)	1,596 (34.4)	
Yes	859 (88.5)	121 (11.5)		628 (68.1)	348 (31.9)	

Abbreviations: CI, confidence interval; GED, General Educational Development.

^aParental refusal to answer a particular question or provide the response of “don’t know” occurred for questions pertaining to 1-year history of injury requiring medical attention in 23 (0.1%); 1-year history of eczema in 35 (0.08%), asthma in 43 (0.2%), hay fever in 65 (0.2%), and food allergy in 46 (0.3%); age in 0 (0.0%); race/ethnicity in 455 (1.7%); sex in 19 (0.07%); family structure in 152 (0.6%); highest level of parental education in 198 (2.4%); household income in 0 (0.0%); health insurance coverage in 54 (0.2%); residence in a metropolitan area in 8,359 (20.3%); and smoking in home in 2 (0.002%), respectively.

^bSurvey-weighted *t* test.

^cRao–Scott χ^2 test for categorical variables.

coverage, residence in a metropolitan area, or smoking in the home (Table 1).

Determinants of Injury Requiring Medical Attention

The prevalence of injury in the past year requiring medical attention was 10.5% (9.5–11.4), of which 64.2% (59.5–68.9) occurred in the home, 10.9% (7.8–13.9) in child care, and 27.0% (22.5–31.4) in some other place. Injury in the past year requiring medical attention was significantly associated with age, race/ethnicity, sex, household income, and level of parental education but not with family structure, health insurance coverage, residence in metropolitan area, or smoking in the home (Table 1). These were considered potential confounding variables and included in multivariate analyses.

Association between Allergic Disorders and PBD

Children with allergic disorders had significantly higher odds of having at least 1 caregiver-reported diagnosis of a comorbid PBD by a health care provider compared with those without allergic disorders (logistic regression; OR 2.93, 95% CI 2.13–4.03; Table 2). In particular, eczema (2.15, 1.41–3.26), asthma (4.19, 2.61–6.71), hay fever (4.10, 2.81–5.97), and food allergies (2.33, 1.47–3.70) were associated with at least 1 comorbid PBD. Associations also were seen between allergic disorders and individual PBDs, including ADD/ADHD (4.75, 2.89–7.80), depression (6.03, 1.29–28.27), anxiety (5.54, 2.70–11.37), conduct disorder (2.97, 1.88–4.70), and learning delay (2.49, 1.70–3.66), but not autism (1.89, 0.98–3.64).

These results remained significant in multivariate models that included age, race/ethnicity, sex, household income, family structure, and level of parental education (Table 2).

Eczema was associated with ADD/ADHD, depression, anxiety, conduct disorder, autism, and learning delay (Table 2). Asthma and hay fever were associated with ADD/ADHD, depression, anxiety, conduct disorder, and learning delay but not with autism.

Association between PBD and Injuries Requiring Medical Attention

In multivariate models, children with a PBD had higher odds of injuries compared with those without a PBD (aOR 1.93, 95% CI 1.11–3.35; Table 3), including ADD/ADHD (2.57, 1.43–4.62), conduct disorder (2.06, 1.16–3.64), autism (2.52, 1.26–5.01), and learning delay (1.62, 1.09–2.41), but not depression (2.25, 0.52–9.80) or anxiety (1.62, 0.63–4.18; Table 3).

In particular, at least 1 PBD was associated with injury occurring at home (1.80, 1.22–2.66), including ADD/ADHD (2.66, 1.28–5.54), conduct disorder (2.67, 1.35–5.30), and learning delay (1.98, 1.27–3.09). Similarly, PBDs were associated with injury occurring in other places. There were inverse associations of at least 1 PBD and specific types of PBD with injury occurring at child care (0.35, 0.14–0.88; Table 3).

Association between Allergic Disorders and Injuries Requiring Medical Attention

Children with allergic disorders had higher odds of injuries compared with those without allergic disorders (aOR 1.74, 95% CI

Table 2Association between allergic disorders and psychological comorbidities in children 2 to 5 years old^a

PBD/allergic disease	No			Yes			OR (95% CI)	aOR (95% CI)
	Patients, n	Frequency	% (95% CI)	Patients, n	Frequency	% (95% CI)		
≥1 PBD	25,010			952				
≥1 allergic disease		7,352	28.4 (27.0–29.8)		494	53.8 (46.0–61.5)	2.93 (2.13–4.03)	2.77 (1.69–4.53)
Eczema		3,959	14.5 (13.6–15.5)		231	26.7 (18.7–34.7)	2.15 (1.41–3.26)	3.41 (1.99–5.86)
Asthma		1,335	6.0 (5.3–6.7)		163	21.1 (13.6–28.7)	4.19 (2.61–6.71)	3.18 (1.87–5.43)
Hay fever		2,840	10.7 (9.8–11.7)		253	33.0 (25.0–41.0)	4.10 (2.81–5.97)	3.15 (1.86–5.32)
Food allergies		1,544	5.9 (5.1–6.6)		127	12.7 (7.8–17.6)	2.33 (1.47–3.70)	2.12 (1.12–4.02)
ADD/ADHD	16,386			216				
≥1 allergic disease		5,434	32.7 (30.8–34.5)		132	69.7 (59.4–80.1)	4.75 (2.89–7.80)	4.41 (2.22–8.76)
Eczema		2,693	15.5 (14.1–16.8)		62	28.4 (18.3–38.4)	2.16 (1.31–3.58)	3.85 (1.94–7.640)
Asthma		1,209	8.2 (7.1–9.3)		44	25.5 (15.2–35.7)	3.81 (2.18–6.68)	3.36 (1.64–6.87)
Hay fever		2,452	14.7 (13.2–16.1)		61	37.1 (24.6–49.7)	3.44 (1.99–5.97)	2.76 (1.24–6.16)
Food allergies		999	6.3 (5.2–7.3)		23	13.7 (5.5–21.9)	2.37 (1.16–4.85)	3.44 (1.24–9.55)
Depression	16,570			46				
≥1 allergic disease		5,547	32.9 (31.1–34.7)		29	74.7 (45.6–100.0)	6.03 (1.29–28.27)	5.23 (1.13–24.22)
Eczema		2,744	15.4 (14.2–16.6)		14	56.3 (16.4–96.2)	7.07 (1.40–35.86)	9.92 (2.94–33.43)
Asthma		1,241	8.1 (7.1–9.2)		15	66.1 (32.3–99.9)	21.96 (4.83–99.82)	21.08 (6.32–70.30)
Hay fever		2,504	14.7 (13.4–16.1)		15	54.7 (13.8–95.6)	6.99 (1.34–36.61)	7.55 (2.28–25.00)
Food allergies		1,020	6.4 (5.4–7.4)		5	2.2 (0.0–5.6)	0.33 (0.07–1.58)	0.24 (0.04–1.33)
Anxiety	16,428			188				
≥1 allergic disease		5,458	32.6 (30.8–34.4)		118	72.8 (58.7–87.0)	5.54 (2.70–11.37)	4.92 (2.01–12.05)
Eczema		2,697	15.1 (13.9–16.4)		61	49.3 (29.0–69.5)	5.45 (2.41–12.30)	8.80 (3.76–20.58)
Asthma		1,210	8.0 (7.0–9.1)		46	38.6 (16.4–60.8)	7.21 (2.80–18.57)	4.56 (1.98–10.52)
Hay fever		2,459	14.6 (13.2–15.9)		60	42.7 (21.2–64.1)	4.37 (1.81–10.58)	4.56 (1.80–11.59)
Food allergies		994	6.3 (5.3–7.4)		29	9.1 (2.8–15.3)	1.47 (0.68–3.20)	1.12 (0.32–3.98)
Conduct disorder	16,376			233				
≥1 allergic disease		5,438	32.8 (31.0–34.6)		134	59.2 (48.3–70.1)	2.97 (1.88–4.70)	2.52 (1.34–4.73)
Eczema		2,688	15.5 (14.2–16.8)		67	23.5 (15.2–31.9)	1.68 (1.05–2.70)	2.27 (1.22–4.25)
Asthma		1,214	8.2 (7.1–9.4)		43	25.6 (15.3–35.9)	3.83 (2.19–6.71)	2.30 (1.05–5.07)
Hay fever		2,455	14.7 (13.3–16.1)		60	32.2 (21.3–43.1)	2.76 (1.65–4.61)	2.47 (1.15–5.31)
Food allergies		993	6.3 (5.2–7.3)		28	12.1 (3.8–19.4)	2.06 (1.01–4.19)	1.69 (0.52–5.49)
Autism	16,390			220				
≥1 allergic disease		5,466	33.0 (31.1–34.8)		107	48.1 (31.9–64.4)	1.89 (0.98–3.64)	2.48 (0.87–7.06)
Eczema		2,697	15.4 (14.1–16.7)		60	28.4 (14.3–42.5)	2.17 (1.08–4.37)	7.17 (2.56–20.04)
Asthma		1,230	8.4 (7.3–9.6)		26	9.7 (3.5–16.0)	1.17 (0.57–2.42)	0.69 (0.25–1.90)
Hay fever		2,468	14.9 (13.5–16.3)		48	18.7 (9.2–28.1)	1.31 (0.70–2.47)	0.47 (0.16–1.41)
Food allergies		983	6.25 (5.2–7.3)		41	15.7 (7.5–23.9)	2.80 (1.47–5.32)	2.45 (0.74–8.07)
Learning delay	16,008			588				
≥1 allergic disease		5,273	32.47 (30.6–34.3)		296	54.5 (45.2–63.8)	2.49 (1.70–3.66)	2.46 (1.36–4.45)
Eczema		2,619	15.3 (14.0–16.6)		138	25.7 (16.7–34.7)	1.92 (1.18–3.10)	2.22 (0.99–4.96)
Asthma		1,149	8.1 (7.0–9.3)		105	17.6 (11.5–23.6)	2.41 (1.55–3.75)	2.30 (1.24–4.26)
Hay fever		2,352	14.4 (12.9–15.8)		165	32.5 (23.9–41.2)	2.88 (1.91–4.35)	2.09 (1.18–3.71)
Food allergies		934	6.0 (5.0–7.0)		89	17.6 (9.7–25.6)	3.35 (1.89–5.96)	2.34 (1.12–4.87)

Abbreviations: ADD, attention-deficit disorder; ADHD, attention-deficit hyperactivity disorder; aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio; PBD, psychiatric and behavioral disorder.

^aParental refusal to answer a particular question or provide a response of “don’t know” occurred for questions pertaining to 1-year history of injury requiring medical attention in 23 (0.1%); ADD/ADHD in 20 (0.1%), depression in 52 (0.3%), anxiety in 6 (0.04%), conduct disorder in 13 (0.08%), autism in 12 (0.07%), and developmental delay in 26 (0.2%); 1-year history of eczema in 35 (0.08%), asthma in 43 (0.2%), hay fever in 65 (0.2%), and food allergy in 46 (0.3%); age in 0 (0.0%), race/ethnicity in 455 (1.7%); sex in 19 (0.07%); family structure in 152 (0.6%); highest level of parental education in 198 (2.4%); household income in 0 (0.0%); health insurance coverage in 54 (0.2%); residence in a metropolitan area in 8,359 (20.3%); and smoking in home in 2 (0.002%), respectively. Logistic regression models were constructed with psychological or behavioral disorders (ADD/ADHD, depression, anxiety, conduct disorder, autism, and learning delay) as the dependent variables. The independent variables were the specific etiologies of allergic disease, including 1-year history of eczema, asthma, hay fever, food allergy, and a composite variable for any of these allergic disorders (all binary). ORs and 95% CIs were estimated. Multivariate logistic regression models were constructed that included age, sex, household income, family structure, and highest level of parental education (selected from bivariate models) and comorbid medical (diabetes, muscle/joint problems, and recurrent ear infections) and dental problems.

1.23–2.46; [Table 4](#)). In particular, eczema (1.67, 1.09–2.56), asthma (1.64, 1.01–2.67), hay fever (2.14, 1.32–3.47), and food allergies (2.06, 1.14–3.72) were associated with injury in multivariate models ([Table 4](#)).

There was an association between at least 1 allergic disease and location of injury in the home (1.65, 1.31–2.09), including eczema (1.63, 1.20–2.21), asthma (2.16, 1.39–3.37), and hay fever (1.81, 1.28–2.56), but not food allergies (1.40, 0.95–2.05). There was an inverse association between eczema and injury in other places (0.51, 0.28–0.91) and an association between food allergy and injury in other places (2.48, 1.17–5.24; [Table 4](#)). However, there were no associations seen between allergic disorders and injury occurring in child care.

Children with at least 1 allergic disorder had significantly higher odds of sustaining injuries requiring medical attention even when

history of PBD was included as a covariate in the previously specified multivariate model (1.74, 1.23–2.46; [Table 5](#)). In particular, the associations remained significant for eczema (1.59, 1.01–2.50), asthma (1.91, 1.10–3.31), hay fever (2.05, 1.24–3.39), and food allergies (2.00, 1.10–3.67). No significant interactions were found among allergic disease, PBD, injury requiring medical attention, and sociodemographic factors.

Association of Allergic Disease and Injury Is Partly Mediated by PBD

The authors tested whether the association between allergic disease and injury requiring medical attention was mediated by PBDs using 3 different approaches. All approaches indicated significant mediation (Sobel test 0.0021, 95% CI 0.0014–0.0029, $P < .0001$; bootstrapping approach, indirect effects, OR 1.005, 95%

Table 3Association between PBD and injuries requiring medical attention in children 0 to 5 years old^a

Type of PBD	No injury (n = 24,687)		Injury in past year (n = 2,856)		OR (95% CI)	aOR (95% CI)
	Frequency	% (95% CI) ^b	Frequency	% (95% CI) ^b		
Overall						
≥1 PBD	761	3.4 (2.8–4.0)	191	7.7 (5.5–9.9)	2.36 (1.64–3.39)	1.93 (1.11–3.35)
ADD/ADHD	164	1.1 (0.8–1.4)	52	2.9 (1.6–4.2)	2.81 (1.64–4.81)	2.57 (1.43–4.62)
Depression	37	0.5 (0.0–1.0)	9	1.0 (0.0–2.2)	2.18 (0.46–10.29)	2.25 (0.52–9.80)
Anxiety	148	1.3 (0.7–1.9)	40	2.2 (0.9–3.5)	1.71 (0.78–3.75)	1.62 (0.63–4.18)
Conduct disorder	183	1.1 (0.9–1.4)	50	2.6 (1.4–3.8)	2.33 (1.36–4.00)	2.06 (1.16–3.64)
Autism	166	1.1 (0.7–1.5)	54	3.3 (1.2–5.4)	3.00 (1.41–6.38)	2.52 (1.26–5.01)
Learning delay	463	3.0 (2.4–3.7)	125	5.1 (3.5–6.6)	1.72 (1.17–2.52)	1.62 (1.09–2.41)
Home						
≥1 PBD	827	3.6 (3.0–4.2)	123	7.5 (5.2–9.7)	2.16 (1.49–3.13)	1.80 (1.22–2.66)
ADD/ADHD	187	1.1 (0.8–1.4)	29	3.2 (1.4–5.0)	2.89 (1.51–5.50)	2.66 (1.28–5.54)
Depression	41	0.6 (0.05–1.1)	5	0.4 (0.0–0.8)	0.65 (0.14–3.12)	0.32 (0.07–1.43)
Anxiety	160	1.4 (0.8–2.0)	28	2.0 (0.7–3.3)	1.48 (0.68–3.24)	1.49 (0.67–3.30)
Conduct disorder	201	1.2 (0.9–1.4)	32	3.2 (1.4–4.9)	2.76 (1.47–5.18)	2.67 (1.35–5.30)
Autism	188	1.3 (0.8–1.8)	32	2.6 (1.0–4.2)	2.04 (0.99–4.20)	1.77 (0.86–3.66)
Learning delay	504	3.0 (2.4–3.6)	82	6.1 (3.9–8.3)	2.09 (1.35–3.24)	1.98 (1.27–3.09)
Child care						
≥1 PBD	937	3.9 (3.3–4.5)	13	1.9 (0.3–3.5)	0.48 (0.20–1.15)	0.35 (0.14–0.88)
ADD/ADHD	211	1.3 (1.0–1.6)	5	0.7 (0.0–1.6)	0.56 (0.17–1.83)	0.67 (0.20–2.24)
Depression	46	0.6 (0.1–1.1)	0	0.0 (NE)	<0.01 (<0.01–<0.01)	<0.01 (<0.01–<0.01)
Anxiety	187	1.4 (0.9–2.0)	1	0.1 (0.0–0.2)	0.05 (0.01–0.35)	0.07 (0.01–0.54)
Conduct disorder	230	1.3 (1.0–1.6)	3	0.4 (0.0–1.0)	0.30 (0.06–1.36)	0.39 (0.08–1.83)
Autism	217	1.4 (1.0–1.9)	3	1.0 (0.0–2.5)	0.70 (0.15–3.22)	0.61 (0.13–2.91)
Learning delay	578	3.3 (2.7–3.9)	8	0.9 (0.01–1.9)	0.28 (0.10–0.78)	0.27 (0.09–0.82)
Other place						
≥1 PBD	890	3.7 (3.1–4.2)	60	10.9 (4.7–17.2)	3.24 (1.66–6.30)	2.18 (1.20–3.94)
ADD/ADHD	197	1.2 (0.9–1.5)	19	3.7 (1.1–6.2)	3.13 (1.47–6.68)	2.74 (1.28–5.89)
Depression	42	0.5 (0.0–0.9)	4	2.9 (0.0–6.6)	6.31 (1.15–34.71)	5.33 (1.05–27.18)
Anxiety	174	1.3 (0.8–1.9)	14	3.5 (0.0–7.3)	2.65 (0.78–9.01)	2.02 (0.61–6.68)
Conduct disorder	215	1.3 (1.0–1.6)	18	2.9 (0.7–5.0)	2.33 (1.04–5.19)	1.70 (0.73–3.94)
Autism	200	1.3 (0.9–1.7)	20	5.6 (0.0–12.1)	4.70 (1.35–16.35)	3.48 (1.26–9.61)
Learning delay	550	3.2 (2.6–3.8)	36	4.4 (2.0–6.8)	1.39 (0.77–2.52)	1.27 (0.69–2.34)

Abbreviations: ADD, attention-deficit disorder; ADHD, attention-deficit/hyperactivity disorder; aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio; PBD, psychiatric and behavioral disorder.

^aParental refusal to answer a particular question or provide a response of “don’t know” occurred for questions pertaining to 1-year history of injury requiring medical attention in 23 (0.1%); 1-year history of ADD/ADHD in 20 (0.1%), depression in 6 (0.04%), anxiety in 6 (0.04%), conduct disorder in 13 (0.08%), autism in 12 (0.08%), and learning delay in 26 (0.2%); age in 0 (0.0%); race/ethnicity in 455 (1.7%); sex in 19 (0.07%); family structure in 152 (0.6%); highest level of parental education in 198 (2.4%); household income in 0 (0.0%); health insurance coverage in 54 (0.2%); residence in a metropolitan area in 8,359 (20.3%); and smoking in home in 2 (0.002%), respectively. Logistic regression models were constructed with 1-year history of injury requiring medical attention and location of injury as the dependent variable. The independent variable was the specific etiologies of PBD, including ADD/ADHD, depression, anxiety, conduct disorder, autism, or learning delay and a composite variable for any of these PBDs (all binary). The ORs and 95% CIs were estimated. Multivariate logistic regression models were constructed that included age, sex, household income, family structure (selected from bivariate models), and comorbid medical (diabetes, muscle/joint problems, and recurrent ear infections) and dental problems.

^bValues represent column percentages, ie, percentages of children with or without injury requiring medical attention who had an allergic disorder.

CI 1.003–1.007) and a partial mediation (Baron–Kenny $\beta(yx,m) = 0.04$, $P < .0001$, $R^2 = 0.002$).

Discussion

Using a US population-based cohort, this study showed higher prevalences of psychological or behavioral disorders and injuries requiring medical attention in young children with allergic disorders, including eczema, asthma, hay fever, and food allergies. Children with eczema, asthma, hay fever, and food allergy had higher odds of injuries requiring medical attention, even after controlling for PBDs. These data suggest that children with allergic disease are at increased risk for injury, with partial mediation by comorbid PBD.

The present study found increased risk of injury in children with eczema, asthma, hay fever, and food allergies. These data confirm and expand on previous studies describing associations between asthma and hay fever and injury in children.^{13,21–24} A large, population-based cohort study of 6- to 30-year-old Australian male patients with asthma showed that children with asthma included in the cohort had increased risk of injury compared with those without asthma, especially after recent hospital admission.²¹ Another Australian study of 37,419 adults and 15,349 children

with asthma found similar associations.²² A study of US children 5 to 17 years old found that chronic asthma was associated with a higher risk for nonfatal injuries in the previous 3 months.¹³ A longitudinal cohort of 878 US families showed that 4-year-old children with asthma had a higher risk of risk of injury during a 2.5-year follow-up period.²³ A survey of primary caregivers for 5-year-olds from low-income families found that asthma and hay fever were associated with a higher risk for injury.²⁴ Of note, these studies did not account for the effects of PBDs as a contributory factor.

The association between allergic and psychiatric disorders, including ADHD, conduct disorder, depression, and anxiety, has recently been increasingly recognized.^{6,7,27–30} Multiple mechanisms underlying this association have been proposed, including sleep deprivation and chronic inflammation. Sleep disturbances accompanying allergic disorders may predispose to psychiatric disorders and strengthen the association between allergic disorders and mental health conditions.^{27,31} Unfortunately, the authors were unable to control for sleep deprivation in this analysis because it was not assessed in children younger than 6 years. Future studies are needed to determine the role of sleep deprivation in the association between allergic disease and injuries. Yaghmaie et al⁶ suggested that the association between allergic and psychiatric

Table 4Association between allergic disorders and injuries requiring medical attention in children 0 to 5 years old^a

Allergic disease	No injury (n = 24,687)		Injury in past year (n = 2,856)		OR (95% CI)	aOR (95% CI)
	Frequency	% (95% CI) ^b	Frequency	% (95% CI) ^b		
Overall						
≥1 allergic disease	6,761	28.1 (26.7–29.6)	1,079	40.0 (35.2–44.7)	1.70 (1.38–2.09)	1.74 (1.23–2.46)
Eczema	3,605	14.6 (13.5–15.6)	582	18.5 (14.9–22.0)	1.33 (1.04–1.71)	1.67 (1.09–2.56)
Asthma	1,250	6.1 (5.4–6.9)	245	10.6 (7.4–13.8)	1.81 (1.26–2.60)	1.64 (1.01–2.67)
Hay fever	2,605	10.7 (9.7–11.6)	485	19.3 (15.0–23.6)	2.00 (1.49–2.69)	2.14 (1.32–3.47)
Food allergies	1,437	5.9 (5.1–6.6)	234	8.6 (5.4–11.8)	1.51 (0.98–2.31)	2.06 (1.14–3.72)
Home						
≥1 allergic disease	7,128	28.6 (27.2–30.0)	697	39.8 (34.5–45.2)	1.65 (1.31–2.09)	1.95 (1.30–2.93)
Eczema	3,792	14.5 (13.5–15.5)	385	21.6 (16.6–26.6)	1.63 (1.20–2.21)	2.25 (1.38–3.68)
Asthma	1,326	6.2 (5.4–6.9)	164	12.5 (7.8–17.1)	2.16 (1.39–3.37)	2.49 (1.33–4.66)
Hay fever	2,784	11.1 (10.1–12.1)	300	18.4 (13.4–23.4)	1.81 (1.28–2.56)	2.08 (1.12–3.86)
Food allergies	1,510	6.0 (5.2–6.8)	156	8.2 (5.4–10.9)	1.40 (0.95–2.05)	1.67 (0.84–3.31)
Child care						
≥1 allergic disease	7,693	29.3 (27.9–30.6)	132	39.9 (25.9–53.9)	1.60 (0.89–2.89)	1.94 (0.84–4.48)
Eczema	4,099	14.9 (13.9–15.9)	78	21.2 (12.5–29.9)	1.54 (0.91–2.61)	2.15 (0.91–5.08)
Asthma	1,463	6.6 (5.8–7.4)	27	9.0 (2.9–15.2)	1.41 (0.67–3.00)	1.34 (0.40–4.75)
Hay fever	3,009	11.4 (10.5–12.4)	75	23.3 (11.1–35.5)	2.35 (1.18–4.68)	1.69 (0.65–4.39)
Food allergies	1,637	6.1 (5.4–6.9)	29	5.5 (2.2–8.8)	0.89 (0.47–1.70)	0.81 (0.25–2.62)
Other place						
≥1 allergic disease	7,555	29.0 (27.7–30.4)	270	41.3 (30.6–52.0)	1.72 (1.10–2.69)	1.26 (0.74–2.14)
Eczema	4,051	15.1 (14.1–16.1)	126	10.6 (6.9–14.3)	0.67 (0.45–0.99)	0.51 (0.28–0.91)
Asthma	1,432	6.6 (5.8–7.4)	58	7.2 (3.9–10.5)	1.10 (0.66–1.83)	0.71 (0.36–1.39)
Hay fever	2,959	11.3 (10.3–12.3)	125	21.0 (11.1–30.9)	2.09 (1.14–3.82)	1.90 (0.98–3.70)
Food allergies	1,615	6.0 (5.3–6.7)	51	10.4 (0.6–20.3)	1.82 (0.63–5.25)	2.48 (1.17–5.24)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

^aParental refusal to answer a particular question or provide a response of “don’t know” occurred for questions pertaining to 1-year history of injury requiring medical attention in 23 (0.1%) and location of injury, eg, home, child care, or other place, in 43 (1.0%); 1-year history of eczema in 35 (0.08%), asthma in 43 (0.2%), hay fever in 65 (0.2%), and food allergy in 46 (0.3%); age in 0 (0.0%); race/ethnicity in 455 (1.7%); sex in 19 (0.07%); family structure in 152 (0.6%); highest level of parental education in 198 (2.4%); household income in 0 (0.0%); health insurance coverage in 54 (0.2%); residence in a metropolitan area in 8,359 (20.3%); and smoking in home in 2 (0.002%), respectively. Logistic regression models were constructed with 1-year history of injury requiring medical attention and location of the injury (home, child care, and other place) as the dependent variables. The independent variable was the specific etiologies of allergic disease, including 1-year history of eczema, asthma, hay fever, and food allergy and a composite variable for any of these allergic disorders (all binary). ORs and 95% CIs were estimated. Multivariate logistic regression models were constructed that included age, sex, household income, family structure, and highest level of parental education (selected from bivariate models) and comorbid medical (diabetes, muscle/joint problems, and recurrent ear infections) and dental problems.

^bValues represent column percentages, ie, percentages of children with or without injury requiring medical attention who had an allergic disorder.

Table 5Association between allergic disorders and injuries requiring medical attention is modified by comorbid psychological or behavioral disorders in children 2 to 5 years old^a

Allergic disease	Injury in past year (n = 2,069), aOR (95% CI)
≥1 allergic disease	1.74 (1.23–2.46)
Eczema	1.59 (1.01–2.50)
Asthma	1.91 (1.10–3.31)
Hay fever	2.05 (1.24–3.39)
Food allergies	2.00 (1.10–3.67)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.

^aParental refusal to answer a particular question or provide a response of “don’t know” occurred for questions pertaining to 1-year history of injury requiring medical attention in 23 (0.1%); attention-deficit disorder or attention-deficit/hyperactivity disorder in 20 (0.1%), depression in 52 (0.3%), anxiety in 6 (0.04%), conduct disorder in 13 (0.08%), autism in 12 (0.07%), and developmental delay in 26 (0.2%); 1-year history of eczema in 35 (0.08%), asthma in 43 (0.2%), hay fever in 65 (0.2%), and food allergy in 46 (0.3%); age in 0 (0.0%); race/ethnicity in 455 (1.7%); sex in 19 (0.07%); family structure in 152 (0.6%); highest level of parental education in 198 (2.4%); household income in 0 (0.0%); health insurance coverage in 54 (0.2%); residence in a metropolitan area in 8,359 (20.3%); and smoking in home in 2 (0.002%), respectively. Logistic regression models were constructed with 1-year history of injury requiring medical attention as the dependent variable. The independent variables were the specific etiologies of allergic disease, including 1-year history of eczema, asthma, hay fever, and food allergy and a composite variable for any of these allergic disorders (all binary). ORs and 95% CIs were estimated. Multivariate logistic regression models were constructed that included a history of at least 1 psychological or behavioral disorder (attention-deficit disorder or attention-deficit/hyperactivity disorder, depression, anxiety, conduct disorder, autism, and learning delay), age, sex, household income, family structure, and highest level of parental education.

disorders is secondary to the wide-ranging effects of inflammation, because eczema, depression, and anxiety are characterized by an increase in proinflammatory cytokines. Together, these studies show that the association between allergic and psychiatric disease is multifactorial.

The association between allergic diseases and PBDs may not be entirely specific. Many of these associations have been found in other chronic medical disorders of childhood and adolescence.³² Indeed, the authors found that diabetes also was associated with an increased odds of at least 1 PBD but not with an injury requiring medical attention (data not shown). Thus, it appears that childhood allergic disease confers additional risk for injury beyond that of some other chronic disorders and that PBD is not the only factor in developing injuries. Rather, disease-specific factors, such as chronic itch or sleep deprivation, might contribute toward PBDs and injury. Several studies of patient accidents in hospitals have found higher fall rates in adults with neurologic, psychiatric, and orthopedic disorders and human immunodeficiency virus.^{33–35} To the best of the authors’ knowledge, no studies have examined the burden of injury in chronic childhood disease. The present study implicates allergic disease as a previously unrecognized risk factor for injury.

It is possible that children with allergic disorders express at least 1 symptom of PBD without meeting previously established criteria, such as those found in the Axis I of the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. For example, children with allergic disorders may have depressive symptoms secondary to chronic disease, pruritus, and sleep deprivation. In such situations, depression might be better categorized as an Axis III disorder, rather than labeling a child with the diagnosis of a major depressive

disorder per se. Thus, the findings of this study may be more appropriately interpreted as specific symptoms or features of psychological comorbidities that occur more commonly in children with allergic disease. Nevertheless, in the context of child safety, these features of psychological comorbidity appear to confer excess risk for injury requiring medical attention. PBDs and allergic disease may be important targets for behavioral and/or pharmacologic intervention to prevent injury and improve overall safety.

The results of the present study are consistent with those of previous studies that have established a link between childhood psychiatric disorders and increased injury risk.^{12–19} Most of these studies have shown an association between accidental injury and behavioral disorders, such as ADHD and oppositional defiant disorder, whereas only a few have shown a link with internalizing psychiatric disorders, such as depression or anxiety. The relation between ADD/ADHD and injury is likely due to the characteristic distractibility and decreased attentional capacity, because children with ADHD tend to exhibit poor impulse control, more risky behavior, decreased risk perception, and a diminished ability to generate adequate safety responses.^{36,37} Similarly, the characteristic behavior of those with conduct and oppositional defiant disorders likely predisposes them to injury,¹² because children with oppositional defiant disorder may be less likely to comply with safety-related rules from supervising adults. The association between conduct disorder and injury risk may be driven in part by comorbid ADD/ADHD and oppositional defiant disorder, which are more clearly linked to increased injury risk.^{12,38} Further longitudinal studies are needed to elucidate the mechanism of increased injury in those with PBDs and identify potential targets for clinical and public health interventions.

The strengths of this study include a US population base with a large and diverse cohort, controlling for several confounding variables in multivariate models, use of formal mediation analysis, and a questionnaire that was administered in 6 different languages with weighted results to reflect the prevalence of disease throughout the United States. However, this study has potential limitations. The NSCH is a cross-sectional study, which does not allow for an assessment of the direction of the association between allergic disease and injuries. The authors hypothesize that children with allergic diseases and comorbid PBDs have an increased risk of injury. However, early childhood injury and its sequelae somehow might contribute to allergic disease. Future longitudinal studies are needed to verify the direction of association. Allergic diseases were assessed by parental report of physician-diagnosed disease. This methodology has been validated previously in the International Study of Asthma and Allergies in Childhood and other studies and is a standard approach in the epidemiologic study of allergic disease. Moreover, the preponderant forms of skin and airway diseases in children are eczema and asthma, respectively. The question about injuries requiring medical attention was asked in the NSCH only for children 5 years and younger as part of the early childhood questionnaire. It is possible that there are differential effects of allergic disease by age. Future studies also are warranted to examine school-age children and adolescents. In the present study, psychiatric comorbidities did not completely account for the relation of eczema, asthma, hay fever, and food allergy to injury, suggesting there are other contributing factors. Sedating antihistamine may be a contributing factor; however, the authors were unable to control for this because the NSCH did not include questions related to antihistamine use. In addition, the authors were unable to compare the characteristics of injuries, such as type and cause, which may clarify the mechanisms of association and identify targets for intervention. Moreover, injury-reporting behaviors of parents of children with developmental or chronic illnesses may be different from those of parents with healthy children. For example, parents of children with medical illnesses may be more vigilant and request

medical assistance more quickly than parents of healthy children. Even so, the results of this study suggest increased health care usage secondary to injury in children with allergic disease.

In conclusion, children with allergic disease have increased risk for injuries requiring medical attention, at least in part from comorbid PBDs. Children with allergic disease, particularly those with PBDs, might benefit from improved education and tailored interventions for decreasing injury risk. Further studies are needed to elucidate the mechanisms of increased injury risk in allergic disease and identify targets for intervention.

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