



Associations of Physical Activity and Sedentary Behavior with Atopic Disease in United States Children

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Objectives To determine if eczema, asthma, and hay fever are associated with vigorous physical activity, television/video game usage, and sports participation and if sleep disturbance modifies such associations.

Study design Data were analyzed from 2 cross-sectional studies including 133 107 children age 6-17 years enrolled in the 2003-2004 and 2007-2008 National Survey of Children's Health. Bivariate and multivariate survey logistic regression models were created to calculate the odds of atopic disease and atopic disease severity on vigorous physical activity, television/video game use, and sports participation.

Results In multivariate logistic regression models controlling for sociodemographic factors, lifetime history of asthma was associated with decreased odds of ≥ 1 days of vigorous physical activity (aOR, 0.87; 95% CI, 0.77-0.99) and decreased odds of sports participation (0.91; 95% CI, 0.84-0.99). Atopic disease accompanied by sleep disturbance had significantly higher odds of screen time and lower odds of sports participation compared with children with either atopic disease or sleep disturbance alone. Severe eczema (aOR, 0.39; 95% CI, 0.19-0.78), asthma (aOR, 0.29; 95% CI, 0.14-0.61), and hay fever (aOR, 0.48; 95% CI, 0.24-0.97) were all associated with decreased odds of ≥ 1 days of vigorous physical activity. Moderate (aOR, 0.76; 95% CI, 0.57-0.99) and severe eczema (aOR, 0.45; 95% CI, 0.28-0.73), severe asthma (aOR, 0.47; 95% CI, 0.25-0.89), and hay fever (aOR, 0.53; 95% CI, 0.36-0.61) were associated with decreased odds of sports participation in the past year.

Conclusions Children with severe atopic disease, accompanied by sleep disturbance, have higher risk of sedentary behaviors. (*J Pediatr* 2016;174:247-53).

Atopic diseases, including atopic dermatitis (or eczema), asthma, and hay fever, are chronic inflammatory disorders that pose significant medical, social, and financial burdens to children and their families.¹⁻³ Children with atopic diseases use more health care services and incur significantly higher health care expenditures than do children without atopic disease.⁴⁻⁷ Additionally, childhood atopic disease is associated with increased prevalence of cardiovascular risk factors such as obesity and hypertension⁸⁻¹² and also is associated with an increased prevalence of sleep disturbance and poor sleep quality.¹³⁻¹⁶

Sedentary behavior and decreased rates of physical activity may contribute to increased cardiovascular risk factors in children with atopic disease. Several aspects of atopic disease may contribute to children avoiding physical activity. First, sleep disturbance in children has been associated previously with increased television usage and sedentary behavior,^{17,18} and exercise is thought to improve overall sleep time and sleep quality.¹⁹ Further, exercise-induced bronchoconstriction affects $\geq 90\%$ of individuals with asthma, resulting in exacerbation of wheezing and other asthma symptoms.²⁰ Physical activity also causes increased heat and sweating, commonly reported aggravating factors of itch in children with eczema.^{21,22} Previous analyses have found conflicting results on the levels of physical activity in children with asthma, eczema, and hay fever. One large study found that symptoms of asthma, allergic rhinitis, and eczema were associated with increased physical activity in adolescents but not children.²³ Some studies found asthma to be associated with increased physical activity,²⁴⁻²⁶ although other studies found no effect or decreased levels of physical activity in children with asthma.²⁷⁻³⁰ Additionally, a recent systematic review of physical activity in eczema found that there was insufficient evidence in the current literature to make concrete conclusions regarding whether eczema was associated with physical activity.³¹ We hypothesized that severe atopic disease and atopic disease accompanied by sleep disturbances are associated particularly with decreased physical activity and increased sedentary behavior. The present study analyzed 2 US population-based studies to determine if childhood eczema, asthma, and hay fever are associated with less vigorous physical activity and more sedentary behavior.

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Methods

Data from 2 cross-sectional studies, the 2003-2004 and 2007-2008 National Survey of Children's Health (NSCH), were analyzed. Both were telephone-based surveys designed and collected by the National Center for Health Statistics, a branch of the Centers for Disease Control and Prevention, for the purpose of estimating the prevalence of children's health issues. The specific characteristics of each survey are detailed in [Table I](#) (available at www.jpeds.com). Each survey's sample was created by screening randomly generated household telephone numbers for the presence of children under the age of 18 and, if a child was present, the survey would be initiated with the caregiver. In households with ≥ 2 children, 1 child was selected randomly to be the subject of the interview. Afterward, the National Center for Health Statistics generated sample weights, using data from the US Census Bureau, which took into account age, sex, race, ethnicity, household size, and educational attainment of the most educated household member. These sample weights allow for frequency and prevalence estimates that accurately represent each state's population of noninstitutionalized children. Frequency and prevalence estimates from both individual and pooled analyses incorporate this complex weighting process. Sample weights between the 2 studies were able to be combined due to similar sampling methodologies. This study was approved by the Institutional Review Board at Northwestern University.

Associations with Atopic Disease

The questions to assess these exposures and outcomes are presented in [Table II](#) (available at www.jpeds.com). A number of different associations of eczema, hay fever, and asthma, as well as a composite atopic variable encompassing ≥ 1 of these diseases were examined. Associations between each disease and either ≥ 1 and ≥ 3 days of vigorous physical activity in the preceding week, ≥ 5 hours of daily television and video game usage, and sports participation in the past year were analyzed. Further, we created models to examine for significant interactions between each atopic disease and sleep disturbance as predictors of the aforementioned measures of physical activity and sedentary behavior. Sleep disturbance was determined by caregiver report of ≤ 3 nights of adequate sleep per week. Finally, we created models to examine the associations of caregiver-reported severity of eczema, asthma, and hay fever with number of days with vigorous physical activity, hours of daily television and video game usage, and sports participation in the past year (NSCH 2007-2008 only).

Statistical Analyses

All statistical analyses and data processes were performed using SAS version 9.4 (SAS Institute, Cary, North Carolina). Binary survey logistic regression models were constructed with either ≥ 1 days or ≥ 3 days of vigorous physical activity

in the previous week, ≥ 5 hours of daily television/video game usage, or sports participation in the past 12 months as the binary dependent variables (yes/no). History of eczema, asthma, or hay fever (yes/no), or disease severity (mild/moderate/severe) were the independent categorical variables. Multivariate models included sex (male/female), age (continuous), race/ethnicity (non-Hispanic Caucasian/non-Hispanic African American/Hispanic/multiracial, or other), household income (0%-399%/ $\geq 400\%$ of the federal poverty level), highest level of household/parental education (high school or less/more than high school), insurance coverage (yes/no), and birth place (US/foreign) as independent variables. Pooled analyses were performed by combining the data sets and dividing each sample weight by the number of studies ($n = 2$). OR and 95% CI were estimated. Two-sided P values $< .05$ were considered significant. Complete data analysis was performed in that subjects with missing datapoints were excluded. The frequency of missing values from each study is presented in [Table III](#) (available at www.jpeds.com). Two-way interactions between atopic disease and age were examined and reported if significant ($P < .01$) and modified the effect size by $> 20\%$.

Results

Overall, data on 133 107 children age 6-17 years were analyzed. The pooled prevalence of eczema was 9.9% (95% CI, 9.5%-10.2%), ever history of asthma was 15.1% (14.6%-15.5%), 1-year history of asthma was 10.1% (9.8%-10.5%), hay fever was 18.0% (17.5%-18.4%), and any atopic disease was 28.6% (28.1%-29.2%).

Association between Atopic Disease and Number of Days of Vigorous Physical Activity in the Preceding Week

In pooled bivariate models, only history of hay fever (OR, 1.18; 95% CI, 1.07-1.32; $P = .0008$) was associated with increased odds of engaging in vigorous physical activity on ≥ 1 days in the preceding week ([Table IV](#)). In multivariate models adjusting for sociodemographics, lifetime history of asthma was associated with lower odds of vigorous physical activity on ≥ 1 days (aOR, 0.87; 95% CI, 0.77-0.99; $P = .03$) and ≥ 3 days (aOR, 0.91; 95% CI, 0.83-0.99; $P = .047$) in the past week. In addition, eczema was associated with decreased odds of vigorous physical activity on ≥ 3 days (aOR, 0.88; 95% CI, 0.80-0.98; $P = .02$). Current history of asthma and any atopic disease were not significantly associated with either ≥ 1 or ≥ 3 days of physical activity ($P > .05$). No significant interactions between atopic disease and age were found as predictors of vigorous physical activity.

Association between Atopic Disease and Sedentary Behavior

In pooled bivariate models, children with eczema (OR, 1.23; 95% CI, 1.03-1.48; $P = .03$), and ever history of asthma (OR, 1.32; 95% CI, 1.13-1.61; $P = .0004$), and current history of asthma (OR, 1.34; 95% CI, 1.12-1.61; $P = .001$) had higher

Table IV. Association between allergic disease and number of days of physical activity in the past week (NSCH 2003-2004 and 2007-2008)

Variables	≥1 days of physical activity in the past week						
	No (n = 13 472)	Yes (n = 118 311)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
No	12 099	106 524	89.2 (88.7-89.6)	1.00	-	1.00	-
Yes	1353	11 643	88.8 (87.6-90.0)	0.97 (0.85-1.09)	.57	0.88 (0.77-1.01)	.06
Hay fever							
No	11 010	94 956	88.8 (88.4-89.3)	1.00	-	1.00	-
Yes	2410	23 095	90.4 (89.7-91.2)	1.18 (1.07-1.32)	.0008	1.06 (0.94-1.19)	.34
Ever asthma							
No	11 271	101 085	89.3 (88.8-89.7)	1.00	-	1.00	-
Yes	2180	17 079	88.3 (87.2-89.3)	0.91 (0.81-1.01)	.08	0.87 (0.77-0.99)	.03
Current asthma							
No	11 902	106 334	89.2 (88.8-89.6)	1.00	-	1.00	-
Yes	1503	11 543	88.4 (87.4-89.5)	0.93 (0.83-1.04)	.18	0.91 (0.80-1.03)	.13
Atopic (any)							
No	9500	82 692	88.9 (88.5-89.4)	1.00	-	1.00	-
Yes	3856	34 901	89.6 (89.0-90.3)	1.07 (0.99-1.17)	.11	0.98 (0.89-1.08)	.71
Variables	≥3 days of physical activity in the preceding week						
	No (n = 31 642)	Yes (n = 100 141)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
No	28 417	90 206	75.5 (75.0-76.1)	1.00	-	1.00	-
Yes	3179	9817	74.4 (72.8-76.0)	0.94 (0.86-1.03)	.19	0.88 (0.80-0.98)	.02
Hay fever							
No	25 734	80 232	74.9 (74.4-75.5)	1.00	-	1.00	-
Yes	5793	19 712	77.7 (76.6-78.9)	1.17 (1.08-1.26)	<.0001	1.06 (0.97-1.15)	.20
Ever asthma							
No	26 763	85 593	75.6 (75.0-76.1)	1.00	-	1.00	-
Yes	4821	14 438	74.7 (73.3-76.2)	0.96 (0.88-1.04)	.29	0.91 (0.83-0.99)	.047
Current asthma							
No	28 192	90 044	75.5 (75.0-76.1)	1.00	-	1.00	-
Yes	3298	9748	74.7 (73.1-76.3)	0.96 (0.88-1.05)	.33	0.92 (0.83-1.02)	.11
Atopic (any)							
No	22 302	69 890	75.2 (74.5-75.8)	1.00	-	1.00	-
Yes	9085	29 672	76.2 (75.2-77.1)	1.06 (0.99-1.13)	.18	0.98 (0.91-1.05)	.55

Binary survey logistic regression models were constructed with number of days in the past week with ≥20 minutes of vigorous physical activity as the binary dependent variable (either 1-7 vs 0 or 3-7 vs 0-2 days). The independent (explanatory) variable was history of either eczema, hay fever, ever or current asthma, or any allergic disease (all binary). Prevalence OR and 95% CI were determined. Multivariate models additionally included age (continuous), gender, race/ethnicity, household income, birth place in the US, highest level of education in the household, and insurance coverage (all categorical) as independent variables. Adjusted prevalence OR and 95% CI were determined. Bold values indicate $P < .05$.

odds of spending ≥5 hours per day watching television or playing video games (Table V; available at www.jpeds.com). However, these associations did not remain significant in multivariate models.

In pooled bivariate models, children with ever (OR, 0.92; 95% CI, 0.86-0.99; $P = .02$) or current (OR, 0.90; 95% CI, 0.83-0.98; $P = .01$) history of asthma had lower odds of participation in sports in the past 12 months compared with children without asthma (Table V). The association with ever history of asthma (aOR, 0.91; 95% CI, 0.84-0.99; $P = .02$) remained significant in multivariate models. Interestingly, hay fever was associated with increased odds of sports participation in the past 12 months (OR, 1.13; 95% CI, 1.06-1.21; $P = .0001$) in the bivariate but not multivariate model. Eczema was not associated with sports participation in bivariate or multivariate models.

There were no interactions between asthma or eczema and age on either television usage or sports participation. A

significant 2-way interaction was found between hay fever and age as predictors of sports participation. In bivariate models, children age 6-9 with hay fever had higher odds of sports participation than did children age 6-9 without hay fever (OR, 1.35; 95% CI, 1.21-1.51; $P < .0001$). However, children age 14-17 with hay fever did not have higher odds of sports participation than did children age 14-17 without hay fever (OR, 0.96; 95% CI, 0.96-1.07; $P = .48$). This effect remained significant in multivariate models.

Interaction between Atopic Disease and Nights of Adequate Sleep on Sedentary Behavior

There were significant 2-way interactions between atopic disease and number of nights with adequate sleep as predictors of number of hours of television watching and sports participation, but not physical activity. In multivariate models of participation in sports in the past 12 months, children with eczema (aOR, 0.66; 95% CI, 0.50-0.86; $P = .002$), asthma

Table VI. Interactions of atopic disease and nights of adequate sleep with physical activity and sedentary behavior (NSCH 2003-2004 and 2007-2008)

		Participation in sports in the past 12 months						
		No (n = 49 364)	Yes (n = 83 599)					
Nights of adequate sleep		Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema								
No	4-7	39 843	68 692	58.2 (57.5-58.8)	1.00 [ref]	-	1.00 [ref]	-
No	0-3	3975	6118	56.3 (54.2-58.5)	0.93 (0.85-1.02)	.11	0.93 (0.83-1.03)	.17
Yes	4-7	4272	7332	59.4 (57.5-61.3)	1.05 (0.97-1.15)	.24	1.03 (0.93-1.13)	.59
Yes	0-3	601	770	51.1 (45.3-56.8)	0.75 (0.59-0.96)	.02	0.66 (0.50-0.86)	.002
Asthma								
No	4-7	37 591	65 453	58.5 (57.8-59.2)	1.00 [ref]	-	1.00 [ref]	-
No	0-3	3643	5663	56.9 (54.7-59.1)	0.94 (0.85-1.03)	.16	0.91 (0.82-1.02)	.10
Yes	4-7	6538	10 552	57.0 (55.3-58.7)	0.94 (0.87-1.01)	.10	0.92 (0.85-1.01)	.08
Yes	0-3	930	1230	51.1 (46.4-55.8)	0.74 (0.61-0.90)	.002	0.73 (0.56-0.94)	.01
Hay fever								
No	4-7	36 057	61 181	57.6 (56.9-58.3)	1.00 [ref]	-	1.00 [ref]	-
No	0-3	3435	5298	56.1 (53.8-58.4)	0.94 (0.85-1.04)	.21	0.93 (0.83-1.04)	.18
Yes	4-7	8011	14 757	61.3 (59.9-62.8)	1.17 (1.09-1.25)	<.0001	1.00 (0.93-1.09)	.94
Yes	0-3	1134	1584	54.1 (49.9-58.3)	0.87 (0.73-1.03)	.10	0.76 (0.61-0.95)	.01
≥5 hours of daily television and video games								
		No (n = 49 364)	Yes (n = 83 599)					
		Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema								
No	4-7	103 604	3992	4.2 (3.9-4.4)	1.00 [ref]	-	1.00 [ref]	-
No	0-3	9346	642	8.7 (7.4-9.9)	2.18 (1.84-2.58)	<.0001	1.94 (1.59-2.37)	<.0001
Yes	4-7	11 044	485	4.6 (3.8-5.4)	1.11 (0.90-1.35)	.33	1.04 (0.82-1.32)	.74
Yes	0-3	1229	127	12.9 (8.4-17.5)	3.41 (2.26-5.15)	<.0001	3.13 (1.98-4.95)	<.0001
Hay fever								
No	4-7	92 750	3617	4.3 (4.0-4.6)	1.00 [ref]	-	1.00 [ref]	-
No	0-3	8060	577	8.9 (7.5-10.3)	2.20 (1.83-2.65)	<.0001	1.97 (1.59-2.45)	<.0001
Yes	4-7	21 780	853	3.9 (3.4-4.4)	0.91 (0.78-1.07)	.26	0.96 (0.81-1.15)	.74
Yes	0-3	2501	192	12.9 (8.4-17.5)	2.58 (1.91-3.49)	<.0001	2.49 (1.77-3.50)	<.0001

Binary survey logistic regression models were constructed with number of days in the past week with ≥20 minutes of vigorous physical activity (1-7 vs 0), participation in sports in the past year (yes vs no) and ≥5 hours of daily television and video games as the binary dependent variable. The independent (explanatory) variable was the history of eczema (yes vs no), number of nights of adequate sleep in the past week (0-3 vs 4-7) and a 2-way interaction term between them. Prevalence OR and 95% CI were determined. Multivariate models additionally included age (continuous), gender, race/ethnicity, household income, birth place in the US, highest level of education in the household, and insurance coverage (all categorical) as independent variables. Adjusted prevalence OR and 95% CI were determined.

Bold values indicate $P < .05$.

(aOR, 0.73; 95% CI, 0.56-0.94; $P = .01$), and hay fever (aOR, 0.76; 95% CI, 0.61-0.95; $P = .01$) accompanied by 0-3 nights of adequate sleep had lesser odds of sports participation; eczema, asthma, hay fever, or 0-3 nights of adequate sleep alone were not significantly associated with sports participation (Table VI). In contrast, insufficient sleep alone was associated with increased odds of ≥5 hours of daily television or video games. However, children with eczema (aOR, 3.13; 95% CI, 1.98-4.95; $P < .0001$) or hay fever (aOR, 2.49; 95% CI, 1.77-3.50; $P < .0001$) accompanied by insufficient sleep had even higher odds of ≥5 hours of daily television or video games (Table VI).

Associations between Atopic Disease Severity and Physical Activity and Sedentary Behavior

In multivariate models, severe eczema (≥1 days: aOR, 0.39; 95% CI, 0.19-0.78; $P = .007$; ≥3 days: aOR, 0.62; 95% CI, 0.34-1.11; $P = .11$), asthma (≥1 day: aOR, 0.29; 95% CI, 0.14-0.61; $P = .001$; ≥3 days: aOR, 0.33; 95% CI, 0.16-0.72; $P = .005$), and hay fever (≥1 day: aOR, 0.48; 95% CI, 0.14-0.61; $P = .04$; ≥3 days: aOR, 0.51; 95% CI, 0.31-0.84;

$P = .008$) were all associated with significantly lesser odds of vigorous physical activity compared with mild disease, respectively (Table VII). However, moderate eczema, asthma, and hay fever were not significantly associated with ≥1 or ≥3 days of vigorous physical activity compared with mild disease.

In multivariate models, severe eczema (aOR, 2.62; 95% CI, 1.19-5.79; $P = .02$) and asthma (aOR, 3.07; 95% CI, 1.14-8.27; $P = .03$), but not severe hay fever (aOR, 0.95; 95% CI, 0.51-1.79; $P = .88$), were associated with increased odds of ≥5 hours of daily television and video games compared with mild disease (Table VIII). However, moderate eczema, asthma, and hay fever were not associated with ≥5 hours of daily television and video game usage.

In multivariate models, moderate eczema (aOR, 0.76; 95% CI, 0.57-0.99; $P = .048$) and severe eczema (aOR, 0.45; 95% CI, 0.28-0.73; $P = .001$), severe asthma (aOR, 0.47; 95% CI, 0.25-0.89; $P = .02$), and severe hay fever (aOR, 0.53; 95% CI, 0.36-0.78; $P = .002$) were all associated with decreased participation in sports in the past 12 months compared with mild disease (Table VIII). Moderate hay fever was

Table VII. Association between severity of atopic disease and number of days of physical activity in the past week (NSCH 2007-2008)

Atopic disease	≥1 days of physical activity in the past week						
	No (n = 5767)	Yes (n = 57 667)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
Mild	374	4267	91.0 (89.2-92.8)	1.00	-	1.00	-
Moderate	178	1652	88.2 (84.1-92.3)	0.74 (0.47-1.17)	.20	0.64 (0.39-1.04)	.07
Severe	81	357	83.7 (76.2-91.1)	0.51 (0.28-0.91)	.02	0.39 (0.19-0.78)	.007
Current asthma							
Mild	430	4194	90.3 (88.5-92.1)	1.00	.36	1.00	-
Moderate	147	1274	89.7 (86.7-92.6)	0.93 (0.64-1.36)	.71	0.87 (0.60-1.27)	.47
Severe	47	195	75.2 (62.5-87.8)	0.33 (0.16-0.66)	.002	0.29 (0.14-0.61)	.001
Hay fever							
Mild	702	8445	92.0 (90.8-93.2)	1.00	-	0.00	-
Moderate	308	3177	90.7 (87.8-93.6)	0.85 (0.58-1.24)	.39	1.21 (0.88-1.65)	.23
Severe	62	399	81.0 (72.5-89.5)	0.37 (0.21-0.66)	.0007	0.48 (0.24-0.97)	.04
Atopic disease	≥3 days of physical activity in the past week						
	No (n = 13 408)	Yes (n = 50 026)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
Mild	942	3699	77.0 (74.0-80.1)	1.00	-	1.00	-
Moderate	422	1408	76.8 (71.9-81.7)	0.99 (0.71-1.37)	.93	0.93 (0.66-1.32)	.69
Severe	133	305	70.1 (60.3-79.9)	0.70 (0.42-1.15)	.16	0.62 (0.34-1.11)	.11
Current asthma							
Mild	986	3638	78.6 (75.8-81.5)	1.00	.36	1.00	-
Moderate	307	1114	72.9 (67.1-78.8)	0.73 (0.52-1.03)	.07	0.79 (0.55-1.14)	.21
Severe	81	161	59.3 (44.1-74.5)	0.40 (0.21-0.76)	.005	0.33 (0.16-0.72)	.005
Hay fever							
Mild	1761	7386	80.8 (78.7-82.9)	1.00	-	0.00	-
Moderate	739	2746	77.7 (73.7-81.7)	0.83 (0.64-1.08)	.17	0.90 (0.69-1.17)	.42
Severe	128	333	65.8 (56.5-75.2)	0.46 (0.30-0.71)	.0005	0.51 (0.31-0.84)	.008

Binary survey logistic regression models were constructed with number of days in the past week with ≥20 minutes of vigorous physical activity as the binary dependent variable (either 1-7 vs 0 days or 3-7 vs 1-2 days). The independent (explanatory) variable was severity of eczema, hay fever, or current asthma (moderate or severe vs mild). Prevalence OR and 95% CI were determined. Multivariate models additionally included age (continuous), gender, race/ethnicity, household income, birth place in the US, highest level of education in the household, and insurance coverage (all categorical) as independent variables. Adjusted prevalence OR and 95% CI were determined.

Bold values indicate $P < .05$.

associated with less sports participation in bivariate (OR, 0.78; 95% CI, 0.63-0.96; $P = .02$), but not multivariate (aOR, 0.86; 95% CI, 0.68-1.08; $P = .20$) models.

There were no interactions between atopic disease severity and age on vigorous physical activity, hours of daily television and video game usage, or sports participation.

Discussion

We found that children with a 1-year history of eczema and asthma, in general, and severe asthma, eczema, and hay fever, in particular, participated in significantly less vigorous physical activity. Severe eczema and asthma were associated with significantly greater odds of ≥5 hours of daily television and video games. Ever history of asthma, moderate to severe eczema, severe asthma, and severe hay fever were all associated with a lesser odds of sports participation. Finally, children with atopic disease and sleep disturbances seem to have even higher odds of sedentary behavior than those with either atopic disease or sleep disturbance alone.

Previous studies of this subject have been conflicting. Data from the International Study of Asthma and Allergies in

Childhood Phase Three, including 76 164 children aged 6-7 years and 201 730 adolescents aged 13-14 years, found that symptoms of wheezing, rhinoconjunctivitis, eczema, and severe asthma were associated with an increased odds of ≥3 episodes of vigorous physical activity per week in adolescents but not children.²³ Symptoms of wheezing, rhinoconjunctivitis, and eczema also were associated with increased odds of daily television viewing in adolescents. A questionnaire-based study of 25 610 Swedish adolescents and adults found a significantly greater proportion of subjects with asthma were physically active compared with subjects without asthma.²⁴ Another study of 636 children attending a racially diverse middle school found that children with asthma were more active than children without asthma, measured in terms of metabolic equivalents per year.²⁶ In contrast, a case-control study of 137 children with asthma and 106 controls who attended an urban primary care clinic found that a significantly greater percentage of children with asthma were active for <30 minutes per day and <3 days per week compared with children without asthma.²⁷ Another study used accelerometers to assess physical activity in 8 children with asthma and 46 children without asthma, and found

Table VIII. Association between severity of atopic disease and sedentary behavior (NSCH 2007-2008)

Atopic disease	≥5 hours of daily television and video games						
	No (n = 60 112)	Yes (n = 2390)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
Mild	196	4392	95.6 (94.4-96.8)	1.00	-	1.00	-
Moderate	84	1729	94.7 (92.6-96.9)	0.98 (0.62-1.54)	.91	1.03 (0.63-1.69)	.90
Severe	38	430	83.7 (74.3-93.1)	3.59 (1.75-7.36)	.0005	2.62 (1.19-5.79)	.02
Current asthma							
Mild	215	4319	95.3 (94.2-96.5)	1.00	-	1.00	-
Moderate	77	1306	94.9 (92.7-97.0)	1.00 (0.64-1.36)	.99	0.85 (0.49-1.48)	.57
Severe	24	210	84.9 (72.9-96.9)	3.77 (1.57-9.10)	.003	3.07 (1.14-8.27)	.03
Hay fever							
Mild	348	8695	95.8 (94.8-96.8)	1.00	-	0.00	-
Moderate	147	3290	94.5 (92.7-96.4)	1.15 (0.79-1.68)	.48	0.95 (0.51-1.44)	.81
Severe	32	446	92.2 (88.2-96.1)	1.67 (0.97-2.85)	.06	0.95 (0.51-1.79)	.88
Atopic disease	Participation in sports in the past 12 months						
	No (n = 23 354)	Yes (n = 40 673)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
Mild	1641	3034	38.9 (35.6-42.1)	1.00	-	1.00	-
Moderate	746	1105	46.6 (40.9-52.4)	0.73 (0.56-0.95)	.02	0.76 (0.57-0.99)	.048
Severe	235	208	61.2 (51.2-72.1)	0.40 (0.26-0.63)	<.0001	0.45 (0.28-0.73)	.001
Current asthma							
Mild	1707	2954	44.4 (40.7-48.1)	1.00	-	1.00	-
Moderate	631	802	44.0 (38.5-49.5)	1.02 (0.78-1.33)	.90	0.99 (0.75-0.89)	.97
Severe	152	97	66.7 (55.0-78.5)	0.40 (0.23-0.69)	.001	0.47 (0.25-0.89)	.02
Hay fever							
Mild	3070	6143	37.2 (34.6-39.8)	1.00	-	0.00	-
Moderate	1351	2165	43.3 (38.8-47.8)	0.78 (0.63-0.96)	.02	0.86 (0.68-1.08)	.20
Severe	239	226	58.2 (49.7-66.6)	0.43 (0.30-0.61)	<.0001	0.53 (0.36-0.78)	.002

Binary survey logistic regression models were constructed with number of hours of daily television and video games (≥5 vs <5) and participation in sports in the past 12 months (yes vs no) as the binary dependent variable. The independent (explanatory) variable was severity of eczema, hay fever, or current asthma (moderate or severe vs mild). Prevalence OR and 95% CI were determined. Multivariate models additionally included age (continuous), gender, race/ethnicity, household income, birth place in the US, highest level of education in the household, and insurance coverage (all categorical) as independent variables. Adjusted prevalence OR and 95% CI were determined. Bold values indicate $P < .05$.

that the children with asthma exhibited significantly less physical activity than children without asthma.³⁰ The present study suggests that children with severe asthma, as well as eczema and hay fever, have decreased vigorous physical activity and increased sedentary behaviors.

Atopic disease overall was not consistently associated with vigorous physical activity or sedentary behavior. Rather, it is children with severe atopic disease accompanied by sleep disturbance who seem to be at greater risk. This phenomenon might be related to more profound activity-related symptom exacerbation in children with more severe eczema (ie, increased itch from excess heat and sweat) and asthma (ie, increased cough and shortness of breath). These findings also may be related to underlying sleep disturbance in atopic disease, because the effect sizes were greater in children with both atopic disease and sleep disturbance compared with children with either condition alone. Future studies would be useful to determine whether improved therapeutic control of eczema, asthma, and hay fever or improvement of sleep quality could improve physical activity and reduce sedentary behavior in children with these diseases. Further, more research is needed to identify the best interventions and counseling to improve physical activity and sedentary behavior in

children with severe atopic disease. Such interventions might even improve the symptoms of atopic disease.^{32,33}

The current study has a number of strengths, including the use of 2 population-based studies that sampled children and adolescents of all ages and socioeconomic backgrounds, and from all states. Inherent to each survey's design is a large sample size acquired with minimal selection bias allowing for an accurate representation of the US population of children. Additionally, we used multivariate regression models to control for potential confounding factors. Finally, the assessment of disease severity in NSCH 2007-2008 allowed for analyses to distinguish differences in behavior between children with mild vs severe disease. The current study also has a number of limitations. History of eczema, asthma, and hay fever were determined by caregiver report of physician diagnosis and not verified by physician evaluation or medical record data. We recently performed a multicenter validation study and found the specific question used to evaluate eczema history in the NSCH surveys to have very good sensitivity, specificity, and positive predictive value.³⁴ Moreover, previous studies of self-reported eczema, asthma, and hay fever found good concordance with physician assessment.³⁵⁻³⁸ Hence, we believe the case definitions of atopic disease are valid. Finally,

the present study is a cross-sectional analysis and, as such, no definitive conclusions can be made on causation or direction of association. It is possible that severe atopic disease in children results in decreased physical activity and increased sedentary behavior. It is also possible that inactive and sedentary children are more prone to developing sleep disturbance, atopic disease, or symptoms of atopy. Further, there could be genetic or environmental factors that underlie symptoms of atopic disease, sleep disturbance, and inactivity. Prospective cohort studies with specific monitoring of activity levels, sleep patterns, and sedentary behavior in addition to atopic disease onset and time course could provide further information on causality. ■

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Table I. Survey characteristics

Study	Size	Age (y)	Type	Languages	Assessments
NSCH 2003-2004	69 031	6-17	Telephone	English Spanish Mandarin Cantonese Vietnamese Korean	Caregiver report
NSCH 2007-2008	64 076	6-17	Telephone	English Spanish Mandarin Cantonese Vietnamese Korean	Caregiver report

Table II. Questions used in this study

Variables	Questions	Surveys asked
Eczema	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?	NSCH 2003-2004 NSCH 2007-2008
Ever asthma	Has a doctor or other health professional ever told you that (child) had asthma?	NSCH 2003-2004 NSCH 2007-2008
Current asthma	Does (child) still have asthma?	NSCH 2003-2004 NSCH 2007-2008
Hay fever	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?	NSCH 2003-2004 NSCH 2007-2008
Nights of adequate sleep	During the past week, on how many nights did (child) get enough sleep for a child (his/her) age?	NSCH 2003-2004 NSCH 2007-2008
Vigorous physical activity	During the past week, on how many days did (child) exercise or participate in physical activity for at least 20 minutes that made [him/her] sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?	NSCH 2003-2004
Vigorous physical activity	During the past week, on how many days did (child) exercise, play a sport, or participate in physical activity for at least 20 minutes that made [him/her] sweat and breathe hard?	NSCH 2007-2008
Television and video game usage	On an average school day, about how many hours does (child) usually watch TV, watch videos, or play video games?	NSCH 2003-2004 NSCH 2007-2008
Sports participation	During the past 12 months, was [CHILD] on a sports team or did [he/she] take sports lessons after school or on weekends?	NSCH 2003-2004 NSCH 2007-2008
Eczema severity	Would you describe (his/her) eczema or skin allergy as mild, moderate, or severe?	NSCH 2007-2008
Asthma severity	Would you describe (his/her) asthma as mild, moderate, or severe?	NSCH 2007-2008
Hay fever severity	Would you describe (his/her) hay fever as mild, moderate, or severe?	NSCH 2007-2008

Table III. Frequency of missing values for variables used in the study

Variables	Frequency (%)
NSCH 2003-2004	
Eczema	176 (0.18)
Ever asthma	218 (0.22)
Current asthma	356 (0.35)
Hay fever	326 (0.32)
Vigorous physical activity	649 (1.17)
Daily television and video game usage	341 (0.64)
Sports participation	64 (0.12)
Nights of adequate sleep	579 (0.85)
Age	0 (0.00)
Race/ethnicity	1416 (1.40)
Sex	80 (0.07)
Household income	9414 (9.20)
Highest level of education in the household	432 (0.42)
US birthplace	22 (0.02)
Insurance coverage	169 (0.17)
NSCH 2007-2008	
Eczema	99 (0.11)
Ever asthma	117 (0.13)
Current asthma	120 (0.14)
Asthma severity	17 (0.02)
Hay fever	187 (0.21)
Hay fever severity	54 (0.05)
Vigorous physical activity	642 (1.15)
Daily television and video game usage	550 (0.92)
Sports participation	49 (0.10)
Nights of adequate sleep	634 (0.70)
Age	0 (0.00)
Race/ethnicity	1546 (1.68)
Sex	110 (0.12)
Household income	0 (0.0)*
Highest level of education in the household	4346 (4.74)
US birthplace	961 (1.05)
Insurance coverage	183 (0.20)

*Multiple imputation of missing values, generated by the National Center for Health Statistics were used. Missing values were encountered in 9.2% of subjects in the raw datasets.

Table V. Association between atopic disease and sedentary behavior (NSCH 2003-2004 and 2007-2008)

Variables	≥5 hours of daily television and video game usage						
	No (n = 121 164)	Yes (n = 10 565)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
No	113 848	4706	4.5 (4.3-4.8)	1.00	-	1.00	-
Yes	12 390	620	5.5 (4.6-6.4)	1.23 (1.03-1.48)	.03	1.18 (0.96-1.47)	.12
Hay fever							
No	101 647	4259	4.6 (4.4-4.9)	1.00	-	1.00	-
Yes	24 451	1059	4.6 (4.0-5.1)	0.98 (0.85-1.14)	.83	1.04 (0.89-1.22)	.61
Ever asthma							
No	107 944	4364	4.4 (4.2-4.7)	1.00	-	1.00	-
Yes	18 292	962	5.8 (5.0-6.6)	1.32 (1.13-1.55)	.0004	1.15 (0.96-1.37)	.13
Current asthma							
No	113 580	4618	4.5 (4.2-4.7)	1.00	-	1.00	-
Yes	12 346	691	6.0 (5.0-6.9)	1.34 (1.12-1.61)	.001	1.12 (0.91-1.37)	.29
Atopic (any)							
No	88 546	3591	4.5 (4.2-4.8)	1.00	-	1.00	-
Yes	37 059	1704	5.0 (4.5-5.5)	1.12 (0.99-1.27)	.08	1.09 (0.95-1.26)	.21
Sports participation in the past 12 months							
Variables	No (n = 49 364)	Yes (n = 83 599)					
	Frequency	Frequency	Prevalence (95% CI)	OR (95% CI)	P	aOR (95% CI)	P
Eczema							
No	44 344	75 347	57.9 (57.3-58.6)	1.00	-	1.00	-
Yes	4940	8167	58.4 (57.3-60.2)	1.01 (0.94-1.10)	.74	0.98 (0.89-1.08)	.68
Hay fever							
No	97 435	8471	57.4 (56.7-58.1)	1.00	-	1.00	-
Yes	9245	16 441	60.4 (59.0-61.8)	1.13 (1.06-1.21)	.0001	0.98 (0.91-1.06)	.62
Ever asthma							
No	41 729	71 633	58.3 (57.6-58.9)	1.00	-	1.00	-
Yes	7566	11 866	56.2 (54.6-57.7)	0.92 (0.86-0.99)	.02	0.91 (0.84-0.99)	.02
Current asthma							
No	43 976	75 321	58.2 (57.6-58.9)	1.00	-	1.00	-
Yes	5183	7981	55.5 (53.6-57.3)	0.90 (0.83-0.98)	.01	0.92 (0.83-1.01)	.07
Atopic (any)							
No	34 608	58 441	57.6 (56.9-58.3)	1.00	-	1.00	-
Yes	14 401	24 669	58.9 (57.8-60.0)	1.05 (1.00-1.12)	.057	0.98 (0.92-1.04)	.48

Binary survey logistic regression models were constructed with ≥5 hours per week of television and video game usage (yes vs no) and sports participation in the past 12 months (yes vs no) as the binary dependent variable and atopic disease as the binary independent variable (eczema, hay fever, current or ever history of asthma, or any atopic disease). Prevalence OR and 95% CI were estimated. Multivariate models additionally included age (continuous), sex, race/ethnicity, household income, highest level of household education, US vs foreign birthplace, and insurance coverage (all binary) as covariates. The aOR and 95% CI were estimated. Bold values indicate $P < .05$.