Physical Activity, Obesity Status, and Blood Pressure in Preschool Children

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Abstract

Objective

To examine the combined effects of physical activity and weight status on blood pressure (BP) in preschool-aged children.

Study design

The sample included 733 preschool-aged children (49% female). Physical activity was objectively assessed on 7 consecutive days by accelerometry. Children were categorized as sufficiently active if they met the recommendation of at least 60 minutes daily of moderate-to-vigorous physical activity (MVPA). Body mass index was used to categorize children as nonoverweight or overweight/obese, according to the International Obesity Task Force benchmarks. BP was measured using an automated BP monitor and categorized as elevated or normal using BP percentile-based cut-points for age, sex, and height.

Results

The prevalence of elevated systolic BP (SBP) and diastolic BP was 7.7% and 3.0%, respectively. The prevalence of overweight/obese was 32%, and about 15% of children did not accomplish the recommended 60 minutes of daily MVPA. After controlling for age and sex, overweight/obese children who did not meet the daily MVPA recommendation were 3 times more likely (OR 3.8; CI 1.6-8.6) to have elevated SBP than nonoverweight children who met the daily MVPA recommendation.

Conclusions

Overweight or obese preschool-aged children with insufficient levels of MVPA are at significantly greater risk for elevated SBP than their non overweight and sufficiently active counterparts. (J Pediatr 2015;167:98-102).

An important risk factor for cardiovascular disease (CVD) is elevated blood pressure (BP). Even though elevated BP is unusual during childhood,[1] prospective cohort studies have shown that BP tracks from early childhood into adulthood, [2,3] In the Bogalusa Heart Study, children in the top quintile of systolic BP (SBP) were 3-4 times more likely to develop clinical hypertension by age 30 than their normotensive peers, and 50% of hypertensive adults had elevated SBP during childhood.[4]

Overweight and obesity are thought to be important contributing factors to the development of elevated BP in children and youth. A number of studies have demonstrated that there is a positive relationship between body mass index (BMI) and SBP in school-aged children,[5-8] as well as preschool-aged children.[9] Among youth, the relationship between physical activity and BP is not well understood; however, it has been shown that moderate intensity physical activity is associated with lower SBP[10-12] and that exercise training can reduce BP in adolescents with hypertension.[13-16] The purpose of the study was to examine the combined effects of physical activity and weight status on BP in preschool-aged children. We hypothesized that overweight or obese and insufficiently active children would be more likely to have elevated BP than healthy-weight children meeting guidelines for daily physical activity.

Methods

Participants in this study were children enrolled in the Preschool Physical Activity, Body Composition and Lifestyle Study. A random sample of 1566 children, aged 2-6 years, was recruited from kindergartens located in the metropolitan area of Porto, Portugal. For this study, we included only children aged 3-6 years with 7 days of accelerometer data, and complete data for BP, height, and weight. The final sample included 733 preschool children (49.6%girls). Data were collected between April 2009 and November 2013. Informed written consent was obtained from parents and school supervisors. Study procedures were approved by the Portuguese Foundation for Science and Technology and by the Scientific Board of Physical Activity and Health Doctoral program. Body mass and height were measured using standard anthropometric methods. Body mass was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and tee-shirt) using a portable digital beam scale (Tanita InnerScan BC 532; Tanita, Tokyo, Japan). Height was measured to the nearest millimeter in bare or stocking feet with children standing upright against a Holtain portable stadiometer (Tanita). The measurements were repeated twice, and the average was recorded. BMI was calculated as body mass (kg) divided by height (m) squared and was classified overweight/ obese according to International Obesity Task Force.[17] Arm circumference was measured with a nonstretchable tape at a point midway between the olecranon and the acromion.

Resting BP was measured by an automated BP monitor using an appropriate size cuff (DP 8800; Colin Corporation, Komaki, Japan). After 15 minutes of supine rest in a quiet, temperature-controlled room, BP measurements were taken with the subjects seated in an upright position with back supported, feet on the floor, and the right arm comfortably placed at heart level.[18,19] Two measures were completed; the second BP measurement was taken 5 minutes after the initial assessment. The average of 2measures for SBP and diastolic BP (DBP) were recorded. A third measurement was made if the difference between the previous 2 were more than 2 mm Hg. All BP measurements were conducted between 8:00 a.m. and 11:00 a.m. by the same investigator and the same automated monitor. The 90th percentile for BP was used as the cut-point for elevated SBP and DBP.

The cut-points were based on BP percentiles for age, sex, and height, as recommended by the Task Force on Blood Pressure Control in Children.[5]

Daily physical activity was measured using an ActiGraph GT1M accelerometer (ActiGraph, Pensacola, Florida). This device produces output in the form of activity counts, which can be used to infer intensity of physical activity, the higher the counts the greater the intensity.[20] Participants wore the accelerometer on 7 consecutive days (Monday to Sunday) and a minimum wear time of 10 hours per day was considered as valid data for the analysis.[21] Non-wear time defined as a period of at least 60 consecutive minutes of zero counts.[22-24] In this study, the epoch duration was set to 5 seconds, which has been shown to be more accurate for the assessment of the spontaneous and intermittent activities of young children.[25] Accelerometer output can also be interpreted using intensity-based cut-points, which categorizes activity counts as sedentary, light, moderate, or vigorous physical activity. Time spent in moderate-to-vigorous physical activity (MVPA) was calculated using a specific pediatric cut-point for preschool-aged children: $420 counts/15 seconds.[26] To process the data we used

Actilife software (Pensacola, Florida), which automatically scaled the 15-second cut-point to the 5-second epoch interval.

Parents were instructed to attach the accelerometer when the child awoke and to remove it when they went to bed.

The accelerometer was firmly attached to the child's right hip by an elastic waist belt under their clothing. Activities were not prescribed or directed by the teachers or researchers.

All children participated in normal activities with their classmates. Children were classified as meeting (sufficiently active) or not meeting (insufficiently active) guidelines if they accumulated at least 60 minutes of MVPA, as measured by the accelerometer, on at least 5 of the 7 monitoring days.[27]

Statistical Analyses

Descriptive data are presented as means and SD. All variables were checked for normality using Kolmogorov–Smirnov tests. For the purpose of this study, we analyzed the combined influence of compliance with the 60-minute daily recommendation and weight status on SBP. Thus, 4 physical activity-weight status groups were created: sufficiently active/nonoverweight, sufficiently active/overweight or obese, insufficiently active/nonoverweight, and insufficiently active/overweight or obese. First, logistic regression analyses were performed to estimate the association between physical activity and elevated BP (high-normal BP) and weight status and elevated BP (high-normal BP). Second, logistic regression analyses were performed to estimate the association between combined physical activity-weight status grouping and elevated BP (high-normal BP). Within each model the sufficiently active/nonoverweight group served as a referent group. We only examined associations with SBP because the prevalence of elevated DBP was lower, 3.0%. The level of significance was set at alpha level of 0.05. Data were analyzed using SPSS Windows v 20.0 (SPSS Inc, Chicago, Illinois).

Results

Descriptive characteristics are summarized in Table I. The prevalence of overweight or obesity was 32%. The prevalence of elevated SBP and DBP was 7.7% and 3.0%, respectively. Approximately 14% of the children did not accomplish the daily MVPA recommendation (Table II).

The results of the logistic regressions indicated that overweight or obese children were about 2 times more likely than their nonoverweight peers to have high-normal SBP values (OR 2.0; CI 1.2-3.5), adjusted for sex and age. No associations were statistically significant among activity and SBP (Figure 1).

The results of the final logistic regression analysis indicated that after controlling for sex and age, insufficiently active/overweight or obese were nearly 4 times more likely than sufficiently active/nonoverweight children (OR 3.8; CI 1.6-8.6) to have elevated SBP. Sufficiently active/overweight or obese (OR 1.6; CI 0.8-3.0) and insufficiently active/nonoverweight (OR 1.0; CI 0.4-2.7) children were not significantly more likely to have elevated SBP compared with sufficiently active/nonoverweight children (Figure 2).

Table I. Children's descriptive characteristics

Total sample (n = 733)	Mean ± SD
Age (y)	5.0 ± 0.9
Weight (kg)	20.8 ± 4.1
Height (cm)	110.4 ± 7.8
BMI (kg/m^2)	16.9 ± 2.0
SBP (mm Hg)	96.3 ± 8.1
DBP (mm Hg)	55.4 ± 6.0
MVPA (min/d)	96 ± 25

Table II. Children's descriptive characteristics

Total sample	n = 733	%
BMI*		
Nonoverweight	502	68.5
Overweight/obese	231	31.5
SBP†		
<90th percentile	677	92.4
≥90th percentile	56	7.6
DBP†		
<90th percentile	711	97.0
≥90th percentile	22	3.0
MVPA ≥1 h		
Sufficiently active	624	85.1
Insufficiently active	109	14.9
Physical activity status/weight status		
Sufficiently active/nonoverweight	436	59.5
Insufficiently active/nonoverweight	66	9.0
Sufficiently active/overweight/obese	188	25.6
Insufficiently active/overweight/obese	43	5.9

*According to International Obesity Task Force (2000).
†According to fourth report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (2005).

Discussion

Previous studies involving older children have examined the clustering of multiple lifestyle factors and shown that health and risk-related behaviors may coexist.[1] However, little research attention has been paid to the potentially synergistic effects of compliance with daily MVPA recommendations and obesity on health outcomes such as BP in preschool children.

The major finding of this study was that preschool children who were both overweight/obese and insufficientlyactive were about 4 times more likely to have elevated SBP compared with those who were nonoverweight and meeting the daily 60 minutes of MVPA recommendation. Comparisons with other studies are difficult due to lack of data in preschool-aged children. Although childhood BP is influenced influenced by genetic and prenatal factors, as well as by dietary habits and environmental factors, such as passive smoking,[28] our results have importance from a primary prevention perspective. First, children who are overweight or obese at an early age have greater odds of having CVD risk factors such as BP[29-32] as well as an increased risk for developing cardiovascular and metabolic conditions later in life.[33] For instance, 1 study showed that the prevalence of elevated BP in obese preschool-aged children was higher than that in normal weight children.[32] Thus, our study confirms the results of previous studies that have reported overweight and obesity to be associated with elevated SBP.[30,34,35]

In addition, our findings showed that, on average, children were engaged in 96 (_25) minutes per day of MVPA. Despite this high level, our data are similar to previous studies reporting preschool-aged children achieving 102 (_40) minutes per day of MVPA.[36] Beyond this, it should be stressed that regular participation in physical activity attenuated the risk of elevated SBP among overweight and obese children.

Indeed, our data showed that low MVPA and obesity increase risk synergistically. We found higher OR for the combined risks than either obese alone or low MVPA alone.

Evidence suggests that increased aerobic physical activity can reduce SBP and significantly restore endothelial function in overweight children and adolescents.[37] Previous studies involving samples of older children have also reported low physical activity levels combined with high BMI to be associated with elevated BP,[38,39] a finding which we also observed in our study. Others investigations showed that active children had lower BP values than less active and/or overweight children.[10,40] Thus, physical activity status and weight status may interact in a synergistic manner among young children.

Our study also showed that among children who were overweight/ obese, being active (meeting recommendations) attenuated the risk of elevated SBP. Thus, our data give important new information highlighting the importance of the combination of maintaining a healthy weight and participating in sufficient MVPA in the early stages of life. Therefore, in addition to traditional BP monitoring among obese individuals, there is a need to monitor and promote regular physical activity in this population.

Strengths of this study included the relatively large sample size and the examination of CVD risk factor aggregation in preschool-aged children. In addition, the study focused on the assessment of physical activity levels using an objective measure.[26] The study also had limitations that should be acknowledged. First, the cross-sectional study design precludes inferring causality and making definitive conclusions regarding the associations between weight status, physical activity, and BP in young children. Second, our analyses were based on indirect measures of adiposity (BMI), although it has been found to be sufficiently accurate and widely used in epidemiological studies.[41] Third, the BP was measured on 1 occasion only. When possible, BP should be measured in different days to establish the true level of BP. Additional research is needed to replicate these findings using longitudinal designs and controlling for other potential confounders such as diet and family history of hypertension.

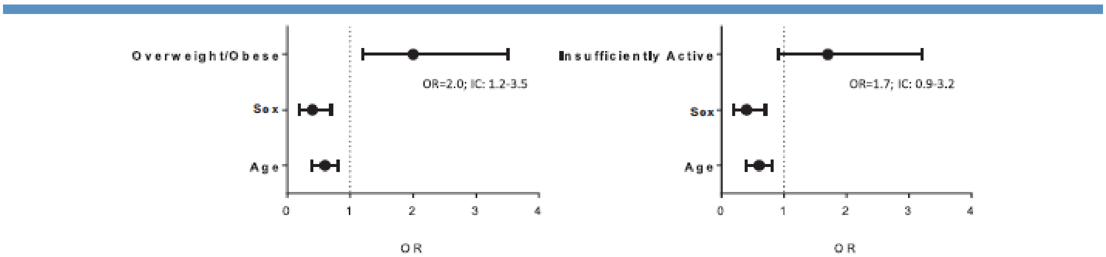

Figure 1. ORs and 95% CIs from multivariate logistic regression analysis of the association between weight status grouping and elevated BP (≥90th percentile) and between physical activity grouping and elevated BP (≥90th percentile).

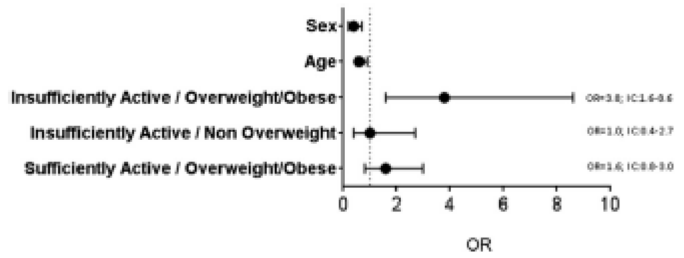

Figure 2. ORs and 95% CIs from multivariate logistic regression analysis of the association between combined physical activity. Weight status grouping and elevated BP (≥90th percentile).

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