

RESEARCH ARTICLE

Physical Activity in Preschool Children: Comparison Between Montessori and Traditional Preschools

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ABSTRACT

BACKGROUND: Little is known about the influence of Montessori methods on children's physical activity (PA). This cross-sectional study compared PA of children attending Montessori and traditional preschools.

METHODS: We enrolled 301 children in 9 Montessori and 8 traditional preschools in Columbia, South Carolina. PA was measured by accelerometry on weekdays during preschool (In-School), non-school (Non-School), and all day (All Day). Minutes/hour of light, moderate-to-vigorous (MVPA), and total PA (light + MVPA) were calculated.

RESULTS: Children attending Montessori preschools accumulated more In-School light (7.7 vs. 6.5 minute/hour), MVPA (7.7 versus 6.5 minute/hour), and total PA (15.4 versus 13.0 minute/hour) than children attending traditional preschools, after adjusting for sex, race/ethnicity, body mass index, parent education and neighborhood poverty index. For Non-School (8.5 versus 6.2 minute/hour) and All Day (8.5 versus 7.6 minute/hour), children in Montessori preschools accumulated more MVPA than children in traditional preschools. In-School PA was higher for children in *private* Montessori than *public* Montessori preschools (8.1 versus 7.0 minute/hour; 8.1 versus 6.7 minute/hour; 16.1 versus 13.6 minute/hour, for light, MVPA, and total PA, respectively).

CONCLUSIONS: Children attending Montessori preschools were more active than children attending traditional preschools. Adopting the Montessori system may be an important strategy for promoting PA in children.

Keywords: accelerometer; light physical activity; preschool; Montessori.

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The prevalence of overweight and obesity in children has increased in recent decades, including very young children. In the most recent National Health and Nutrition Examination Survey (NHANES), 22.8% of US children aged 2 to 5 years were observed to be overweight or obese (≥ 85 th percentile).¹ Many experts believe that low levels of physical activity

(PA) have contributed to the increase in obesity prevalence.^{2,3} Recently, 4 authoritative organizations released guidelines that call for regular PA for preschool-age children.³⁻⁶ One set of guidelines, from the Institute of Medicine,³ provides specific recommendations for PA in preschools and child care centers. Although some research has examined PA

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levels of children attending traditional preschools and child care centers, little is known about PA levels of children who attend Montessori preschools.

Montessori education has existed for more than 100 years, and Montessori methods are used worldwide.⁷ The first Montessori school in the United States opened in 1911.⁸ By 2007, about 5000 schools in the United States used Montessori methods,⁸ and a growing number of Montessori programs are found in public schools.⁹ Children in Montessori programs learn through action and self-discovery. They choose activities⁷ and move about freely during the course of the day.¹⁰ Whereas research has examined differences in educational development between young children who attend Montessori and traditional preschools,⁷ little is known about differences in PA levels between children who attend the 2 types of programs.

To our knowledge, no study has described the PA levels of children attending Montessori preschools. The purpose of this study, therefore, was to compare PA levels of children attending Montessori preschools with those of children attending traditional preschools, using accelerometry as the measure of PA.

METHODS

Study Design and Participants

The study used a cross-sectional design. Participants were children enrolled in 4-year-old classrooms in Montessori and traditional preschools in Columbia, South Carolina. All of the preschools were licensed by the South Carolina Department of Social Services and enrolled 15 or more children in 4-year-old classrooms. Montessori preschools also met the following criteria: (1) accredited by or a member of at least 1 national Montessori association; and (2) employed certified Montessori teachers. Eight traditional preschools were recruited to participate in the study from a pool of 62 traditional preschools that met the study criteria. In the target geographic area, 12 Montessori preschools met the study criteria. All 12 were invited to participate in the study, and 9 accepted the invitation. The parents of all children enrolled in 4-year-old classrooms in the participating preschools were invited to take part in the study, and all those consenting were included in the data collection protocol. The study included 301 children who met the prescribed standard for compliance with the accelerometry protocol and for whom complete data were available for all study variables. The number of study participants per preschool ranged from 8 to 31 in Montessori preschools and from 5 to 37 in traditional preschools. Data were collected between 2008 and 2011.

For the current analyses, we examined 3 time periods: In-School, Non-School, and All Day. In-School included the time when the child attended preschool, and Non-School included the time (on

school days) when the child did not attend preschool. All Day included the entire monitoring period (In-School and Non-School). Children's parents or guardians provided written informed consent prior to collection of data.

Assessment of PA

PA was measured using ActiGraph accelerometers (ActiGraph models GT1M and GT3X, Pensacola, FL). Accelerometers were initialized to save data in 15-second intervals (epochs) to account for the spontaneous PA of 4-year-old children. Children wore the accelerometers on an elastic belt on the right hip (anterior to the iliac crest) for 5 consecutive weekdays (Monday to Friday). Parents were instructed to remove the accelerometer during water activities (bathing, swimming) and when the child went to bed. Trained data collectors checked each child's accelerometer at the beginning of each school day. If a child was not wearing the accelerometer upon arrival at preschool, study staff provided a temporary accelerometer for the child to wear that day. Accelerometer data were later linked for each child. Trained data collectors recorded participants' arrival and departure times from the preschools every day, to distinguish In-School PA from Non-School PA. Each child's daily PA data were summarized by time period: In-School, Non-School, and All Day.

Cut points developed specifically for preschool children were applied to the raw accelerometry data to determine time spent in light, moderate, and vigorous PA. The cut points for light, moderate, and vigorous PA were ≥ 200 counts/15 seconds, ≥ 420 counts/15 seconds, and ≥ 842 counts/15 seconds, respectively.^{11,12} Total PA was defined as the sum of light, moderate, and vigorous intensity activity. Sixty-minutes of consecutive zeros were considered as non-wear time and were excluded from the analyses.

Owing to variations in actual in-school hours among the preschools, children must have worn the accelerometer for at least 50% of the In-School period for their data from that day to be considered valid. Children must have worn the accelerometer for at least 4 hours during the Non-School period for their data from that day to be considered valid. Valid All Day data required both valid In-School and Non-School data for that day. Days that children were absent from preschool and days on which total wear time ≥ 18 hours were excluded from the analyses because they do not represent typical school days. Children who had at least 3 days of valid data were included in the analyses. The average time spent in light PA, moderate-to-vigorous PA (MVPA), and total PA was expressed as minutes per hour of observation (minute/hour), using each child's wear time as the divisor to account for differences in monitoring time.

Table 1. Characteristics of Children Attending Montessori and Traditional Preschools

Characteristic	In-School			Non-School			All Day		
	Montessori	Traditional	p	Montessori	Traditional	p	Montessori	Traditional	p
No. (%)	145 (48.2)	156 (51.8)		123 (49.8)	124 (50.2)		123 (49.8)	124 (50.2)	
Age, mean (SD), years	4.4 (0.5)	4.6 (0.4)	.02	4.4 (0.6)	4.6 (0.3)	.04	4.4 (0.6)	4.6 (0.3)	.04
Boys, no. (%)	71 (49.0)	80 (51.3)	.69	59 (48.0)	64 (51.6)	.57	59 (48.0)	64 (51.6)	.57
BMI, mean (SD), kg/m ²	15.9 (1.7)	16.4 (2.2)	.01	15.8 (1.8)	16.3 (2.1)	.05	15.8 (1.8)	16.3 (2.1)	.05
Monitor wear, mean (SD), hours/day	5.7 (1.2)	5.9 (1.1)	.28	6.5 (1.4)	6.5 (1.5)	.83	12.2 (1.2)	12.0 (1.9)	.30
Race/ethnicity, no. (%)									
African American	33 (22.8)	65 (41.7)	<.001	30 (24.4)	48 (38.7)	<.001	30 (24.4)	48 (38.7)	<.001
White	98 (67.6)	60 (38.5)		82 (66.7)	51 (41.1)		82 (66.7)	51 (41.1)	
Other	14 (9.7)	31 (19.9)		11 (8.9)	25 (20.2)		11 (8.9)	25 (20.2)	
Parent education ≥ 4-year degree, no. (%)	126 (87.5)	70 (44.9)	<.001	109 (88.6)	69 (55.7)	<.001	109 (88.6)	69 (55.7)	<.001
Poverty index	11.7 (9.3)	14.0 (8.6)	.03	12.1 (9.6)	13.3 (7.7)	.27	12.1 (9.6)	13.3 (7.7)	.27

BMI, body mass index.

Assessment of Demographic and Anthropometric Measurements

A parent or guardian reported the child’s age, sex, race/ethnicity, home address, and parent education via a parent survey. Surrogate indicators of socioeconomic status were parent education (categorized as having a 4-year baccalaureate degree or more, or less than a 4-year degree) and poverty index (percent of homes with incomes below the federal poverty level) for the census tract in which the family’s home was located.¹³ Weight was measured in duplicate to the nearest 0.1 kg using an electronic scale (Seca, Model 770; Hamburg, Germany), and height was measured in duplicate to the nearest 0.1 cm using a portable stadiometer (Shorr Productions; Olney, MD), after children removed their shoes and outer clothing. Body mass index (BMI) was calculated (kg/m²) from the averages of height and weight.

Data Analysis

Descriptive statistics (mean and SD; frequency and percent) were calculated for children attending Montessori and traditional preschools for each of the 3 time periods. Mixed-model ANOVA was used with preschool as a random variable to determine if there were differences in light PA, MVPA, and total PA between children attending Montessori and traditional preschools. In-School and All Day models were adjusted for sex, race/ethnicity, BMI, parent education and poverty index. Non-School models were adjusted for sex, race/ethnicity, BMI, parent education, poverty index and time in school. We then tested for sex differences between Montessori and traditional preschools by testing an interaction between sex and preschool type for the PA variables. We used another set of models to test for differences in the PA variables between Montessori and traditional preschools based on funding type (private vs. public). All data were analyzed using SAS version 9.3 (SAS Institute, Cary, NC).

RESULTS

Children attending Montessori preschools (N = 145) were predominately white and more likely to have parents with higher education levels, compared to children attending traditional preschools (N = 156; Table 1). Children attending Montessori preschools were slightly younger and had lower mean BMI than children attending traditional preschools. Mean accelerometer wear time was similar in children attending both Montessori and traditional preschools.

During the In-School period, children attending Montessori preschools accumulated more light, moderate-to-vigorous and total PA than children attending traditional preschools, after adjusting for sex, race/ethnicity, BMI, and parent education (Table 2). The differences for light and total PA were statistically significant (p ≤ .05). For the Non-School and All Day periods, children in Montessori preschools accumulated more MVPA than children in traditional preschools. During each of the 3 time periods, boys were more active than girls. There were no significant interactions between sex and type of preschool for any of the PA variables.

PA levels for children attending privately- and publicly funded preschools are presented in Table 3. For the In-School period, children in private Montessori preschools were more active than children in public Montessori preschools. For All Day, children in private Montessori preschools participated in more MVPA than children in public Montessori, private traditional, and public traditional preschools.

DISCUSSION

The major finding of this study was that children attending Montessori preschools were more physically active than children attending traditional preschools. Boys were more physically active than girls, but the difference between Montessori and traditional preschools was consistent for both sexes. That is,

Table 2. Time Spent in Physical Activity (minute/hour)* Among Children Attending Montessori and Traditional Preschools, by Sex

			p	Montessori		Traditional		Montessori or Traditional P		
	Montessori	Traditional		Boys	Girls	Boys	Girls	Type	Sex	Type by Sex Interaction
In-School [†]										
Light PA	7.7 (0.4)	6.5 (0.4)	.03	7.9 (0.4)	7.6 (0.4)	6.8 (0.4)	6.3 (0.4)	.03	.01	.51
MVPA [§]	7.7 (0.5)	6.5 (0.5)	.08	8.1 (0.6)	7.2 (0.6)	7.1 (0.5)	5.9 (0.5)	.08	<.001	.53
Total PA	15.4 (0.9)	13.0 (0.9)	.05	16.0 (0.9)	14.7 (0.9)	13.8 (0.9)	12.1 (0.9)	.04	.001	.52
Non-School [‡]										
Light PA	7.8 (0.6)	8.3 (0.6)	.57	8.0 (0.6)	7.7 (0.6)	8.7 (0.6)	7.9 (0.6)	.57	.01	.30
MVPA [§]	8.5 (0.5)	6.2 (0.4)	<.001	9.0 (0.5)	8.1 (0.5)	6.1 (0.5)	6.3 (0.5)	<.001	.10	.35
Total PA	16.5 (0.9)	14.5 (0.9)	.11	17.2 (0.9)	15.9 (0.9)	14.9 (1.0)	14.2 (1.0)	.11	.06	.52
All Day [†]										
Light PA	7.6 (0.5)	8.0 (0.5)	.60	7.8 (0.5)	7.4 (0.5)	8.3 (0.5)	7.7 (0.5)	.59	.003	.50
MVPA [§]	8.5 (0.3)	7.6 (0.3)	.03	8.8 (0.4)	8.1 (0.4)	8.2 (0.4)	7.0 (0.4)	.03	.001	.51
Total PA	16.0 (0.6)	15.5 (0.6)	.50	16.6 (0.7)	15.4 (0.7)	16.4 (0.7)	14.5 (0.6)	.51	<.001	.37

PA, physical activity; MVPA, moderate-to-vigorous physical activity.

*Estimated times spent in light PA, MVPA, and total PA are least-square means and SE.

[†]Adjusted for race/ethnicity, BMI, parent education, and poverty index.

[‡]Adjusted for race/ethnicity, BMI, time in school, parent education, and poverty index.

[§]Skewed distribution. Least-square means (SE) refers to original minute/hour; p-values after square root transformation.

Table 3. Time Spent in Physical Activity (minute/hour)* Among Children Attending Montessori and Traditional Preschools, by Preschool Setting (Private or Public)

	Montessori		Traditional		Type	Setting [¶]	p	Type by Setting Interaction
	Private	Public	Private	Public				
In-School [†]								
Light PA ^{#,**}	8.1 (0.4)	7.0 (0.5)	5.7 (0.5)	7.3 (0.5)	.03	.59		.004
MVPA ^{§,#}	8.1 (0.6)	6.7 (0.7)	5.6 (0.7)	7.2 (0.6)	.12	.81		.02
Total PA ^{#,**}	16.1 (0.9)	13.6 (1.2)	11.2 (1.1)	14.5 (1.0)	.06	.72		.01
Non-School [‡]								
Light PA	8.4 (0.7)	7.2 (0.9)	8.9 (0.8)	7.3 (0.9)	.71	.11		.83
MVPA [§]	9.3 (0.6)	8.2 (0.6)	7.1 (0.6)	5.3 (0.6)	<.001	.03		.64
Total PA	17.9 (1.0)	15.4 (1.2)	16.0 (1.0)	12.5 (1.1)	.03	.01		.56
All Day [†]								
Light PA	7.9 (0.6)	7.0 (0.8)	8.4 (0.7)	7.5 (0.7)	.49	.23		.97
MVPA ^{§,#,††,‡‡}	9.0 (0.4)	7.6 (0.4)	7.5 (0.4)	7.7 (0.3)	.04	.10		.02
Total PA	16.9 (0.7)	14.6 (0.9)	15.8 (0.8)	15.2 (0.8)	.73	.08		.29

PA, physical activity; MVPA, moderate-to-vigorous physical activity.

*Estimated times spent in light PA, MVPA, and total PA are least-square means and SE.

[†]Adjusted for sex, race/ethnicity, BMI, parent education, and poverty index.

[‡]Adjusted for sex, race/ethnicity, BMI, time in school, parent education, and poverty index.

[§]Skewed distribution. Least-square means (SE) refers to original minute/hour; p-values after square root transformation.

^{||}Montessori or traditional.

[¶]Private or public.

[#]Private Montessori differs from private traditional.

^{**}Private traditional differs from public traditional.

^{††}Private Montessori differs from public Montessori.

^{‡‡}Private Montessori differs from public traditional.

both boys and girls were more physically active in the Montessori schools, compared to children in the traditional preschools. Further, similar differences were observed for MVPA during both the Non-School and All Day periods. This indicates that the higher PA level observed in the Montessori preschools during the school day was not offset by lower activity during out-of-school hours. In fact, our data suggest the opposite—that the higher activity levels during the school day in Montessori schools carried over to children’s activity behavior outside of school.

These effects were not explained by sociodemographic differences between the samples, because all analyses were adjusted for sex, race/ethnicity, parent education, neighborhood poverty index and BMI.

Our findings indicate that children’s PA behavior is associated with the type of school attended, and the findings suggest that the classroom environment that is characteristic of the Montessori system may provide children with more PA than traditional preschools.^{8,14,15} This system, first established by Dr. Maria Montessori in 1907,⁷ encourages children to

choose activities and direct their own learning.¹⁶ Children in Montessori preschools move about freely during the day.¹⁴ This contrasts with traditional preschools, in which children are expected to be seated for much of the day as they perform teacher-directed activities. In addition, the Montessori systems calls for classrooms to be large and open,¹⁷ and to contain materials that encourage activities such as cleaning.^{15,17} This allows children to direct their own learning and to participate in movement opportunities throughout the preschool day. Our findings suggest that this approach may positively influence their PA levels.

An interesting finding was that children in *private* Montessori preschools accumulated more In-School light, MVPA, and total PA than children in *public* Montessori preschools. Further, children in private Montessori preschools obtained more All Day MVPA than children in public Montessori preschools. The higher levels of PA in private Montessori preschools may indicate that those schools adhered more closely to the Montessori methods than did the public Montessori schools. The public Montessori preschools operate within the public school system, and policies and practices of that system dictate aspects of the school day (lunch, recess, teacher-lead activities). Therefore, the public Montessori preschools may have incorporated some, but not all, aspects of the Montessori methods. A recent study by Lillard⁷ found that fidelity to Montessori methods affected academic performance: children from Classic Montessori programs (high fidelity) showed greater gains in academic outcomes compared to children from Supplemented Montessori (lower fidelity) programs. Our study suggests that fidelity to Montessori methods also may influence children's PA levels.

Strength and Limitations

This study has both important strengths and some significant limitations. Strengths include use of objective measurement of PA via accelerometry and observation of the children's PA during both the school day and the non-school period. Both groups studied included diverse samples of children from multiple preschools. The major limitations are associated with the cross-sectional study design. This design precludes drawing a conclusion regarding a possible causal relationship between exposure to the Montessori educational system and children's PA. Further, because parents self-selected one type of preschool or the other, we cannot preclude the possibility that inter-group differences are explained in part or wholly by family characteristics rather than characteristics of the school environment. Comparisons of the 2 groups of children were adjusted for BMI, race/ethnicity, parent education and poverty index, so our findings should

not have been unduly influenced by these factors. However, it is possible that other characteristics of the 2 sets of families, not measured in this study, could have affected our findings. For example, we found that children attending the Montessori preschools were more active than children attending the traditional schools during the non-school period as well as during the school day. This could be explained by differences in the home environments, and this was not examined in the present study. Further, this study did not examine factors such as classroom and playground dimensions, and we recommend that these factors be considered in future investigations comparing Montessori versus traditional preschools.

Conclusions

We studied 4-year-old children attending Montessori preschools and compared their PA levels with those of children attending traditional preschools. We found that children attending preschools that applied Montessori methods were more physically active during the school day. They also engaged in more PA during non-school hours. Within the limitations imposed by this study's cross-sectional design, we conclude that application of the Montessori system may be an important strategy for providing PA to children who attend preschools.

IMPLICATIONS FOR SCHOOL HEALTH

The ongoing "obesity epidemic" has prompted public health authorities to encourage schools to adopt policies and practices aimed at preventing excessive weight gain in children. Some of the recommended initiatives have been aimed at increasing children's PA levels, and these have included enriching physical education programs, consistently providing recess in outdoor settings, and including structured classroom exercise breaks in the daily schedule. The findings of the present study suggest that the classroom management and instructional methods prescribed by the Montessori system may represent an effective means for providing and promoting PA in the preschool setting. The Montessori system is based on "child-centered learning," a key aspect of which is encouragement of children to move about the classroom. Whereas more research will be needed to fully elucidate the impact of the Montessori system on children's PA, it is possible that providing children with freedom to move within a planned educational environment constitutes an important source of healthful PA.

Human Subjects Approval Statement

The study was approved by the University of South Carolina's Institutional Review Board. Parents

provided written informed consent prior to children's participation in the study.

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