



# 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  $\geq 1$  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  $\geq 1$  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.<sup>1-3</sup> Children with atopic diseases use more health care services and incur significantly higher health care expenditures than do children without atopic disease.<sup>4-7</sup> Additionally, childhood atopic disease is associated with increased prevalence of cardiovascular risk factors such as obesity and hypertension<sup>8-12</sup> and also is associated with an increased prevalence of sleep disturbance and poor sleep quality.<sup>13-16</sup>

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,<sup>17,18</sup> and exercise is thought to improve overall sleep time and sleep quality.<sup>19</sup> Further, exercise-induced bronchoconstriction affects  $\geq 90\%$  of individuals with asthma, resulting in exacerbation of wheezing and other asthma symptoms.<sup>20</sup> Physical activity also causes increased heat and sweating, commonly reported aggravating factors of itch in children with eczema.<sup>21,22</sup> 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.<sup>23</sup> Some studies found asthma to be associated with increased physical activity,<sup>24-26</sup> although other studies found no effect or decreased levels of physical activity in children with asthma.<sup>27-30</sup> 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.<sup>31</sup> 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](http://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  $\geq 2$  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](http://www.jpeds.com)). A number of different associations of eczema, hay fever, and asthma, as well as a composite atopic variable encompassing  $\geq 1$  of these diseases were examined. Associations between each disease and either  $\geq 1$  and  $\geq 3$  days of vigorous physical activity in the preceding week,  $\geq 5$  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  $\leq 3$  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  $\geq 1$  days or  $\geq 3$  days of vigorous physical activity

in the previous week,  $\geq 5$  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](http://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  $\geq 1$  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  $\geq 1$  days (aOR, 0.87; 95% CI, 0.77-0.99;  $P = .03$ ) and  $\geq 3$  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  $\geq 3$  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  $\geq 1$  or  $\geq 3$  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

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