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Risk Factors for Physical Inactivity Among Children With and Without Asthma Living in Peri-Urban Communities of Lima, Peru

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Background: The authors sought to examine physical activity patterns among children with and without asthma in 2 peri-urban communities in Lima, Peru, to identify socioeconomic and demographic risk factors for physical inactivity and examine the relationship between asthma and physical activity. **Methods**: The authors measured mean steps per day in 114 children (49 with asthma and 65 without) using pedometers worn over a 1-week period. They also used the 3-day physical activity recall to determine the most common activities carried out by children. **Results**: The authors found that 84.2% of the children did not meet the daily international physical activity recommendations. Girls took significantly fewer mean steps per day as compared with boys (2258 fewer steps, 95% confidence interval, 1042–3474), but no other factors, including asthma status, showed significant differences in the mean daily steps. Mean daily steps were positively associated with higher socioeconomic status among girls, and current asthma had a larger inverse effect on daily steps in boys when compared with girls. **Conclusion**: Physical activity levels were below recommended guidelines in all children. There is a need for policy and neighborhood-level interventions to address low physical activity levels among Peruvian youth. Special focus should be given to increasing the physical activity levels in girls.

Keywords: gender, epidemiology, South America

Physical inactivity is a worldwide epidemic and is one of the leading risk factors for premature death worldwide.[1] An estimated 23% of adults and 81% of adolescents do not currently meet the World Health Organization's recommendations for regular exercise of 60 minutes of daily exercise for adolescents and 150 minutes of weekly exercise for adults.[1] A lack of physical activity is an important and well-recognized risk factor for noncommunicable diseases across the lifespan, and regular activity is a critical component of promoting and maintaining mental and physical health and well-being. For this reason, World Health Organization member states have pledged to reduce physical inactivity by 10% by 2025, and the promotion of physical activity and sport is a key element of the United Nations 2030 Agenda for Sustainable Development to ensure healthy lives and promote well-being for all.[2]

The evidence suggests that physical inactivity may be an important modifiable risk factor for asthma, influencing its development, course, and severity.[3–5] Asthma is the most common chronic disease in childhood and, similar to physical inactivity, is strongly associated with living in an urban environment.[6] Physical activity may influence the severity and progression of asthma by reducing inflammation; at the same time, physical activity may serve as a mediator for the relationship between asthma and obesity.[7–9] Individuals with asthma may also be less physically active due to real or perceived limitations in their ability to engage in exercise. Given the paucity of research regarding physical activity patterns among youth in low- and middle-income countries, we conducted a study to evaluate physical activity in children with and without asthma in Peru.

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Methods

Study Setting

We enrolled children between the ages of 9 and 19 living in one of 2 communities, Pampas de San Juan and Villa El Salvador, located in the southern cone of Lima, Peru. Both districts have seen significant population growth in recent decades, largely due to an influx of migrants from the country's highland regions. This demographic shift is representative of Peru as a whole, where the percentage of individuals living in urban areas has increased from 47% to 78% between 1960 and 2018.[10] In 2011, our prior research demonstrated that, among adolescents 13–15 years of age in Pampas de San Juan, 22% experienced lifetime wheeze, 12% currently had asthma symptoms, and 13% had a physician's diagnosis of asthma.[11] This study was approved by the institutional review boards at the Johns Hopkins University School of Medicine, Baltimore, and the Asociación Benéfica PRISMA in Lima, Peru, and informed consent was obtained from all participants.

Study Design

This study was ancillary to an unmatched case-control study carried out in 506 children, 9–19 years of age, with current asthma and 671 children without asthma. We enrolled a random, sex-stratified subset of 114 children, 49 with asthma and 65 without asthma. Children having had ocular, thoracic, or abdominal surgery in the last 3 months were excluded from the parent study, as were children who had been hospitalized for cardiac reasons in the last

3 months, had tuberculosis or a chronic respiratory condition other than asthma, were receiving treatment for tuberculosis, or were pregnant. Additional details regarding recruitment for the parent study have been published elsewhere.[12,13] This study had 3 objectives. The first objective was to characterize physical activity patterns among youth, using both qualitative (questionnaire based) and quantitative (motion tracking) methods. The second objective was to identify sociodemographic risk factors for physical inactivity. Finally, we sought to examine the relationship between current asthma and physical activity in Peruvian children and adolescents in these communities. We hypothesized that children with asthma would be less physically active than children without asthma and that the majority of children would have physical activity levels below those recommended by international guidelines.[1]

Definitions

We defined asthma as having had symptoms of asthma or medication use for asthma in the previous 12 months. The data collection for this ancillary study was carried out between November 2013 and November 2014.

Baseline Questionnaire

We administered a baseline questionnaire that included sociodemographic information, the family history of asthma, medication use, health care utilization, and socioeconomic status.

3-Day Physical Activity Recall

The 3-day physical activity recall (3DPAR) is a validated instrument designed to prompt children to recall their daily activities, as well as their intensity, in 30-minute increments over the previous 3 days.[14,15] The 3DPAR has been validated in pediatric populations and distinguishes between sedentary and nonsedentary physical activities.[15] The questionnaire can also be used to calculate metabolic equivalents, a measure of energy expended, although we did not collect the relevant data to do so in this study.[16,17] We administered the 3DPAR once to each child at the end of the week of pedometer use to capture the last 3 days of the activity period.

Pedometers

We used the HJ-720ITC Pocket Pedometer (Omron Healthcare, Inc, Bannockburn, IL) to measure the number of steps taken by children per day over 7 full consecutive days. The HJ-720ITC allows for the direct download of data to a computer, thus avoiding the need for children to remember to record their total steps at the end of each day.[18] This pedometer also has a sensor to detect whether it was worn during each hour of the day. We asked children to complete diaries in which they recorded whether they wore the pedometer on that day. Using a combination of the pedometer report and self-report, we removed days from the analysis in which the pedometer was worn by the child for less than 10 hours in a single day.

Biostatistical Methods

We used both single variable and multivariable linear and logistic regressions to determine the unadjusted and adjusted associations between physical activity (mean steps per day) and asthma status, as well as other factors, including sex, age, SES, body mass index (BMI), and study community. We generated a composite score for SES using principal component analysis techniques. Under this method, a higher score indicated a lower SES. This score was based on a series of variables related to the SES of participant households, such as the presence or absence of common household appliances, the size of the household, and years of parental education. Additional details about these methods can be found elsewhere.[12,13] We also calculated the frequencies of daily activities, which were reported in 30-minute increments over the 3-day period. Each activity was also classified into sedentary versus nonsedentary based on whether the child was seated while doing the activity, and we calculated the number of minutes per day that the child was engaged in activities in each of these categories. This analysis was carried out by counting each 30-minute increment that a child reported a certain activity, adding up the total number of 30-minute increments that the children performed each activity and dividing each activity's tally by the total number of data points. We also calculated the percentage of time the children were engaged in each of the reported activities and conducted comparisons of daily activities stratified by asthma status. All analyses were carried out using R (www.r-project.org) and Stata (version 15; StataCorp, College Station, TX).

Results

Participant Characteristics

Among 114 children included in this analysis, 49 had asthma and 65 did not have asthma. There were no differences in age, community of residence, or the season in which children participated in the study between children with and without asthma (Table 1). Furthermore, there were no significant differences in measures of SES or BMI between children with and without asthma.

Patterns of Physical Activity

Overall, the children took an average number of 8102 steps per day (SD = 3440), with 84.3% of children taking fewer than 11,000 daily steps per day.[19,20] The 3DPAR data also demonstrated that children spent the majority of their time (81.5% of time on a typical day) engaged in sedentary activities, with the most common activities for all groups studied being sleeping, watching television, eating, and studying and/or sitting in class.

Risk Factors of Physical Inactivity

In Figure 1, we display crude associations between various risk factors and mean daily steps. We conducted unadjusted and adjusted linear regression analyses examining the associations between mean steps per day and age, sex, and community of residence (Table 2). In both the crude and adjusted analyses, the only factor significantly associated with mean daily steps was sex. In the adjusted analyses, girls took an average of 2258 fewer steps per day compared with boys (95% confidence interval [CI], 1042–3474). In Figure 2, we display the empirical cumulative distribution functions of mean daily steps per day for girls versus boys. Age, community of residence, and BMI were not significantly associated with mean steps per day.

The results of adjusted analyses stratified by sex demonstrate that higher socioeconomic status is positively associated with mean

Table 1 A Comparison of Demographic Values Among Children With Asthma and Children Without Asthma

	Asthma	No asthma	
Sample size	**49**	**65**	***P* value**
Demographics			
Number of boys, %	22 (44.9)	30 (46.2)	.89
Age in years, mean (SD)	12.5 (2.10)	13.0 (2.51)	.22
Lives in Pampas de San Juan, n (%)	30 (61.2)	48 (73.9)	.15
Anthropometry			
Average body mass index in kg/m^2 (SD)	21.8 (4.38)	22.1 (4.07)	.72
Socioeconomics, n (%)			
Maternal education ≥ 6 y, n (%)	65 (92.9)	55 (93.2)	.94
6 or more household members, n (%)	18 (39.1)	28 (45.2)	.53
Smoking			
Has ever smoked	2 (4.35)	4 (6.45)	.64
Lives with a current smoker	3 (7.50)	8 (13.8)	.33
Season of data collection			
Fall–winter (April–September), n (%)	19 (38.8)	17 (26.2)	.15
Spring (October–March), n (%)	30 (61.2)	48 (73.9)	–

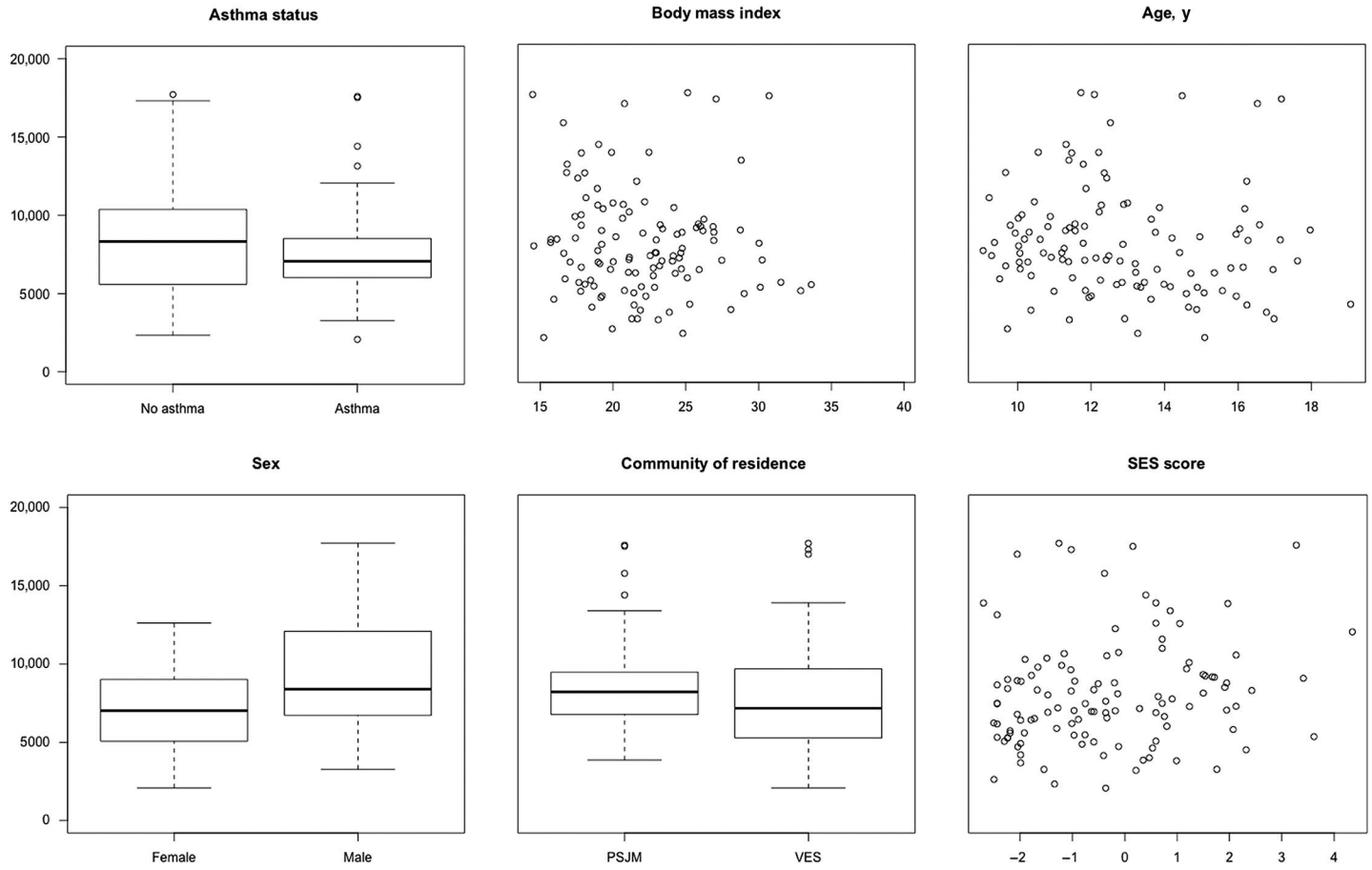

Figure 1 — Side-by-side boxplots and scatterplots displaying associations of key risk factors with mean daily steps. PSJM indicates Pampas de San Juan; VES, Villa El Salvador.

Table 2 Crude and Adjusted Associations of Mean Steps Per Day With Current Asthma and Risk Factors

	Unadjusted (β, 95% CI)	*P* value	Adjusted (β, 95% CI)	*P* value
Current asthma	−759.0 (−2046.5 to 528.49)	.25	−995.9 (−2221.5 to 229.8)	.11
Age (per 10 y)	−162.04 (−434.51 to 110.23)	.24	−91.18 (−371.0 to 188.6)	.52
Sex (female is reference)	2366.0 (1157.1 to 3574.9)	<.001	2258.0 (1041.7 to 3474.4)	<.001
BMI, per 10 kg/m^3	−666.76 (−219.89 to 86.543)	.39	−242.2 (−1835.2 to 1350.6)	.76
Location (Pampas de San Juan is reference)	−1113.8 (−2477.5 to 249.88)	.11	−798.4 (−2251.5 to 654.66)	.28
SES score	357.58 (−38.857 to 754.025)	.08	253.1 (−170.6 to 676.8)	.24

Abbreviations: BMI, body mass index; CI, confidence interval.

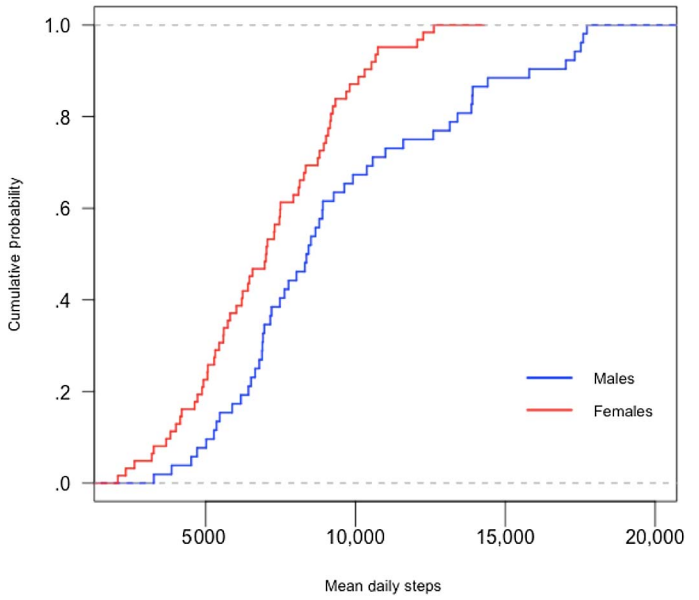

Figure 2 — Cumulative distribution function of mean daily steps among male and female children.

daily steps among girls, but not among boys (Table 3). The magnitude of the association between current asthma and mean daily steps was 15 times larger among boys, and this association approached statistical significance in the latter group (Table 3).

Physical Activity and Asthma Status

We compared mean daily steps among children with and without asthma (Table 2). The results of the adjusted analyses showed that children with asthma took an average of 995.9 fewer steps per day than children without asthma (95% CI, −2221.5 to 229.8); however, this difference was not statistically significant ($P = .11$).

We display the 3 most common activities for each 30-minute period and the relative frequency of activities overall (Table 4). The 5 most common activities for children both with and without asthma were sleeping, watching television/movies, eating, studying/doing homework, and writing/taking notes in class. There was no statistically significant difference in sedentariness between the asthma and control groups, with children with asthma spending an average of 16.6% of each day engaged in nonsedentary activity compared with 15.7% among children without asthma ($P = .14$).

Discussion

In our cohort of 114 children in a peri-urban community in Lima, Peru, we found that physical activity levels were far lower than what is recommended by international and national guidelines.[1–2] The data from the 3-day recalls demonstrated that both groups of children spent the majority of their time engaged in sedentary activities, including watching television, schoolwork, and Internet or video games. When comparing the data based on sociodemographic factors, girls took fewer steps than boys, even after adjusting for confounders, while other variables, such as BMI, age, and community of residence, did not significantly impact the number of steps taken per day. We found that higher SES was associated with higher mean daily steps among girls but not boys. We also found that the magnitude of the inverse association of current asthma with the mean daily steps was 15 times higher in boys as compared with girls. Finally, while we did not find differences in physical activity, as measured by the mean steps per day, between children with and without asthma, there was a trend whereby children with asthma took fewer steps per day compared with children without asthma.

Overall, children had lower levels of physical activity than the international recommendation of 11,000 to 16,500 steps per day for children and adolescents,[19,20] and children spent most of their days engaged in sedentary activities. Across many settings in high-income countries and low- and middle-income countries alike, it has been shown that children living in urban and peri-urban environments live a more sedentary lifestyle due to a variety of factors.[21] Physical activity in children living in urban communities is often severely limited by the built and social environments, which may be less conducive to outdoor play and other activities. Increased exposures to crime and traffic-related hazards in such environments also make children less likely to engage in outdoor physical activity.[22] Consequently, these children are at an increased risk of developing noncommunicable diseases throughout the lifespan. As the number of children growing up in cities rapidly increases in low- and middle-income countries, it will be increasingly important for strategies and policies to address these factors and recognize the additional risks from sedentariness experienced by children living in urban environments.

Sex differences in physical activity levels among children have been documented in many diverse settings, including Australia, Japan, and Brazil.[23–25] For example, in a study of 691 Japanese children, Ishii et al[25] found that boys had significantly higher physical activity levels, as measured in metabolic equivalents, when compared with girls. In a study of the recess activities of 407 French children in 2014, Baquet et al[26] found that girls engaged in significantly fewer vigorous recreational activities

Table 3 Stratified Analyses by Sex Showing Adjusted Associations of Mean Steps Per Day With Current Asthma and Risk Factors

	Boys (β, 95% CI)	*P* value	Girls (β, 95% CI)	*P* value
Current asthma	−2210.1 (−4629.7 to 209.6)	.07	−145.5 (−1426.0 to 1135.0)	.82
Age (per 10 y)	−116.8 (−690.8 to 457.3)	.68	−92.6 (−380.1 to 194.9)	.52
BMI, per 10 kg/m^3	−78.4 (−425.2 to 268.3)	.65	−34.5 (−189.2 to 120.2)	.66
Location (Pampas de San Juan is reference)	−2120.9 (−4980.0 to 738.1)	.14	−236.8 (−1766.2 to 1292.6)	.76
SES score	−129.7 (−952.2 to 692.8)	.75	456.1 (12.2 to 900.0)	.04

Abbreviations: BMI, body mass index; CI, confidence interval.

Table 4 The Top 10 Self-Reported Activities Engaged in Over a 3-Day Period by Children With and Without Asthma

Asthma n = 49		No asthma n = 65	
Activity	**Percentage of time spent (%)**	**Activity**	**Percentage of time spent (%)**
Sleeping	25.6	Sleeping	24.6
Watching television/movie	16.2	Watching television/movie	15.4
Eating	8.0	Eating	8.3
Studying/doing homework	6.4	Studying/doing homework	8.0
Writing/taking notes in class	6.5	Writing/taking notes in class	5.4
Internet/video games	5.4	Internet/video games	5.4
Walking	5.3	Walking	4.6
Dressing/getting ready	3.7	Dressing/getting ready	3.4
Lying down	2.0	Riding the bus/train/car	2.7
Riding the bus/train/car	1.8	Simply sitting	1.8

during recess as compared with boys. There is also evidence from longitudinal studies that the disparity in physical activity levels worsens as children become adolescents, with girls' activity declining at a faster rate than boys' as they age.[27,28] Forthofer et al[29] showed that the factors most protective against physical activity decline during this transition to adolescence among both genders were sport and physical activity-related class participation, parent-reported support for physical activity, and neighborhood resources. However, they also found that children's self-efficacy and parents' leisure-time physical activity were more important among girls as compared with boys.[29]

In stratified analyses by sex, we observed a significant positive association between mean daily steps and SES score among girls but not boys (Table 4). One potential explanation for this result is that girls may be more discouraged by family members or less comfortable than boys engaging in outside play if they live in unsafe neighborhoods. This phenomenon has been observed in other studies.[30–32] Furthermore, it is possible that higher income families may be able to access activites that require greater financial resources, such as dance, which girls may be more likely to engage in. The results of our research and other studies, therefore, highlight the importance of developing strategies that acknowledge and address the social and environmental factors that make girls more vulnerable to physical inactivity.[33] In the case of Peru, an understanding of the role that gender norms, child self-efficacy, and resources play in physical activity outcomes among children merits further qualitative and longitudinal investigation.

Children with asthma were less active than those without asthma, although this difference did not reach statistical significance. Given the moderate effect size (~1000 steps per day), it is possible that this association may have reached statistical significance with a larger sample size. Furthermore, in stratified analyses by sex, boys with current asthma took over 2000 fewer steps than boys without asthma, with this difference approaching statistical significance. One possible explanation for this difference may be that, because boys are more physically active overall than girls, asthma symptoms may have a greater impact on their activity levels than for girls, who are generally more sedentary. Studies of the relationship between asthma and physical activity have shown conflicting results. In a longitudinal study of 147 children aged 5–12 years of age in Baltimore, MD, Nnodum et al[34] found a significant association between physical activity, as measured by the physical activity questionnaire, and an increased frequency of asthma symptoms. These results suggest that children may be more bothered by their asthma when engaged in higher levels of physical activity. Furthermore, Holderness et al[35] found that, among the 324 children studied, there was a significant correlation between the level of asthma control and physical activity, with children having uncontrolled asthma reporting less physical activity than their peers who had mild asthma or no asthma. However, Matsunaga et al[36] found no such correlation in a population of 100 children studied. A meta-analysis of 8 cross-sectional and 1 longitudinal study using data from accelerometry demonstrated no significant difference in physical activity levels between children with and without asthma; however, our study used pedometers as opposed to accelerometers, the former of which do not measure exercise intensity.[37] Therefore, our study was unable to probe this hypothesis further.

Although not statistically significant, the trend toward higher physical activity levels in children without asthma could indicate a propensity for the latter group to engage in fewer strenuous

activities. Indeed, despite the likely benefits of exercise, children with asthma, especially those with severe disease, are often less likely to participate in physical activity for reasons such as parental fears or children's lack of confidence in their own physical abilities because of their asthma.[38] Further qualitative research into the perceptions of the impact of physical activity on disease and quality of life in this population would help elucidate potential barriers to physical activity promotion among this population.

There are several strengths to this study. We are one of the first groups to characterize the daily activity patterns of children living in Peru or other South American countries. We also employed both quantitative and qualitative methods to assess physical activity, allowing for a triangulation of our results and greater granularity in terms of the specific daily activities engaged in by children in these communities.

This study also has important limitations. First, due to the cross-sectional nature of this study, we are unable to determine temporality or causality of the relationship between risk factors and physical activity levels. The statistical power to detect a difference in physical activity levels by different risk factors was also limited by the small sample size. Being both questionnaire-based and retrospective, the 3DPAR is susceptible to recall bias. However, the 3DPAR uses a relatively short recall window of 3 days, which helps minimize the impact of this bias.[17] We also used pedometers to provide a quantitative complement to the qualitative physical activity information collected by the 3DPAR.[18] The use of pedometers did not allow us to determine the intensity of the physical activity or calculate metabolic equivalents. Furthermore, we did not collect data on the days of the study on which the children attended school, which could affect their physical activity levels. We also did not collect data on asthma severity, thus leaving us unable to evaluate whether this variable would be correlated with a change in physical activity levels. Lastly, there is potential for differential misclassification bias resulting from girls being engaged in activities that make it more difficult to wear pedometers, such as dance.

Given the importance of physical activity for preventing future disease and ensuring well-being throughout the lifespan, our data demonstrate the need for strategies and policies to promote physical activity and education among youth in urban and peri-urban communities of Peru. Our data do not indicate that children with asthma should be targeted specifically in physical education strategies; however, future qualitative studies into perceptions regarding the dangers of physical activity for children with asthma may be warranted, given the trend toward greater inactivity among these children. Strategies and policies for youth physical activity should take into account the social, cultural, and environmental factors that drive disparities in physical activity between certain groups, particularly gender-based differences.

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