HHS Public Access

Author manuscript

J Allergy Clin Immunol Pract. Author manuscript; available in PMC 2021 September 01.

Published in final edited form as:

J Allergy Clin Immunol Pract. 2020 September ; 8(8): 2808–2810. doi:10.1016/j.jaip.2020.04.032.

Association between atopic dermatitis and learning disability in children

Joy Wan, MD, MSCE[a], **Daniel B. Shin, PhD**[a,b], **Joel M. Gelfand, MD, MSCE**[a,b]

[a]Department of Dermatology, Epidemiology and Informatics, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

[b]Department of Biostatistics, Epidemiology and Informatics, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

Keywords

atopic dermatitis; eczema; learning disability; attention deficit hyperactivity disorder; autism; developmental delay; epidemiology; population health; pediatrics

Atopic dermatitis (AD) affects up to 20% of children and is linked to significant disruptions in sleep, attention, and memory.[1–3] Although such impairments may contribute to difficulties in learning, the impact of AD on learning is unknown. Learning disability (LD), which encompasses disorders that impair areas of learning such as reading, writing, or mathematics, is associated with poor mental health, lower educational achievement, and worse occupational outcomes.[4] In this study, we examine the relationship between AD and LD.

We conducted a cross-sectional study using data from the National Health Interview Survey (NHIS), which uses multi-stage probability sampling to survey a representative sample of U.S. households to monitor the population's health.[5] Each selected household is provided information about the study and visited by field interviewers who obtain consent for participation and conduct face-to-face interviews. For each household with children, one child is randomly selected and information is collected from an adult caregiver. We included

Corresponding author: Joy Wan, MD, MSCE, 3400 Civic Center Blvd, PCAM South Tower, 7th floor, Office 773, Philadelphia, PA 19104, Tel: 215-349-8610, Fax: 215-615-3127, joywan@pennmedicine.upenn.edu.

Conflicts of interest and financial disclosures:

Dr. Wan receives a research grant from Pfizer Inc. (to the Trustees of the University of Pennsylvania) for work unrelated to this study. Dr. Gelfand served as a consultant for BMS, Boehringer Ingelheim, Janssen Biologics, Novartis Corp, UCB (DSMB), Pfizer Inc., and Sun Pharma, receiving honoraria; receives research grants (to the Trustees of the University of Pennsylvania) from Abbvie, Boehringer Ingelheim, Janssen, Novartis Corp, Celgene, Ortho Dermatologics, and Pfizer Inc.; received payment for continuing medical education work related to psoriasis that was supported indirectly by Lilly, Ortho Dermatologics, and Novartis; is a co-patent holder of resiquimod for treatment of cutaneous T cell lymphoma; and is a Deputy Editor for the Journal of Investigative Dermatology, receiving honoraria from the Society for Investigative Dermatology. Dr. Shin has no conflicts of interest to declare.

The analyses, interpretations, and conclusions in this paper are credited to the authors and not to the National Center for Health Statistics in the Centers for Disease Control and Prevention, which is responsible only for the initial data.

children surveyed between 1/1/2013 and 12/31/2017. Children with intellectual disability, i.e. mental retardation, were excluded. Subjects were between 3 and 17 years old, as younger children were not assessed for LD.

The exposure was self-reported AD in the preceding 12 months. The outcome was self-reported LD, which was assessed using the question, “Has a representative from a school or a health professional ever told you that [the child] had a learning disability?” Logistic regression was performed to measure the association between AD and LD, adjusting for potential confounders determined *a priori*, including sociodemographic characteristics and other atopic disorders. As attention deficit hyperactivity disorder (ADHD), autism, and other developmental delays commonly co-occur with LD and may mediate the relationship between AD and LD, secondary stratified analyses were conducted. Data were weight-adjusted to account for NHIS sampling design and obtain population estimates. The study was granted exemption by the University of Pennsylvania Institutional Review Board.

A weighted total of 7,284,818 (11.9%) of 61,012,269 subjects reported AD. Children with AD were more likely to be younger, be non-Hispanic or black, and have parents with higher educational attainment (Table I). They were also more likely to have asthma, hay fever, food allergy, ADHD, autism, and other developmental delay (Table I).

LD was reported by 10.4% (95% CI 9.3–11.6) of children with recent AD compared to 6.2% (95% CI 5.8–6.5) of those without ($p<0.001$). AD was associated with LD with an unadjusted odds ratio (OR) of 1.77 (95% CI 1.55–2.01) and adjusted OR of 1.48 (95% CI 1.28–1.72) (Table II). Asthma and hay fever were associated with LD to lesser degrees than AD [ORs 1.20 (95% CI 1.06–1.37) and 1.25 (95% CI 1.11–1.42), respectively], while food allergy was not significantly associated with LD (OR 1.09, 95% CI 0.89–1.34). Among children with ADHD, autism, or other developmental delays, LD was reported in 23.2% (95% CI 20.7–26.0) of those with AD compared to 15.5% (95% CI 14.6–16.4) of those without ($p<0.001$). Although the interaction between AD and ADHD, autism, or other developmental delays was not statistically significant ($p=0.12$), AD was associated with LD with an adjusted OR of 1.96 (95% CI 1.46–2.64) among children without these neurodevelopmental conditions (data not shown). In contrast, among children with ADHD, autism, or other developmental delays, the strength of association between AD and LD was attenuated (OR 1.32, 95% CI 1.10–1.57) (data not shown). There was no effect modification of the association between AD and LD by age ($p=0.55$) or sex ($p=0.61$).

To our knowledge, this is one of the first studies to examine the relationship between AD and LD. Our findings indicate that LD is more common in children with AD and suggest that AD may impair learning independent of sociodemographic characteristics and comorbid illnesses including ADHD and other atopic disorders. Although causality cannot be inferred from this cross-sectional study, our results would suggest that 200,000 cases of LD in U.S. children could potentially be attributed to AD, assuming 4,000,000 cases of LD in the population, 11.9% of the population has AD, and a relative risk of 1.437 for LD among children with AD (estimated from OR of 1.48 using a common conversion method[6]). Although two previous studies did not find associations between AD and educational attainment or standardized test performance, they were limited by potential information and

selection bias and smaller sample size.[7,8] Our population-based study is generalizable to U.S. children and focuses on those with active skin disease. However, study limitations include possible misclassification, residual confounding, and the cross-sectional design. Although AD was assessed using a caregiver's report based on a single question, this method has 87% positive predictive value, 96% specificity, and 70% sensitivity when compared to physician diagnosis of AD.[9] The assessment of LD using caregiver report, however, has not been similarly validated, thus outcome misclassification remains a potential limitation. The temporal relationship between AD and LD also cannot be distinguished; however, AD most commonly begins in the first few years of life while LD is usually identified later once children enter school; reverse causation is thus unlikely to account for the observed association. Furthermore, as the NHIS did not collect data on sleep or AD severity, we were unable to examine their impact on the relationship between AD and LD. We did not perform formal mediation analyses to assess the role of ADHD, autism, or other developmental delays, as it was beyond the scope of this exploratory study. Finally, it is possible that LD may be a feature of many chronic diseases of childhood or that parents of children with AD may be more likely to report comorbidities. Nevertheless, our multivariable analysis indicates a distinct association between AD and LD independent of many sociodemographic characteristics and comorbid conditions.

AD is a common disease of childhood, and learning disabilities have lifelong consequences for health, educational, and social outcomes.[4] Additional work is needed to understand the drivers and mediators of the observed association between AD and LD. Prospective studies are also necessary to further characterize LD risk in AD so that the most vulnerable children can be identified and supported.

Funding sources:

This work was supported by the National Institutes of Health [P30-AR069589].

References

1. Ramirez FD, Chen S, Langan SM, Prather AA, McCulloch CE, Kidd SA, et al. Association of Atopic Dermatitis With Sleep Quality in Children. JAMA pediatrics. 2019;173(5):e190025. [PubMed: 30830151]
2. Riis JL, Vestergaard C, Deleuran MS, Olsen M. Childhood atopic dermatitis and risk of attention deficit/hyperactivity disorder: A cohort study. The Journal of allergy and clinical immunology. 2016;138(2):608–610. [PubMed: 27025346]
3. Camfferman D, Kennedy JD, Gold M, Simpson C, Lushington K. Sleep and neurocognitive functioning in children with eczema. International journal of psychophysiology : official journal of the International Organization of Psychophysiology. 2013;89(2):265–272. [PubMed: 23353660]
4. Stein DS, Blum NJ, Barbaresi WJ. Developmental and behavioral disorders through the life span. Pediatrics. 2011;128(2):364–373. [PubMed: 21768324]
5. National Center for Health Statistics. National Health Interview Survey, 2017. Public-use data file and documentation. https://www.cdc.gov/nchs/nhis/data-questionnaires-documentation.htm. Published 2018 Accessed.
6. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. Jama. 1998;280(19):1690–1691. [PubMed: 9832001]

7. Smirnova J, von Kobyletzki LB, Lindberg M, Svensson A, Langan SM, Montgomery S. Atopic dermatitis, educational attainment and psychological functioning: a national cohort study. The British journal of dermatology. 2019;180(3):559–564. [PubMed: 30339272]
8. Ruijsbroek A, Wijga AH, Gehring U, Kerkhof M, Droomers M. School Performance: A Matter of Health or Socio-Economic Background? Findings from the PIAMA Birth Cohort Study. PloS one. 2015;10(8):e0134780. [PubMed: 26247468]
9. Silverberg JI, Patel N, Immaneni S, Rusniak B, Silverberg NB, Debashis R, et al. Assessment of atopic dermatitis using self-report and caregiver report: a multicentre validation study. The British journal of dermatology. 2015;173(6):1400–1404. [PubMed: 26186170]

Clinical implications:

Atopic dermatitis is associated with greater odds of learning disability independent of sociodemographic factors and other atopic and neurodevelopmental disorders.

Table I.

Subject characteristics (weighted N=61,012,269; unweighted N=47,933)

	AD in last 12 months	No AD in last 12 months
Characteristic, weighted % (95% CI)	**Weighted N = 7,284,818 (11.9%)**	**Weighted N = 53,727,451 (88.1%)**
Sex		
Male	49.1 (47.4–50.8)	51.1 (50.5–51.8)
Female	50.9 (49.2–52.6)	48.9 (48.2–49.5)
Age, y, mean (95% CI)	9.47 (9.33–9.61)	10.07 (10.01–10.12)
Birth weight, g, mean (95% CI)	3267.1 (3244.1–3290.1)	3293.7 (3284.9–3302.6)
Ethnicity		
Non-Hispanic	80.1 (78.6–81.6)	75.1 (74.1–76.1)
Hispanic	19.9 (18.4–21.4)	24.9 (23.9–25.9)
Race		
White	67.0 (65.1–68.7)	75.0 (74.2–75.8)
Black / African American	20.5 (18.9–22.1)	14.0 (13.4–14.6)
American Indian / Alaskan Native	0.8 (0.6–1.2)	1.2 (1.0–1.5)
Asian	5.4 (4.6–6.2)	5.4 (5.0–5.7)
Multiracial	6.4 (5.6–7.2)	4.4 (4.1–4.7)
Region		
Northeast	15.9 (14.3–17.6)	16.4 (15.4–17.4)
Midwest	22.1 (20.5–23.7)	22.3 (21.4–23.2)
South	37.6 (35.5–39.7)	37.6 (36.3–38.9)
West	24.4 (22.6–26.4)	23.8 (22.6–24.9)
Annual household income, USD		
$0–34,999	28.3 (26.7–30.0)	26.4 (25.6–27.1)
$35,000–74,999	26.0 (24.4–27.6)	26.3 (25.7–26.9)
$75,000–99,999	11.6 (10.6–12.7)	11.4 (11.0–11.8)
≥ $100,000	27.8 (26.1–29.6)	27.1 (26.3–27.9)
Not reported / unknown	6.3 (5.5–7.2)	8.9 (8.4–9.3)
Highest maternal education		
Less than high school	10.1 (9.0–11.2)	13.6 (13.0–14.2)
High school graduate / GED	17.9 (16.7–19.2)	18.8 (18.3–19.4)
Some college, no degree	19.0 (17.7–20.3)	16.2 (15.7–16.8)
Associate degree	14.5 (13.3–15.8)	11.9 (11.5–12.3)
Bachelor degree	20.5 (19.0–22.0)	20.2 (19.5–20.8)
Master, professional, or doctoral degree	12.2 (11.1–13.5)	11.5 (11.0–12.0)
Not reported / unknown	5.8 (5.1–6.6)	7.8 (7.5–8.1)
Highest paternal education		
Less than high school	7.8 (6.9–8.9)	11.0 (10.5–11.5)
High school graduate / GED	14.5 (13.4–15.6)	17.1 (16.6–17.7)

	AD in last 12 months	No AD in last 12 months
Characteristic, weighted % (95% CI)	**Weighted N = 7,284,818 (11.9%)**	**Weighted N = 53,727,451 (88.1%)**
Some college, no degree	11.4 (10.4–12.6)	10.8 (10.3–11.3)
Associate degree	7.9 (7.0–8.9)	7.6 (7.2–7.9)
Bachelor degree	15.8 (14.5–17.2)	15.8 (15.2–16.4)
Master, professional, or doctoral degree	10.4 (9.3–11.5)	10.5 (10.0–11.1)
Not reported / unknown	32.3 (30.7–33.9)	27.2 (26.6–27.9)
Has health insurance coverage	95.5 (94.7–96.2)	94.2 (93.9–94.5)
General health status		
Excellent	50.8 (49.0–52.5)	59.7 (58.9–60.4)
Very good	28.4 (26.9–30.0)	25.3 (24.8–25.9)
Good	17.6 (16.3–18.9)	13.6 (13.1–14.1)
Fair	2.8 (2.3–3.5)	1.2 (1.1–1.4)
Poor	0.4 (0.2–0.8)	0.18 (0.1–0.2)
History of asthma	26.4 (24.9–28.0)	13.0 (12.6–13.5)
History of hay fever or respiratory allergy in last 12 mon	32.9 (31.2–34.7)	14.7 (14.2–15.2)
History of food allergy in last 12 mon	16.7 (15.4–18.1)	4.3 (4.1–4.6)
History of attention deficit hyperactivity disorder	11.6 (10.5–12.8)	8.4 (8.1–8.8)
History of autism	3.3 (2.6–4.1)	1.9 (1.7–2.1)
History of any other developmental delay	6.2 (5.4–7.2)	3.2 (3.0–3.5)
History of learning disability	10.4 (9.3–11.6)	6.2 (5.8–6.5)

Data Source: NCHS, National Health Interview Survey, 2013–2017. AD, atopic dermatitis.

Table II.

Multivariable logistic regression model for learning disability

Variable	Odds ratio (95% CI)
Atopic dermatitis in last 12 mon	1.48 (1.28–1.72)
Sex	
Male	Reference
Female	0.59 (0.53–0.66)
Age, y	1.08 (1.07–1.10)
Birth weight	
Normal (2500–3999 g)	Reference
Very low (< 1500 g)	2.80 (2.09–3.75)
Low (1500–2499 g)	1.35 (1.12–1.62)
High (≥ 4000 g)	0.85 (0.72–1.01)
Ethnicity	
Non-Hispanic	Reference
Hispanic	0.68 (0.59–0.79)
Race	
White	Reference
Black / African American	0.80 (0.68–0.94)
American Indian / Alaskan Native	0.59 (0.38–0.91)
Asian	0.30 (0.21–0.43)
Multiracial	0.95 (0.76–1.19)
Region	
Northeast	Reference
Midwest	0.72 (0.59–0.87)
South	0.81 (0.67–0.96)
West	0.74 (0.61–0.89)
Annual household income, USD	
$0–34,999	Reference
$35,000–74,999	0.80 (0.69–0.92)
$75,000–99,999	0.75 (0.60–0.92)
≥ $100,000	0.67 (0.55–0.80)
Not reported / unknown	0.74 (0.57–0.96)
Highest maternal education	
Less than high school	Reference
High school graduate / GED	0.87 (0.72–1.05)
Some college, no degree	0.97 (0.79–1.19)
Associate degree	0.79 (0.63–0.99)
Bachelor degree	0.67 (0.53–0.85)
Master, professional, or doctoral degree	0.72 (0.54–0.94)
Not reported / unknown	0.84 (0.66–1.06)
Highest paternal education	

Variable	Odds ratio (95% CI)
Less than high school	Reference
High school graduate / GED	0.94 (0.75–1.18)
Some college, no degree	0.87 (0.67–1.12)
Associate degree	1.06 (0.82–1.37)
Bachelor degree	0.71 (0.55–0.94)
Master, professional, or doctoral degree	0.73 (0.53–1.01)
Not reported / unknown	1.11 (0.90–1.35)
General health status	
Excellent	Reference
Very good	1.43 (1.26–1.63)
Good	2.44 (2.14–2.78)
Fair	5.20 (3.92–6.90)
Poor	10.22 (5.29–19.76)
Has health insurance coverage	1.27 (1.002–1.60)
Asthma	1.20 (1.06–1.37)
Hay fever or respiratory allergy in last 12 mon	1.25 (1.11–1.42)
Food allergy in last 12 mon	1.09 (0.89–1.34)

Data Source: NCHS, National Health Interview Survey, 2013–2017.