Accelerometer-Based Physical Activity, Sedentary Time, and BMI among Preschoolers in Puerto Rico

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Objective: A minimum of 3-h/day of any intensity physical activity (PA) has been recommended for preschoolers. No previous study has documented accelerometer-based PA and sedentary time (ST) among Hispanic preschoolers in Puerto Rico, a population with high obesity and low PA prevalence. The purpose of this study was to describe and compare total, weekdays (during- and out-of-preschool) and weekend PA and ST, and test associations with body mass index (BMI).

Methods: A group of 3-5-year-old preschoolers (9 boys,13 girls) completed height and weight measurements, and wore an accelerometer during 7-days. Shapiro-Wilk, Mann-Whitney U test and Spearman correlations were used to test for normality, sex differences and associations, respectively.

Results: No sex differences were observed for BMI, weekdays and weekends PA and ST. Light to vigorous intensity PA (LVPA=3.2±0.6 h/day) and moderate to vigorous intensity PA (MVPA=80.4±21.7 min/day) were within guidelines only on weekdays. LVPA occupied 21.3% (15.4±3.7 min/h), MVPA 9.5% (6.6±2.3 min/h), and ST 65.3% (4.8±0.4 h/day) of preschool time. Boys had higher MVPA than girls only during-preschool time. BMI indicative of overweight-obesity was identified in 36.3%, and BMI directly correlated with total ST and inversely correlated with LVPA.

Conclusion: Total and during-preschool LVPA and ST, and their association with BMI highlight the need for interventions to promote PA and reduce ST, particularly during-preschool time. [*P R Health Sci J 2022;41(4):239-242*]

Key words: Movement behavior, Hispanic, Preschool children

Childhood is a period in which physical activity (PA) influences growth and development, lifetime behaviors, and well-being (1). PA guidelines for 3-5-year-old preschoolers suggest at least 3 h/day of light to vigorous intensity PA (LVPA), of which at least 60 min is moderate to vigorous PA (MVPA) under supervision in a safe environment (1-2), including the expectation of 11,000-15,000 steps/day (3). Because preschoolers spend 4-10 h/day in preschools (4), activities during preschool time could significantly contribute to meeting PA guidelines.

Preschool PA interventions have shown improvements in bone health, motor skills, aerobic fitness, and control of overweight-obesity among preschoolers (5). However, a high proportion (>50%) of preschoolers fail to meet PA guidelines, partly explained by insufficient structured PA (6). Although ST associated with sitting during reading and storytelling is encouraged, a limit of 1-2 h/day has been recommended (2), particularly sitting-inducing screen time (1-2).

Insufficient PA and too much ST are associated with poor cardiometabolic health, poor fitness, and increased adiposity among children (2, 7); and overweight-obese preschoolers have 5-times the risk of becoming overweight-obese adults compared to healthy-weight children (8). Hispanic preschoolers in the United States (US) have a higher obesity prevalence (22.0%) than non-Hispanic whites (15.9%) (9). From 2008-2011, this prevalence decreased in the US but stayed between 17.9-18.3% in Puerto Rico (PR) (10). PA and ST among preschoolers in PR have not been documented using accelerometers. Therefore, the purpose of this study was to describe and compare total, weekdays (during- and out-of-preschool), and weekend accelerometer-based PA and ST, and correlations with BMI percentile among Hispanic preschoolers in PR. We hypothesized that BMI percentile will be inversely associated with PA but directly associated with ST.

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Materials and Methods

Participants

Twenty-four (3-5-year-old) children were recruited from the Preschool Development Center at the University of Puerto Rico, Río Piedras Campus (UPRRP). After all questions were answered, parents and children signed the informed consent and ascent forms previously approved by the UPRRP Institutional Review Board.

Instrumentation

Children wore an ActiGraph® wGT3X-BT accelerometer (ActiGraph®, LLC, Pensacola, FL) in the right hip for 24 h/day during 7-days and completed weight (Tanita UM-081 scale, Tanita Corporation of America, Inc., Arlington Heights, IL) and height (SECA 217 stadiometer, SECA® Chino, CA) measurements during April 2018. Body mass index (BMI = kg/m^2), BMI percentile, and BMI percentile classification were determined using the CDC calculator (https://www.cdc.gov/healthyweight/bmi/calculator.html).

Procedure

Accelerometers were initialized using a 60 Hz sampling rate; and downloaded using 1-s epochs aggregated to 30-s, 3-axes, and steps for data analysis (ActiLife® v. 6.13, ActiGraph®, LLC, Pensacola, FL, USA). The algorithm by Pate et al. (11) was used to identify ST, light, moderate and vigorous PA. Filters were used to determine total (7-days), weekdays (during- and out-of-preschool) and weekend PA and ST. For preschool PA and ST, a filter was set from 8:00 AM to 3:30 PM following the UPRRP preschool hours. Out-of-preschool included before and after preschool time (average based on parent's report= before school: 7:00-7:59 AM; after school: 3:31-10:00 PM). Non wear time, sleep time, and preschool nap time were excluded from the analysis.

Data analysis

Shapiro-Wilk test for normality, Mann-Whitney U tests for sex differences and comparisons between time periods, and Spearman correlations for associations between variables were conducted with STATA 15.1 (StataCorp LLC, College Station, TX, USA) using an alpha of 0.05 for significance.

Results

Two participants were excluded because of incomplete accelerometer data, therefore, the final sample consisted of 22 children. Mean daytime wear time was 13.9±4.9 h/day. Table 1 shows more girls (59.1%) participating in the study, and no sex differences for age, weight, BMI, BMI percentile, and wear time. A total of 13.6% (3/22) were overweight and 22.7% (5/22) were obese.

No sex differences were observed for weekdays (during- and out-of-preschool) and weekends PA and ST (Table 2). Near 60% of all PA on weekdays and weekends was of light intensity. Although mean weekdays LVPA and MVPA were within guidelines, less than half (45%) achieved LVPA of at least 3 h/day. MVPA, LVPA, and steps/day were lower on weekends compared to weekdays (P=0.006, 0.001, and 0.003, respectively).

Table 1. Descriptive Characteristics of Preschool Children Participants (mean ± SD)

Variable	Girls (n = 13)	Boys (n = 9)	P
Age (years)	3.9 ± 0.6	4.0 ± 0.7	0.79
Weight (kg)	17.8 ± 2.1	20.4 ± 4.6	0.09
BMI (kg/m^2)	16.1 ± 1.6	17.3 ± 2.4	0.16
BMI Percentile	59.9 ± 30.3	68.9 ± 33.7	0.52
Accelerometer wear time (h/day)	13.8 ± 4.4	14.1 ± 5.9	0.92

Note: BMI = body mass index

During-preschool MVPA was higher in boys than girls (Table 3). For both, MVPA occupied 9.5% (6.9 min/h), and LVPA 21.3% (15.4 min/h); however, 65.3% (4.8 h/day) was ST. During-preschool contribution to weekdays MVPA, LVPA, and ST was 53.4%, 53.1%, and 56.9%, respectively. No children achieved 3 h/day of LVPA during preschool time, but 13.6 % (3/22) achieved MVPA recommendation of 60 min/day. During- and out-of-preschool's PA and ST were not different among girls, but boys engaged in more MVPA and had more steps during-preschool compared to out-of-preschool (P=0.05).

BMI percentile directly correlated with total ST (rho=0.45, P=0.038), and inversely correlated with total light PA (rho=-0.43, P=0.048), total MVPA (rho=-0.42, P=0.047), total LVPA (rho=-0.45, P=0.038), and weekdays vigorous PA (rho=-

Table 2. Physical Activity (PA) and Sedentary Time (ST) on Weekdays and Weekends (mean ± SD)

	Weekdays		
Variable	Girls (n = 13)	Boys (n = 9)	P
Light PA (min/day)	119.1 ± 20.6	96.9 ± 31.8	0.39
Moderate PA (min/day)	66.6 ± 14.9	68.6 ± 15.7	0.76
MVPA (min/day)	79.3 ± 21.5	82.1 ± 23.2	0.78
LVPA (h/day)	3.3 ± 0.58	2.8 ± 0.9	0.44
Number of steps	8,662 ± 1,311	6,914 ± 1,837	0.06
ST (h/day)	10.1 ± 0.5	10.2 ± 0.7	0.59
	Weekend Days		
Light PA (min/day)	81.7 ± 52.6	82.6 ± 58.8	0.97
Moderate PA (min/day)	38.5 ± 27.5	47.8 ± 34.6	0.50
MVPA (min/day)	51.4 ± 38.9	63.9 ± 48.2	0.52
LVPA (h/day)	2.2 ± 1.4	2.4 ± 1.7	0.75
Number of steps	5,751 ± 3,758	6,206 ± 3,765	0.79
ST (h/day)	9.6 ± 5.7	10.5 ± 7.0	0.76

Note: MVPA = moderate to vigorous physical activity, LVPA = light to vigorous physical activity

Table 3. Physical Activity (PA) and Sedentary Time (ST) In- and Out-of-preschool (mean ± SD)

	During-Preschool		
Variable	**Girls (n = 13)**	**Boys (n = 9)**	**P**
Light PA (min/day)	58.3 ± 9.3	55.8 ± 17.9	0.67
Moderate PA (min/day)	32.4 ± 7.4	41.8 ± 13.7	0.05
MVPA (min/day)	37.6 ± 9.2	50.3 ±19.1	0.05
(min/h)	5.8 ± 1.4	7.7 ± 3.0	0.05
LVPA (h/day)	1.6 ± 0.3	1.8 ± 0.5	0.30
(min/h)	14.7 ± 2.4	16.3 ± 5.0	0.34
Number of steps	3,705 ± 356	4,161 ± 1,247	0.22
ST (h/day)	4.9 ± 0.3	4.7 ± 0.5	0.32
	Out-of-Preschool (before + after)		
Light PA (min/day)	52.9 ± 13.5	49.2 ± 12.1	0.52
Moderate PA (min/day)	29.4 ± 7.9	29.3 ± 10.5	0.97
MVPA (min/day)	35.1 ± 9.8	36.3 ± 13.4	0.80
(min/h)	6.7 ± 2.8	7.1 ± 3.6	0.75
LVPA (h/day)	1.5 ± 0.3	1.4 ± 0.4	0.79
(min/h)	16.2 ± 4.2	16.4 ± 5.7	0.94
Number of steps	2,002 ± 462	2,013 ± 421	0.96
ST (h/day)	4.3 ± 1.1	4.3 ±1.3	0.99

Note: MVPA = moderate to vigorous physical activity, LVPA = light to vigorous physical activity

0.41, P=0.052). During-preschool MVPA correlated with total MVPA (rho=0.48, P=0.023). During-preschool LVPA correlated with weekdays LVPA (rho=0.80, P<0.0001) and total LVPA (rho=0.54, P=0.010). Preschool ST correlated with total ST (rho=0.80, P<0.0001).

Discussion

To our knowledge, this is the first report of total, weekdays (during- and out-of-preschool), and weekends accelerometer-based PA and ST, and their correlations with BMI percentile among Hispanic preschoolers in PR. Obesity prevalence was similar to Hispanic preschoolers in the US (9), but slightly higher than previously reported in PR (10). The prevalence of overweight-obesity (36.3%) was similar to Hispanic preschoolers in the US (12).

Previous self-reports have shown a 20-25% compliance with PA guidelines among children and adolescents in PR, with males being more active than females, and a 40-41% prevalence of overweight-obesity (13, 14). Preschoolers in our study had better compliance with PA guidelines (MVPA=36.3%, LVPA=41%), and similar obesity prevalence; but sex difference in MVPA was observed only during-preschool time where boys had higher MVPA than girls. Compared with preschoolers elsewhere (12, 15-17), our group was within the range of MVPA (5.5-9.9% of daytime) but had more daytime ST; therefore, highlighting the need to implement interventions to discourage too much ST.

Preschools in general appear to provide limited opportunities for PA, with 50-94% of the time dedicated to sedentary behaviors (6, 15-17), and sex differences observed at this young age. For example, Pate et al. (18) reported a 34-58% prevalence of meeting PA guidelines based on LVPA (≥15 min/h), which was higher in boys than girls. Although no LVPA sex differences were observed during preschool time, boys engaged in more MVPA during preschool compared with girls. It is possible that unstructured PA when outdoor recreational space is available, and structured PA with 45 min/day of physical education class might not be enough encouragement for girls to engage in MVPA compared with boys. We were not able to distinguish MVPA during recreational time and physical education class; therefore, actual gender differences between unstructured and structured PA during preschool time remains unknown.

It has been reported that preschoolers in the US spend between 4.5-11.3 min/h in MVPA and 8.4-20 min/h in LVPA, with zero to 83% able to achieve PA guidelines (19). Our results during-preschool time MVPA (6.9 min/h) and LVPA (15.4 min/h) were within these values; however, more than half of preschool time (65.3%) was ST. Our findings also suggest a potential compensation effect among boys who were more active than girls during-preschool time but reduced their active behavior after school time. We also highlight that active and sedentary behaviors during-preschool appears to influence weekly active and sedentary behaviors.

Increasing PA and reducing ST can help prevent preschoolers' unhealthy weight gain (19). Overweight-obese preschoolers in our study had less total and out-of-school MVPA, and more ST than normal weight participants, which highlights the association between PA, ST, and unhealthy weight. Although Garza et al. (13) found no correlation between BMI and self-reported PA among children and adolescents in PR, others have shown an inverse correlation between vigorous PA and overweight-obesity in this age group (20). We concur with Arhab et al. (20) and Timmons et al. (5) in suggesting the need to better understand the association between preschoolers' PA, ST, overweight-obesity, and general health during and beyond preschool years.

The accelerometer-based assessment of PA and ST, and general good compliance with the accelerometer protocol was an important strength. However, our small sample size could have limited some of our findings. With this limitation we summarize that our Hispanic preschoolers at the UPRRP: 1) engaged in sufficient PA during weekdays but not during weekends, 2) had a large proportion of during-preschool time and weekends in sedentary behaviors, 3) girls had similar active and sedentary behaviors during- and out-of-preschool, but boys engaged in more MVPA during-preschool compared to girls and compared to out-of-preschool, 4) those with higher BMI percentile were less active and more sedentary, and 5) those more active during the week were also more active during-preschool, while those more sedentary during the week were also more sedentary during-preschool. Our results highlight the need to implement and frequently evaluate preschools' structured and unstructured activities to help preschoolers move more and sit less during preschool time.

Resumen

Objetivo: En prescolares se recomienda actividad física (AF) de cualquier intensidad por al menos 3-h/día. La AF y tiempo sedentario (TS) utilizando acelerómetros no se ha documentado entre prescolares en Puerto Rico, una población con alta prevalencia de obesidad y baja AF. El propósito de este estudio fue describir y comparar AF y TS total, en días de semana (durante y fuera de la escuela) y en fin de semana, y evaluar asociaciones con el índice de masa corporal (IMC). Métodos: Un grupo de prescolares (9 niños, 13 niñas; edad: 3-5 años) completaron medidas de estatura y peso y utilizaron un acelerómetro durante 7-días. Las pruebas Shapiro-Wilk, Mann-Whitney U y correlación Spearman se utilizaron para determinar normalidad, diferencias por sexo y asociaciones entre variables, respectivamente. Resultados: No hubo diferencias por sexo en IMC, AF y TS en días de semana y fin de semana. La AF liviana a vigorosa (AFLV=3.2±0.6 h/día) y la AF moderada a vigorosa (AFMV=80.4±21.7 min/día) en la semana se encontró dentro de lo recomendado. La AFLV ocupó 21.3% (15.4±3.7 min/h), AFMV 9.5% (6.6±2.3 min/h) y TS 65.3% (4.8±0.4 h/día) del tiempo prescolar. Los niños tuvieron mayor AFMV que las niñas durante el tiempo prescolar. IMC de sobrepeso-obesidad se identificó en 36.3% y correlacionó directamente con el TS total e inversamente con la AFLV. Conclusión: La AFLV y TS total y durante el tiempo prescolar, y su asociación con el IMC sugieren la necesidad de promover la AF y reducir el TS, particularmente dentro del tiempo prescolar.

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