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Asthma and physical activity in multiracial girls from three US sites

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Abstract

Objective—Studies comparing physical activity levels in children with and without asthma have had mixed results. Our objective was to investigate the association between asthma diagnosis and physical activity and to examine differences in these associations by race/ethnicity, weight status and caregiver education.

Methods—We investigated the association between asthma (defined as report of physician-diagnosed asthma with at least one asthma related symptom) and measures of physical and sedentary activity in a study of 6- to 8-year-old girls in the Breast Cancer and the Environment Research Project. We compared reported activity and pedometer measurements among girls with and without asthma, and examined modification of these associations by race/ethnicity, weight status and caregiver education.

Results—Girls (n = 1182) were included with 33.5% White, 4.8% Asian, 30.6% non Hispanic Black and 30.7% Hispanic. Asthma was present in 16.2% of girls. Overall, 38% of girls reported no participation in organized recreational activities and 58% had > 2 h/day of television, video game and computer time combined. Girls with asthma whose parents were less educated reported fewer pedometer steps and less non-scheduled activity than girls without asthma with similar caregiver education level. Among girls with asthma, those on a controller medication had higher levels of sedentary activity and more structured physical activity but were less likely to report high intensity physical activity.

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Declaration of interest
The authors have no potential conflicts of interest or corporate sponsors to disclose.

Conclusions—Among girls whose parents are less educated, girls with asthma may have lower physical activity levels than girls without asthma. Use of a controller medication may be related to physical and sedentary activity.

Keywords

Asthma; children; physical activity; sedentary activity

Introduction

Asthma

Pediatric asthma is highly prevalent in US children with over 10 million children aged younger than 17 years (14%) who have ever been diagnosed with the condition [1]. A rising trend in asthma prevalence has been observed across all demographic groups over several decades including recent increases from 2001 to 2009 [2]. In 2008, children with asthma missed 10.5 million school days, and in 2007, there were 1.75 million asthma-related emergency department visits and 456 000 asthma hospitalizations with higher rates in children than in adults [3].

Several studies have found an association between obesity and asthma in children including a meta-analysis which estimated that children with high body weight have a risk of asthma equal to 1.5 times the risk of children without high body weight (95% CI for RR 1.2–1.8) [4]. The reasons for the association between obesity and asthma are unclear, but physical activity may be related to both. While physical activity levels are clearly associated with obesity, the relationship between asthma diagnosis and level of physical activity is less clear.

The goal of this research was to examine the prevalence of asthma symptoms and diagnosis in relation to physical activity and sedentary behaviors and to measure the association between asthma and physical activity in a national study of young girls. We hypothesized that girls with asthma would have lower levels of physical activity and higher levels of sedentary activity than girls without asthma and that these relationships might be modified by race/ethnicity, weight status or level of caregiver education. A secondary goal was to examine associations between physical and sedentary activity and reported use of an asthma controller medication, frequency of asthma exacerbations and number of emergency room visits.

Methods

Study design and participants

The study used baseline data from three Breast Cancer and the Environment Research Program (BCERP) sites. The BCERP network was created in 2003 by the National Institute of Environmental Health Sciences and the National Cancer Institute to examine environmental and genetic determinants of puberty. The three study populations are: (a) *Icahn School of Medicine at Mount Sinai (New York, NY)* which enrolled 416 girls from pediatric clinics and school-affiliated clinics located in East Harlem, NY. (b) *Kaiser Permanente (San Francisco Bay Area, CA)* which consists of 444 girls who are members of

Kaiser Permanente, in San Francisco, Marin and Alameda Counties, CA and (c) *The University of Cincinnati (Cincinnati, OH)* which recruited 360 girls from the greater Cincinnati metropolitan area (selected public school districts in SW Ohio and Northern Kentucky). English and Spanish speaking children were recruited as per institutional review board–approved protocols (including caregiver consent and participant assent) at each site.

Measurements

Asthma outcome—Asthma diagnosis was assessed using the Brief Pediatric Asthma Screen (BPAS) [5]. This asthma screen (four questions about asthma related symptoms including wheeze, persistent cough, night cough and response to change in air temperature) has been validated to identify children with asthma. In addition to the BPAS, we asked about physician diagnosed asthma with the question "Has a doctor or nurse ever said that (CHILD'S NAME) has asthma?" This question has been used in large epidemiologic studies such as The National Health and Nutrition Examination Survey (NHANES). In this study, a girl was defined to have asthma if there was a positive BPAS score (a positive response to at least one of four asthma symptom questions or BPAS 1+) *and* a report of physician diagnosed asthma. Parents of girls with asthma from the New York City site also reported on use of asthma controller medications (including inhaled corticosteroids with or without long acting beta agonists and/or leukotriene receptor antagonists) and frequency of asthma exacerbations, emergency room visits and hospitalizations for asthma in the previous year.

Physical activity assessment—We assessed physical activity with a pedometer diary (completed by girls from the California and New York sites). Girls were asked to wear a Yamax SW-200 Digi-walker pedometer to monitor most daily activity; other activities were queried in the diary for seven consecutive days. Average number of pedometer steps per day was calculated for girls with at least 4 days of steps reported.

We also asked parents questions about the girls' physical activities (questionnaire self-administered at the Cincinnati site and administered by an interviewer at the other sites). Usual activities were reported using standard questions (hours per week and months per year). Metabolic equivalent (MET) values assigned to each type of activity [6] were then used to convert to metabolic hours (met-hours) per week of moderate to vigorous activity averaged over the year. Nonscheduled activities, active hours and hours spent weekly in physical education were also reported in the questionnaire. Time spent each day in sedentary activities was included (time spent watching television, playing video games, sitting/doing homework, working on the computer and sleeping).

Covariates—Models were adjusted for confounders that were selected based on the literature including: age, self-reported race/ethnicity, body mass index and level of caregiver education. We did not include site as a covariate when building adjusted models because of possible overadjustment of the differences that exist across sites and because of its collinearity with other variables including race and BMI. However, we did examine models with site added because of the many observed differences by site. Using standard cutoffs, we examined caregiver education as less than or greater than a high school degree and as less than and greater than a Bachelors degree. Interviewers were trained and certified to measure weight and standing height using standardized scales and stadiometers. The SAS program from the US Centers for Disease Control and Prevention was used to calculate sex- and age-specific body mass percentiles based on the 2000 CDC growth charts, and children were placed into categories of low/normal weight (BMI less than 85th percentile), overweight (BMI 85th to 95th percentile) and obese (BMI greater than 95th percentile) [7].

Statistical analyses—Analyses were performed using SPSS, version 19.0 software (SPSS Inc, Chicago, IL) and SAS software, version 9.2 (SAS Institute Inc, Cary, NC). Descriptive statistics were examined for the whole group, across study sites and among girls with and without asthma. Differences between girls with and without asthma were examined using *t*-tests and chi-squared tests.

Physical and sedentary activity measures were compared between girls with and without asthma. Measures that were normally distributed (sleeping hours, mean pedometer steps and hours of sedentary activity) were analyzed as continuous variables. Some variables that were not normally distributed were categorized based on commonly accepted cut points (TV time < 1, 1–2, > 2 h and total screen time < 2 and > 2h) [8]. For met-hours (for which 443 out of 1154 total girls with available data had zero hours of recreational activity), we categorized as none and then as less than or greater than 4.5 met-hours, the cut off for ~1 h of moderate to vigorous physical activity (none, low and high), corresponding to the current recommendation for daily physical activity in children) [6,8]. Other variables without commonly accepted cutpoints were categorized based on distribution of the data as less than or greater than the median (< 1 or > 1-h homework/sitting per day, < 1 or > 1 h of physical education per week and < 7 or > 7 free play hours per week). Variables that were markedly skewed with many girls having zero reported hours, such as daily time spent playing video games or using the computer outside of school were categorized into “none” versus “any”.

Categorized physical activity variables were compared by asthma status using chi square testing, while continuous variables were compared using *t*-tests (associations reported when $p < 0.1$). Multivariate models were created when bivariate analyses showed a positive association ($p < 0.1$) between asthma diagnosis and activity outcomes. Using backward stepwise logistic regression, covariates were removed if there was <10% change in the estimate for asthma. Interactions between asthma diagnosis and race/ethnicity, body mass index and level of caregiver education were examined in relation to the activity outcomes. Finally, we examined associations between activity variables and parent-reported use of an asthma controller medication, frequency of asthma exacerbations and number of emergency room visits using more detailed asthma information available for girls with asthma from the New York site.

Results

Overall, the mean age of the girls ($n = 1182$) was 7.3 years (SD 0.7 years) (range 6–8 years) and there were similar numbers of non Hispanic Blacks, Whites and Hispanics. Racial/ethnic distribution varied across study sites (Table 1). While about half of the families at all sites reported owning their home, only 3.6% of families from the New York City site owned a home. Approximately one-third of all respondents reported highest level of caregiver education as high school or less, one-third as some college and one-third as a bachelor's degree or higher, again with differences across sites. More than three-fourths of all the girls had ever been breastfed and 27% of families had at least one smoker in the home. Based on measured BMI, 15.2% of girls were overweight and 17.5% were obese.

In terms of overall report of asthma diagnosis and asthmarelated symptoms, there was parental report of physician diagnosed asthma in 18.3% of girls and a positive BPAS score (BPAS 1+) in 42.5% of girls. Asthma, based on a positive BPAS score *and* parental report of physician diagnosed asthma, was present in 16.2% of the girls. Asthma diagnosis and symptom prevalence varied by site (Table 1). The number of girls with zero, one, two, three and all four of the BPAS symptoms were 670 (57.5%), 228 (19.6%), 127 (10.9%), 79 (6.8%) and 61 (5.2%), respectively. The vast majority of girls with asthma reported "ever wheeze" (84.7%) with somewhat fewer reporting "persistent cough" (60.8%), "night time cough" (61.9%) and "breathing problems with temperature changes" (54.0%). As expected, rates of reported symptoms among girls without asthma were lower and ranged from 6.6% (breathing problems with temperature changes) to 20.1% (night time cough).

When examining bivariate associations between variables in Table 1 and asthma diagnosis, we found significant associations ($p < 0.05$) between asthma and race/ethnicity, study site, BMI, history of breastfeeding, number of smokers in the home, level of parent education and owning/renting home. There were racial/ethnic differences in asthma prevalence (higher in Black and Hispanic girls, lowest in White girls). Girls from the New York City site (where only Black and Hispanic girls were recruited) had the highest asthma prevalence (22.7%). There was also a significant association between BMI and asthma, with asthma prevalence in underweight girls (12%) about half that of obese girls (23%). In addition, asthma rates were lower in girls who were breastfed and in girls with fewer smokers in the home. Asthma prevalence was also greater in girls of less-educated parents and in girls from families who rented homes.

In terms of physical activity, we began by examining basic descriptive statistics for physical activity variables (met-hours, pedometer steps and time spent in physical education) and sedentary activity variables (sedentary time and screen time). Overall, less than half of girls participated in organized recreational activities (38% of 1154 girls with available data for met-hours). Of those participating in such activities, only half had at least 1 h of moderate-to-vigorous physical activity daily (>4.5 met-hours). The median time spent in physical education was 1.0 h/week (n = 1092, IQR 0.75–2.0 h) and only 12% had at least 3 h of physical education per week. The mean number of pedometer steps (for girls from the New York and California sites where pedometer data were collected) was 10 206 (SD 4195 steps, N = 591). Average daily sedentary time (time spent watching television, playing video games, using the computer outside of school and doing homework/sitting combined) was 3.6 h [(SD 2.3 h) n = 732]. Almost 60% of girls (n = 687) had > 2 h of daily screen time (television, video game and computer time combined).

In bivariate analyses examining associations between activity variables and asthma diagnosis (associations reported when $p < 0.1$), fewer girls with asthma had high (>4.5) met-hours compared to girls without asthma (Table 2). Girls with asthma also reported higher

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total daily sedentary hours and screen time and lower average pedometer steps compared to girls without asthma. Other physical activity variables did not vary between girls with and without asthma (Table 2).

In adjusted models, there were no longer significant main effects of asthma diagnosis in relation to activity measures. However, girls with asthma with caregiver education levels of bachelor's degree or less had fewer daily pedometer steps and hours per week of non-scheduled activity compared to girls without asthma with similar caregiver education (Table 3). We did not find significant results when using less than or greater than a high school degree as the cutoff for level of parent education. Although we did not include study site as a covariate when building models, we did examine models with site added because of the many observed differences by site. Adjusted means changed very little when site was added, with small changes in precision for non-scheduled activity ($p = 0.098$) and sedentary activity ($p = 0.04$) and no change for pedometer steps ($p = 0.01$). Interactions between asthma diagnosis and race/ethnicity and asthma diagnosis and body mass index in relation to activity outcomes were not significant.

In the subset of girls from New York City (with more detailed information available for girls with asthma), girls with asthma were more likely than girls without asthma to report that health problems limited their physical activity (17.4% compared to 1.1%, $p < 0.001$). Girls with asthma who used a controller medication had more total sedentary activity hours (6.0 h versus 4.2 h, $p = 0.027$) as well as higher rates of daily computer use outside of school (45.8% versus 22.0%, $p = 0.02$) and higher rates of daily video game use (42.3% versus 26.9%, $p = 0.1$). In addition, even though overall participation in any structured physical activity was higher in girls on a controller medication (42.3% versus 23.4% for girls with asthma not on a controller medication, $p = 0.06$), none of the girls on a controller medication were in the "high" category for met-hours.

Discussion

In this study we aimed to examine the prevalence of asthma symptoms and diagnosis, describe physical activity and sedentary behaviors and measure the association between asthma and physical activity in a study of young girls across three US sites.

While asthma rates in our study were comparable to national prevalence estimates, girls in our study had low levels of physical activity and high levels of sedentary activity compared to current recommendations. Asthma prevalence, based on a positive BPAS score *and* parental report of physician diagnosed asthma, was 16.2% in this sample of 1182 racially mixed girls from three US locations. In comparison, nationally 15% of youth ages 5–11 years have ever been told they have asthma [1]. In terms of physical activity, 62% of girls in our study reported no participation in organized recreational activities and only 19% had the recommended 1 h or more of daily moderate-to-vigorous physical activity [8]. On the other hand, almost 60% of girls in our study had more than the recommended maximum of 2 h of daily screen time [8].

In our study, we did not find strong associations between asthma diagnosis and physical activity or sedentary activity. Previous studies examining the relationship between asthma and physical activity in children have had mixed results. Several studies have reported lower physical activity levels in asthmatic children [9–14]. However, physical activity measurements obtained by questionnaire may be subject to bias related to inaccurate recall of activities or over/under reporting. The addition of objective physical activity measures offers several advantages including the avoidance of bias, greater accuracy in the amount of activity measured and improved ability to relate variation in activity levels to variation in health outcomes. In terms of studies that have examined asthma history and symptoms in relation to *objective* physical activity measurements, decreased levels of physical activity measured objectively by motion sensor wristwatches have been associated with a history of wheezing in the last 12 months, the diagnosis of asthma and presentation to the emergency room in the last 12 months for wheezing or asthma [15]. Other studies using objectively measured physical activity have shown no differences in activity levels in asthmatics and non-asthmatics [16–20] or even increased activity levels in children with a history of wheezing [21].

Despite lack of a main effects association between asthma diagnosis and physical activity in adjusted models, we did find in our interaction analyses that girls with asthma whose parents were less educated had fewer pedometer steps and less non-scheduled activity than girls without asthma with similar caregiver education level. Similarly, among girls with asthma, those with higher caregiver education have more pedometer steps and nonscheduled activity than those with lower caregiver education. These findings imply that asthma diagnosis with low caregiver education is more detrimental to physical activity than asthma diagnosis alone. The impact of parent education on the association between asthma and physical activity in children has not been previously studied. Our findings imply that strategies to increase physical activity in children with asthma might have to be modified based on external factors such as level of caregiver education.

One important consideration is that cross-sectional data were used in our study, making it impossible to make conclusions about causality. Parents of children with asthma (especially those who are less educated) may limit their child's activity, or lower physical activity levels may actually contribute to the development of asthma. Studies have shown that parents of children with asthma may limit their child's activity due to fear or concern about the health condition [22]. However, longitudinal studies have also shown that children who were more physically fit had lower rates of incident asthma over 10 years [23], implying that higher levels of physical activity and associated physical fitness may in fact be protective against development of asthma over time.

Among girls with asthma from NYC, those who used an asthma controller medication had higher rates of participation in structured physical activity but were less likely to have high met-hours (> 1 h of moderate-to-vigorous physical activity daily). Adequate control of asthma is important in insuring that children are physically active. Another study [24] found that improvement in asthma control with use of inhaled corticosteroids was associated with a significant increase in total daily activity of 2.8 h/week and in moderate-vigorous activity by 33 min/week compared with healthy controls. However, children with asthma may also believe that they cannot take part in more vigorous physical activities and parents of children with asthma have been found to restrict their child's activity [22]. In addition, symptoms that may not be asthma-related (e.g. breathlessness due to physical exertion from more vigorous activities) may be misinterpreted as asthma resulting in avoidance of participation in such activities. We also found that girls with asthma on a controller medication were more sedentary than those not on such medication. Another study of 224 urban children with persistent asthma (65% Black and 74% Medicaid insurance) found that children who needed to slow down or stop normal activity due to asthma had more screen time compared with children who did not need to slow down [25]. Participation in sedentary activity has also been linked to adverse health effects such as obesity and for children with persistent asthma, may also lead to increased exposure to indoor environmental asthma triggers, especially in urban environments where sensitization to these allergens is very high [26].

Our study had several potential limitations including the measures used to assess the main predictor (asthma diagnosis) and the main outcome (physical activity) and possible residual confounding from unmeasured factors. We used parental report of asthma symptoms and physician diagnosed asthma as our main asthma outcome rather than more objective measures such as pulmonary function testing and methacholine challenge testing. However, report of physician diagnosed asthma has been used widely as a measure of asthma diagnosis in large epidemiologic studies such as the National Health and Nutrition Examination Survey [27], and use of a positive BPAS score and report of physician diagnosed asthma is a more conservative estimate of asthma prevalence than use of either of these methods alone. Furthermore, rates of asthma in our study are consistent with other estimates of asthma prevalence using more detailed measures for asthma diagnosis [28,29]. In our study, we measured physical activity using a validated questionnaire and pedometers as an objective measure of activity levels. While studies have described limitations of pedometer measurements compared to other objective measures such as accelerometers, laboratory and field validations of pedometers yield relatively high correlations using oxygen consumption ($r = 0.62–0.93$) or direct observation ($r = 0.80– 0.97$) as criterion measures [30]. Finally, while we were able to control for several potential factors that may be related to both asthma and physical activity (age, gender, race/ethnicity, weight status and caregiver education level), there may be significant residual confounding due to several unmeasured factors such as toxin/allergen exposures, family history of asthma or additional measures of socioeconomic status.

Conclusion

In conclusion, this study shows that there may be an association between asthma and activity levels in certain groups, including girls whose parents have lower education levels and girls on an asthma controller medication. Improving activity levels in children with asthma (particularly in the most vulnerable children including children from economically disadvantaged backgrounds and children on asthma controller medications) likely requires a combination of adherence to preventive medications and education of parents about the ability of children to take part in activities as long as the asthma is in good control.

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Table 1

Descriptive characteristics of girls from 3 BCERP sites (NY, OH, CA) baseline data 2004–2007 (*n* = 1182)[a].

Characteristic (total *N*)	Mount Sinai (*n* = 399)	Cincinnati (*n* = 339)	Kaiser (*n* = 444)	*p* Value
Race/ethnicity (1182)				
Black	159 (39.8%)	107 (31.6%)	96 (21.6%)	<0.001
Hispanic	240 (60.2%)	15 (4.4%)	108 (24.3%)	
Asian	0 (0%)	5 (1.5%)	52 (11.7%)	
White	0 (0%)	211 (62.2%)	185 (41.7%)	
Other	0 (0%)	1 (0.3%)	3 (0.7%)	
Own home (1131)				
Yes	14 (3.6%)	232 (76.3%)	314 (72.0%)	<0.001
Caregiver education (1153)				
<High School	137 (34.9%)	8 (2.5%)	33 (7.5%)	<0.001
High School	94 (24.0%)	24 (7.5%)	51 (11.6%)	
Some College	111 (28.3%)	106 (33.1%)	136 (30.8%)	
College Degree	38 (9.7%)	101 (31.6%)	128 (29.0%)	
Advanced Degree	12 (3.1%)	81 (25.3%)	93 (21.1%)	
Ever Breastfed (1169)				
Yes	280 (70.5%)	219 (66.8%)	415 (93.5%)	<0.001
Smokers in home (1175)				
0	255 (63.9%)	242 (72.9%)	359 (80.9%)	<0.001
1	97 (24.3%)	54 (16.3%)	73 (16.4%)	
2+	47 (11.8%)	36 (10.8%)	12 (2.7%)	
BMI percentile (1180)				
<85th percentile	243 (61.1%)	240 (71%)	312 (70.3%)	0.003
85th–<95th percentile	62 (15.6%)	52 (15.4%)	65 (14.6%)	
≥95th percentile	93 (23.4%)	46 (13.6%)	67 (15.1%)	
Asthma Symptoms				
Wheeze (1174)	106 (26.6%)	57 (17.2%)	99 (22.3%)	0.009
Persistent cough (1176)	85 (21.3%)	47 (14.1%)	98 (22.1%)	0.012
Night time cough (1174)	126 (31.6%)	90 (27.2%)	104 (23.4%)	0.029
Breathing Problems with Temperature Changes (1168)	89 (22.4%)	43 (13.1%)	36 (8.1%)	<0.001
Brief Pediatric Asthma Screen (BPAS) 1+ (1165)[b]	198 (49.9%)	110 (33.8%)	187 (42.2%)	<0.001
Physician Diagnosed Asthma (1175)	101 (25.3%)	39 (11.7%)	75 (16.9%)	50.001
BPAS 1 and Physician Diagnosed Asthma (1164)	90 (22.7%)	33 (10.2%)	66 (14.9%)	50.001

[a]otal *N* includes girls from three BCERP sites with asthma data.

[b]he BPAS (Brief Pediatric Asthma Screen) includes four questions about asthma related symptoms. A child had a positive BPAS score (BPAS 1+) if parents reported at least one of the four symptoms.

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Table 2

Physical activity and sedentary activity by asthma diagnosis in 6-to-8-year-old girls (*n* = 1182)[a].

Measure (Total *N*)	**Asthma**	**No asthma**	***p* Value**
Computer hours per day (n = 770)			
None	82 (63.1%)	408 (63.8%)	0.88
Any	48 (36.9%)	242 (36.3%)	
TV hours per day (*n* = 1047)			
<1 h	29 (16.9%)	165 (18.9%)	0.50
1–2 h	91 (52.9%)	482 (55.1%)	
>2 h	52 (30.2%)	228 (26.1%)	
Video hours per day (*n* = 751)			
None	94 (75.8%)	498 (79.4%)	0.37
Any	30 (24.2%)	129 (20.6%)	
Screen time hours per day (*n* = 679)			
52 h	46 (39.3%)	242 (43.1%)	0.46
42 h	71 (60.7%)	320 (56.9%)	
Homework/sitting (*n* = 1057)			
≤1 h	91 (51.7%)	511 (58.0%)	0.12
>1 h	85 (48.3%)	370 (42.0%)	
MET-hours per week (*n* = 1143)			
None/low	145 (77.5%)	647 (67.7%)	0.007
High	42 (22.5%)	309 (32.3%)	
Gym hours per week (*n* = 1080)			
≤1 h	105 (59.0%)	523 (58.0%)	0.80
>1 h	73 (41.0%)	379 (42.0%)	
Free play time hours per week (*n* = 1021)			
<7 h	97 (57.1%)	431 (50.6%)	0.13
>7 h	73 (42.9%)	420 (49.4%)	
Total daily sedentary time[b]			
Hours, Mean (SD) (*n* = 722)	3.9 (2.5)	3.5 (2.3)	0.09
Daily screen time[c]			
Hours, Mean (SD) (*n* = 679)	2.8 (2.3)	2.4 (1.9)	0.08
Daily sleeping time			
Hours, Mean (SD) (*n* = 1132)	9.9 (1.5)	10.1 (1.8)	0.11
Daily pedometer steps			
Mean (SD) (*n* = 588)	9590 (4348)	10359 (4161)	0.09

[a]Unadjusted results; Asthma defined as parental report of physician-diagnosed asthma and at least one asthma related symptom.

[b]Defined as time spent watching television, playing video games, using the computer outside of school and doing homework/sitting combined.

[c]Defined as television, video game and computer time combined.

Table 3

Relationship between asthma diagnosis and physical activity, modified by caregiver education[a] (BCERP cohort, 2004–2007).

Mean steps per day (from pedometer diary)					
	No asthma		**Asthma**		
Caregiver's education	***N***	**Adjusted means (CI)**	***N***	**Adjusted means (CI)**	***p* Value[b]**
<BS Degree	395	10 528 (9892, 11 164)	226	9139 (8113, 10 164)	0.01
≥BS Degree	226	10 194 (9481, 10 908)	38	11 355 (9788, 12 921)	0.185
	p Value	0.484		0.018	
Final model adjusted for child race					
p value for adjusted interaction term=0.013					

Hours per week in non-scheduled activity					
	No asthma		Asthma		
Caregiver's education	*N*	Adjusted means (CI)	*N*	Adjusted means (CI)	*p* Valueb
<BS Degree	405	7.09 (6.53, 7.70)	101	5.92 (5.02, 6.97)	0.055
≥BS Degree	330	6.90 (6.30, 7.56)	38	8.08 (6.18, 10.56)	0.109
	p Value	0.665		0.053	
Geometric means in final model adjusted for age					
p value for adjusted interaction term=0.051					

Hours per day in sedentary activity					
	No asthma		Asthma		
Caregiver's education	*N*	Adjusted means (CI)	*N*	Adjusted means (CI)	*p* Valueb
<BS Degree	546	2.82 (2.62, 3.04)	378	2.85 (2.50, 3.24)	0.909
≥BS Degree	378	2.47 (2.27, 2.69)	50	3.01 (2.49, 3.64)	0.065
	p Value	0.012		0.625	
Geometric means in final model adjusted for child race and BMI					
p value for adjusted interaction term=0.125					

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[a] Asthma defined as parental report of physician-diagnosed asthma and at least one asthma related symptom. Final covariates included are listed below each model.

[b] *p* values are from pairwise comparisons of least squares means.