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Children's Physical Activity and Associated Variables during Preschool Physical Education

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Abstract

Physical activity (PA) is important for children's growth and development and for their current and future health. Schools, especially during physical education (PE), are important locations for children to accrue PA. The purpose of this study was to assess the PA levels of preschool children during structured PE lessons and to evaluate the impact of selected characteristics (e.g., lesson context, length, and location; teacher behavior; class size; activity area density). Trained observers used SOFIT (System for Observing Fitness Instruction Time) to assess 90 structured PE lessons taught by 25 different teachers. Intact classes (n = 5 to 6 and representing 3 different grade levels) in 4 selected preschools were observed on 4 days over a 4-week period. Overall, children engaged in moderate-to-vigorous physical activity (MVPA) 49.9% (SD = 15.7) of lesson time and there were differences in MVPA% among the four preschools, by lesson context, and by teacher behavior. There were no significant differences in MVPA% either between indoor (n = 69) and outdoor (n = 21) lessons or among the 3 grade levels. Even though the lessons approached the 50% MVPA guideline, the brevity of them left children far short of recommended daily amounts of PA. Future studies should investigate how preschools can increase on-campus opportunities for PA both during PE and throughout the school days.

Keywords

Environment, Hong Kong, Movement, Observation, School

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1. Introduction

High rates of physical inactivity during childhood are problematic in most developed countries, and they are believed to be a direct or indirect cause of many pediatric diseases. Physical activity (PA) in young children can help to improve their cardio-metabolic profile (Janssen & LeBlanc, 2010) and bone health (Janz et al., 2004), contribute to their gross motor skill and psycho-social development (Timmons, Naylor, & Pfeiffer, 2007) and help to protect against child obesity (Reilly, 2008; Waters et al., 2011). In line with the growing concern about childhood obesity worldwide (Wang & Lobstein, 2006), promoting PA in young children has become increasing important for public health.

With the recognition of the importance of PA, recommendations and guidelines for PA are emerging from government and professional groups, even for young children (Pate & O'Neill, 2012). For example, in the USA the National Association for Sport and Physical Education (NASPE, 2011) recommends that preschoolers should accumulate at least 60 minutes of structured PA and up to several hours of unstructured play time every day and the American Heart Association (2014) recommends that all children aged 2 and older should participate in at least 60 minutes moderate-intensity physical activities every day. Meanwhile, the Australian (Commonwealth of Australia, 2014) and UK (Department of Health, Physical Activity, Health Improvement and Protection, 2011) governments recommend that young children should accrue at least 3 hours of daily PA spread throughout the day. Contrary to popular thinking, young children are quite inactive (Tucker, 2008). The bulk of the evidence indicates that preschool children have low levels of moderate-to-vigorous PA (MVPA) and are engaged mostly in sedentary activities whether assessed by direct observation (Pate, Mclver, Dowda, Brown, & Addy, 2008), accelerometry (Cardon & Bourdeaudhuij, 2008; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004), or pedometry (Reznik, Wylie-Rosett, Kim, & Ozuah, 2013). There are exceptions, however, especially in structured PA settings such as during preschool physical education (PE) lessons (Van Cauwenberghe, Labarque, Gubbels, De Bourdeaudhuij, & Cardon, 2012).

The significant role that schools play in providing and promoting PA and subsequently contributing to population health is well recognized (e.g., Institute of Medicine (IOM), 2013; Pate et al., 2006), and the recent "*Educating the Student Body–Taking Physical Activity and Physical Education to School*" report (IOM, 2013) suggests that schools should provide children with at least 50% of their recommended 60 daily MVPA minutes. Many children worldwide attend preschools and child care centers, and these locations have been identified as important sites for promoting PA. Reviews (e.g., Timmons et al., 2007; Tremblay, Boudreau-Larivière, & Cimon-Lambert, 2012) have identified numerous policies and practices within preschools and child care centers that influence PA, such as time allocated for PE and outdoor play and the amount of space and equipment available. Additionally, the education and training of staff and their behavior on the playground may also influence children's PA (Trost, Ward, & Senso, 2010) and the intervention literature suggests that teacher-planned and teacher-led activities during both indoor and outdoor sessions are important to children's PA accrual (IOM, 2011).

Most structured physical activities at preschools are part of PE, an important part of the preschool curriculum that provides regular opportunities for PA while promoting physical fitness and motor skill development and helping children develop cognitive, social, and emotional skills. While there are many ways to assess PA, validated direct observation instruments provide the distinct advantage of assessing the contexts in which the activity occurs (McKenzie & van der Mars, in Press). Of the available tools, SOFIT (System for Observing Fitness Instruction Time) (McKenzie, Sallis, & Nader, 1991) is widely used because it simultaneously measures PA and how lessons are delivered (i.e., context) and what the teacher is doing. Van Cauwenbergh et al. (2012), for example, recently used SOFIT to evaluate children's PA levels, lesson context, and teacher behavior in 35 preschools in Belgium.

The school physical environment influences the quantity and quality of PA that preschool children receive on campus, and Louie & Chan (2003) indicate that lack of play areas (particularly outdoor areas) appears to limit children's activity levels in Hong Kong. While Australia and Taiwan have mandatory preschool outdoor space requirements of at least 3 and 5 m^2 per child, respectively, Hong Kong has no such specifications. In Hong Kong, over 90% of preschool-aged children attend preschools, all of which are privately run and charge tuitions (Hong Kong Government Census and Statistics Department, 2006). Hong Kong is densely populated, and most preschools occupy part of a floor inside a multi-level residential building and do not have an outdoor PE space. Meanwhile, the Hong Kong Government Education Bureau (2006) recommends that preschools should offer 45 - 60 minutes or 60 - 105 minutes of daily physical fitness and music and arts for half-day and whole-day sessions,

respectively. Preschools typically schedule 25 to 30 minutes of PE daily during half-day sessions, but little is known about how active children are in these classes. Thus, the main purposes of the current study were to assess children's PA levels during PE and to determine how they were influenced by specific conditions such as lesson context and location, activity area density and teacher behavior.

2. Methods

2.1. Schools and Setting

Based on their structural and program differences, four preschools in Hong Kong were selected to participate; three had both indoor and outdoor PA areas and one had an indoor activity space only. **Table 1** presents information on the preschools, including the length of school day and size of indoor and outdoor activity areas. In each preschool, five to six classes across three preschool grade levels (nursery, lower grade, upper grade) were randomly selected for observation. A total of 90 lessons (nursery, n = 27; lower grade, n = 31; upper grade, n = 32; range = 19 - 24 lessons per preschool) of children aged 3 to 6 years were observed over a 3-month period. The lessons were from 23 different intact preschool classes observed over four different days and they were led by 25 different teachers (24 females; 1 male). The teaching experience of lead teachers ranged from 2 - 28 years (mean: 13.4 ± 7.4) and all had degrees or diplomas and were certified in Early Childhood Education. Each lead teacher had one assistant. Permission for the study was granted by the University Ethics Committee and written consent was obtained from parents of the observed children and the preschool principals.

2.2. Data Collection

Observation Schedule. SOFIT was used to record children's PA, lesson context, and teacher behavior during the PE lessons, and the observation schedule in each preschool consisted of four different week days spread over two to four weeks during summer season, 2012. Teachers were informed of the days that lessons were to be visited, but not about the precise behaviors to be coded; they were asked not to modify their original lesson content or instructional methods. Canceled lessons were re-scheduled on the same day of the following week.

SOFIT Instrument. Observation procedures followed the technical descriptions of the SOFIT training manual (McKenzie, 2012). Before the start of a class, four preschool children (2 boys, 2 girls) from a class were selected for observation. The observer sequentially focused on a target child for 4 consecutive minutes before changing to the next child. The recordings in each observation interval (10 seconds observe, 10 seconds record) contain information on *student activity levels* which were coded as 1 to 4 based on bodily movements of lying down, sitting, standing, walking, and code 5 (vigorous) for movements requiring greater energy than normal walking. *Lesson context* contained 6 codes about how the lesson was being delivered: management, knowledge, fitness, skill practice, game play, and free play. *Teacher behavior* was coded on what the teacher was doing during the observation interval: promotes and demonstrates fitness, instructs, manages, observes, and other. The following environmental conditions were also recorded once per lesson: lesson location (indoor vs. outdoor), class size (i.e., number of children participating), lesson length, size of area used, density (preschoolers per 100 m^2), air temperature (˚C), and humidity (%).

Table 1. Characteristics of four selected preschools.

Preschool	PE Lessons Observed (n)	Scheduled Lesson Length (min)	Mean Actual Lesson Length (min)	Mean Class Size (no.)	Indoor Activity Area (m^2)	Outdoor Activity Area (m^2)	Mean Area Used in PE (m^2)
1[ad]	19	30	20.2 ± 5.0	20.7 ± 2.2	96	360	163.3 ± 83.9
2[a]	24	25	19.5 ± 4.0	30.2 ± 2.6	160	350	179.2 ± 83.7
3[b]	24	24	20.8 ± 3.8	23.3 ± 4.2	67	150	87.8 ± 36.7
4[bc]	23	20	18.8 ± 3.6	20.0 ± 2.4	110	0	110.0 ± 0.0

[a]Provided half-day sessions only; [b]Provided both half- and whole-day sessions; [c]No outdoor activity area; [d]Tuition was 2.5 to 2.6 times higher than other preschools for half-day session.

Observer Training. Five observers completed training sessions conducted by the criterion observer (lead author), an experienced SOFIT observer and trainer. The observers practiced coding using pre-coded videos of PE lessons and observations of lessons in the field. Training procedures followed those specified by SOFIT manual (McKenzie, 2012), and reliability assessments during data collection showed observer agreement to be well over the established 85% criterion.

2.3. Data Analyses

SOFIT is a lesson-level measure, and the data for 90 lessons were averaged for statistical analyses. The main dependent variable was lesson MVPA percentage (MVPA%) which was computed by summing the proportion of time students engaged in walking and being vigorous. Independent t tests and one-way ANOVAs were computed to compare lesson location (outdoors, indoors), grade levels, the four preschools, and preschoolers per 100 m^2 (low, medium, high density). Correlations between MVPA% and percentage of time spent in each lesson context and teacher behavior categories were determined, and regression analysis was conducted to determine the amount of explained variance in MVPA% by the environmental variables. In addition to MVPA minutes and MVPA%, two other summary variables were computed: mean Energy Expenditure Rate per child (EER; kcal/kg/min), and Total Energy Expenditure per child per lesson (TEE; kcal/kg). EER was calculated using the following equation: (proportion of observations spent lying down × 0.029 kcal/kg/min) + (proportion of observations sitting × 0.047 kcal/kg/min) + (proportion of observations standing × 0.051 kcal/kg/min) + (proportion of observations walking × 0.096 kcal/kg/min) + (proportion of observations being vigorous × 0.144 kcal/kg/min). These energy expenditure constants for activity levels were derived from heart rate monitoring (McKenzie et al., 1991). Total Energy Expenditure (TEE), an estimate of the total energy expended per lesson per child, was calculated by multiplying EER by the lesson length.

3. Results

3.1. General

Of the 90 PE lessons observed, 19 (23%) were coded independently by two observers. Intraclass reliability coefficient averages for agreements between an observer and the criterion observer for the SOFIT codes were 0.89 for activity, 0.97 for lesson context, and 0.92 for teacher behavior, indicating good inter-observer reliability (Baumgartner & Hensley, 2006).

Observed lessons ranged from 9 to 30 minutes (mean = 19.8 ± 4.2 minutes), and the number of students in classes ranged from 11 to 36 (mean = 23.8 ± 5.0). Most lessons (77%) were conducted in indoor play spaces, and the overall mean size areas used for lessons were 133.8 ± 71.0 m^2.

The lessons were conducted in temperatures ranging from 23˚C - 37˚C (mean = 27.9˚C ± 3.3˚C) and humidity ranging from 41% - 67% (mean = 52.4% ± 6.2%). Because location and temperature variables were confounded, temperature was not analyzed as an independent variable.

The lessons primarily provided children opportunities to engage in fundamental movements, with the following activities seen most frequently: jumping (39% of lessons), crawling (32%), throwing (29%), moving on a balance beam (22%), climbing (20%), and tricycle riding (18%). Few lessons offered rhythmic activities (6%) or free play (2%), and activities involving sandbox, water, and parachute play were provided during only one lesson each.

3.2. Overall Student Activity, Lesson Context, and Teacher Behavior

Tables 2-3 present the number of minutes and proportion of lesson time for student activity levels, lesson context, and teacher behavior variables during the 90 lessons and by preschool. The large standard deviations and ranges indicate substantial variability among the lessons and among the four preschools. Overall, however, children engaged in 9.9 MVPA minutes per lesson (49.9% of lesson), with more time in walking/moderate activity (6.1 minutes; 30.3% of lesson) than vigorous activity (3.8 minutes; 19.5% of lesson). Children also spent a substantial proportion of lesson time standing (37.6%), but very little time sitting (12.3%) or lying down (0.3%) (**Table 3**). Boys were more active than girls (MVPA% = 52.8 ± 17.4 vs. 46.6 ± 19.5, $p = 0.002$; MVPA minutes per lesson = 5.6 ± 2.2 vs. 4.2 ± 1.9 minutes, $p < 0.001$) (data not shown).

Table 2. Lesson length, energy expenditure, and minutes per lesson for student physical activity, lesson context, and teacher behavior.

	All Lessons		By Preschool	Test of Equality across Four Preschools		
	(n = 90) Mean (SD)		(n = 19 - 24) Mean Range	*F*	*p*	η^2
Lesson length (min)	19.8	(4.2)	18.7 - 20.8	1.17	0.325	0.04
Lesson TEE ($kcal \cdot kg^{-1}$)	1.6	(0.4)	1.5 - 1.7	0.84	0.476	0.03
Student activity (min)						
Lying down	<0.1	(0.3)	0.0 - 0.1	0.45	0.719[b]	0.02
Sitting	2.3	(2.4)	0.9 - 3.6	7.85	<0.001[*]	0.21
Standing	7.5	(3.7)	5.9 - 9.5	6.90	<0.001[*]	0.19
Walking	6.1	(3.5)	5.4 - 6.9	0.61	0.614[a]	0.02
Vigorous	3.8	(2.9)	2.3 - 4.7	7.15	<0.001[a*]	0.09
MVPA	9.9	(3.7)	8.3 - 10.6	1.63	0.189	0.05
Lesson context (min)						
Management	3.8	(2.1)	2.3 - 5.5	13.45	<0.001[*]	0.32
Knowledge	1.4	(1.5)	1.0 - 1.9	1.93	0.137[a]	0.07
Fitness activity	2.9	(2.1)	1.8 - 4.2	6.29	0.001[*]	0.18
Skill practice	8.8	(5.0)	6.9 - 10.7	3.53	0.022[a*]	0.10
Game play	1.0	(2.9)	0.4 - 2.0	1.09	0.366[a]	0.04
Free play	1.9	(4.4)	0.0 - 4.8	6.94	<0.001[ab*]	0.19
Teacher behavior (min)						
Promoting fitness	4.2	(3.0)	3.5 - 4.6	0.90	0.448[a]	0.03
General instruction	1.4	(1.8)	0.8 - 2.2	3.54	0.022[a*]	0.12
Class management	9.3	(4.8)	7.8 - 11.9	3.04	0.033[*]	0.10
Observing	5.0	(4.4)	2.3 - 6.8	4.15	0.009[*]	0.13
Other	<0.1	(0.1)	0.0 - 0.1	1.75	0.162[ab]	0.06

[a]Significance based on Welch (by robust tests of equality of means) because of violation of homogeneity of variances; [b]Robust tests of equality of means cannot be performed because at least one preschool has zero variance; [*]Significant at $p < 0.05$.

Table 3. Energy expenditure rate and proportion of observed intervals for physical activity, lesson context, and teacher behavior.

	All Lessons		By Preschool	Test of Equality across Four Preschools		
	(n = 90) Mean (SD)		(n = 19 - 24) Mean Range	*F*	*p*	η^2
Lesson EER ($kcal \cdot kg^{-1} \cdot min^{-1}$)	0.1	(0.01)	0.07 - 0.09	4.86	0.004[*]	0.17
Student activity (%)						
Lying down	0.3	(1.3)	0.0 - 0.4	0.45	0.719[b]	0.02
Sitting	12.3	(13.6)	4.1 - 19.2	11.29	<0.001[a*]	0.19
Standing	37.6	(15.7)	29.7 - 45.9	6.57	<0.001[*]	0.19
Walking	30.3	(16.7)	27.7 - 32.8	0.50	0.683[a]	0.02

Continued

Vigorous	19.5	(14.3)	12.3 - 24.2	5.72	0.002[a*]	0.11
MVPA	49.9	(15.7)	40.9 - 56.0	3.52	0.018[*]	0.11
Lesson context (%)						
Management	19.5	(10.4)	11.8 - 26.3	11.65	<0.001[*]	0.29
Knowledge	7.1	(7.6)	4.7 - 9.9	2.38	0.081[a]	0.08
Fitness activity	14.5	(10.0)	8.6 - 20.7	6.29	0.001[*]	0.18
Skill practice	43.8	(22.6)	34.6 - 51.3	3.83	0.016[a*]	0.11
Game play	5.1	(14.4)	2.1 - 8.8	0.80	0.495	0.03
Free play	10.0	(24.0)	0.0 - 26.7	7.16	<0.001[ab*]	0.20
Teacher behavior (%)						
Promoting fitness	21.2	(15.6)	18.4 - 24.5	0.77	0.516[a]	0.03
General instruction	6.7	(8.4)	3.4 - 10.7	4.53	0.007[a*]	0.14
Class management	46.5	(21.5)	38.8 - 59.0	4.34	0.007[*]	0.13
Observing	25.4	(22.6)	11.4 - 33.1	3.74	0.014[*]	0.12
Other	0.1	(0.8)	0.0 - 0.5	1.70	0.173[ab]	0.06

[a]Significance based on Welch (by robust tests of equality of means) because of violation of homogeneity of variances; [b]Robust tests of equality of means cannot be performed because at least one preschool has zero variance; [*]Significant at $p < 0.05$.

Relative to lesson context (i.e., how PE was delivered), overall the largest proportion of time was allocated for skill practice (43.8%), followed by class management (19.5%), fitness development (14.5%), free play (10.0%), knowledge (7.1%), and game play (5.1%). There was no significant correlation between MVPA% and the percentage of time children spent in any of the lesson context categories (data not shown).

Overall teachers spent most of lesson time managing students and the environment (46.5%), followed by observing (25.4%), promoting and demonstrating fitness (21.2%), and providing general instruction (6.7%). Other (i.e., attending to tasks beyond the lesson) was coded infrequently (0.1% of lesson time).

3.3. Lesson Context, MVPA%, and Teacher Behavior

Table 4 shows substantial differences for MVPA% during the 6 different lesson contexts, with children being the most active during time allocated to skill practice (MVPA% = 61.0) and least active during time for knowledge acquisition (MVPA% = 16.7). Teacher behavior also varied during the lesson contexts, and teachers spent substantial time managing students in all 6 contexts (range = 13.1% to 93.9% of individual context time). The highest rates of inactive observing occurred during skill practice (42.5%), free play (39.3%), and game play (23.4%). MVPA% was negatively associated with the proportion of lesson time teachers spent instructing ($r = -0.21$, $p < 0.05$) and managing ($r = -0.26$, $p < 0.05$) and positively associated with the proportion of time they spent observing students ($r = 0.29$, $p < 0.05$) (data not shown).

3.4. Differences among Preschools

There were significant differences among the four preschools on numerous student activity, lesson context, and teacher behavior variables, both for lesson minutes (**Table 2**) and proportion of lesson time (**Table 3**). Of note, **Table 3** shows there were significant differences among preschools in the proportion of lesson time the children spent sitting, standing, in vigorous physical activity, MVPA, and EER. The preschool explained 17% of the variance in EER. The proportion of time allocated for lesson contexts were significantly different among preschools for all variables, except for knowledge and game play. As well, the proportion of time for teacher behavior variables, except promoting and demonstrating fitness and "other", differed significantly by preschool.

Table 4. MVPA and teacher behavior during six lesson contexts (n = 90 lessons).

	Proportion of Lesson and (min) for MVPA and Teacher Behavior in Each of 6 PE Contexts				
Lesson Context	Student MVPA%	Promoting Fitness	General Instruction	Managing Class	Observing Class
Management	40.4 (1.5)	2.9 (0.1)	1.4 (0.1)	93.9 (3.6)	1.9 (0.1)
Knowledge	16.7 (0.2)	33.4 (0.5)	52.5 (0.7)	13.1 (0.2)	0.0 (0.0)
Fitness activity	46.8 (1.4)	72.8 (2.1)	2.6 (0.1)	16.0 (0.5)	8.6 (0.2)
Skill practice	61.0 (5.4)	9.1 (0.8)	4.3 (0.4)	44.0 (3.9)	42.5 (3.7)
Game play	46.9 (0.5)	14.7 (0.1)	8.8 (0.1)	52.7 (0.5)	23.4 (0.2)
Free play	52.5 (1.0)	23.2 (0.4)	2.0 (<0.1)	35.1 (0.7)	39.3 (0.7)

Note: "Other" teacher behavior not included because it was coded for less than 0.2% of total lesson time.

3.5. Environmental Variables

Results from one-way analysis of variance showed that lesson MVPA% differed significantly among the four preschools ($F = 3.52$, $p = 0.02$). There were no significant differences in MVPA% for grade level, lesson location, class size, lesson length, or activity area density.

4. Discussion

Physical activity is important for children's growth and development; and while school PE has been identified as an important source for its accrual (IOM, 2013), relatively few studies of physical activity during preschool PE lessons have been reported. Most young children in Hong Kong attend preschools, with over two thirds of them attending half-day sessions (School Education Statistics Section, Hong Kong Education Bureau, personal communication, 25 November, 2014). During these half-day sessions most preschools offer one 30-minute PE lesson daily. As recess is offered rarely, PE is likely the only opportunity many preschoolers have to be physically active during school hours. Meanwhile, in Hong Kong many preschools are located inside multi-complex buildings that house only a small activity area for PE. Because a small area might limit physical activity levels, we sought to assess environmental conditions in this study of PE in Hong Kong preschools. This study follows our earlier investigations of PE in Hong Kong elementary and secondary schools (Chow, McKenzie, & Louie, 2008; 2009) and used the same observation instrument.

Overall the children spent about half their PE time in MVPA (i.e., 9.9 minutes) during lessons that averaged about 20 minutes in length. Thus, the intensity standard of 50% MVPA identified by USA Healthy People 2010 (USDHHS, 2000) and the Institute of Medicine (IOM, 2013) was met. This is a positive finding, especially in the light that PE lessons for young children rarely reach this physical activity level. Fairclough & Stratton (2006), for example, reviewed 44 elementary school PE studies and found children averaged only 37.4 ± 15.7% of lesson time in MVPA.

The high levels of MVPA% by the preschoolers in the current sample were similar to students observed in Hong Kong elementary PE lessons (i.e., 51%; Chow et al., 2008) and slightly higher than during 35 lessons observed in Belgium preschools (i.e., 46%; Van Cauwenberghe et al., 2012). Nonetheless, because their PE lessons were much shorter, children in the current sample accrued fewer overall MVPA minutes than those in the comparison studies. With only about 10 minutes of MVPA per lesson, the Hong Kong preschoolers fell 50 minutes short of the NASPE (2011) guidelines of 60 minutes of structured PA per day. Nevertheless, the activity obtained by the children during their PE is especially important because they were mostly sedentary during the rest of the school day (e.g., observations showed they were sedentary from 88.4% to 91.2% of the time during the 30 minutes prior to and after their PE lessons) (data not shown). Additional opportunities for children to engage in PA are thus needed, and this might result from increasing the length of PE lessons and adding recess time. As mean actual lesson length was only 81% of scheduled lesson length (i.e., 19.8 vs. 24.5 minutes), an additional strategy would be to implement accountability measures to ensure that PE lessons are held as scheduled.

Preschool girls have previously been found to be less physically active than boys both at home and during free play at schools (McKenzie, Sallis, Nader, Broyles, & Nelson, 1992) and girls are typically less active than boys during PE in both elementary (e.g., NICHD, 2003) and secondary schools (e.g., McKenzie et al., 2006). Nonetheless, the finding that girls accrued less MVPA during PE than boys in this preschool sample is discon-

certing. Even though the amount appears small (4.2 vs. 5.6 minutes/lesson; 6.2% less), MVPA is a critical element for both boys and girls to become physically fit and physically skilled and it helps to control for overweight and obesity. These outcomes are not only essential to children's growth and development, they are cumulative and their effects track into adolescence.

Increased attention to equitable opportunities for PA accrual during PE, which is a required subject matter, is warranted. This is not only because of the reduced health and development opportunities for girls, but because of social and political reasons—parents (especially of girls) and school administrators would be outraged if girls received only about 94% of the opportunities that boys received to master other subjects (e.g., reading and math and language skills).

There could be numerous reasons for the gender differences in MVPA during the lessons observed (e.g., biological, cultural, artifact of data collection), but it is beyond the capacity of this study to resolve them. Future studies could be conducted to address the issue, such as determining whether the PE curriculum is sufficiently girl-friendly or assessing whether teachers may differentially interact with boys and girls (e.g., have greater expectations for boys to be more active and achieve; call on them to demonstrate more often; provide them with different activities). In the interim, the finding of potential gender inequalities in opportunities to be active and learn during PE should be addressed during both preservice and in service teacher preparation programs.

The finding that MVPA% varied by preschool concurs with previous investigations (Dowda, Pate, Trost, Almeida, & Sirard, 2004; Pate et al., 2004), and as indicated in **Tables 2-4**, the relatively large standard deviations in child physical activity levels, lesson context, and teacher behavior, indicate that there was substantial variation in how PE lessons were conducted in these Hong Kong preschools. Class size and activity area density were not found to be significantly related to student MVPA%. These findings are contradictory to a study that showed having fewer preschoolers per 100 m^2 was associated with increased physical activity (Van Cauwenberghe et al., 2012); thus, class size and PE space parameters remain important variables for additional investigation.

Outdoor PE lessons are typically found to provide more physically active than indoor lessons (e.g., McKenzie et al., 2006; NICHD, 2003). Nonetheless in the current study and in one conducted in Hong Kong secondary schools (Chow et al., 2009), lessons held outdoors were not associated with increased PA. As well, one Australian study found using indoor space for gross motor activities in child care centers was associated with more PA and less sedentary time (Sugiyama, Okely, Masters, & Moore, 2012). Most Hong Kong preschools do not have sufficient space to be able to house outdoor play areas. In the current study only 23% of the observed lessons were held outdoors, and the preschool with no outdoor areas at all had the highest MVPA% (56%) during PE. For children to accrue ample PA in smaller spaces it is important that their teachers be efficient instructors, use an activity-based curriculum, and have sufficient equipment and supplies.

Overall the data are indicative that these preschoolers were participating in of high quality PE lessons. This includes the amount of time they were engaged in MVPA (about 50%), the relatively large proportion of class time allocated to skill development (44% of the lesson) and little to class management time (20%). With the exception of time allocated for knowledge, MVPA% was relatively high during all other lesson contexts including management time (**Table 4**). With only about 0.1% of teacher behavior coded as 'other', the data indicate that the teachers were fully focused on the lesson. This focus included teachers spending about 46% of their time managing the young children (e.g., keeping them on task), a rate much higher than that typically found with elementary and secondary school lessons and in a study of preschoolers in Belgium (Van Cauwenberghe et al., 2012). As expected, higher rates of teachers observing inactively (i.e., for at least 10 consecutively seconds) occurred during the contexts of skill practice, free play, and game play—times when it is important for teachers to observe for child skill performance and safety.

5. Summary, Limitations, and Recommendations

Our findings showed that preschooler's PA levels during PE were highly variable, suggesting that contextual conditions and teacher behaviors were important influences on activity levels. These findings need to be considered relative to several limitations, including being restricted to observations of 90 PE lessons. A further consideration is that only four different preschools were involved, limiting a comprehensive analysis of the potential of different environmental characteristics such as size of activity area, the presence or absence of outdoor activity facilities, and play equipment. Unlike our previous elementary and secondary studies which used a random sample of Hong Kong schools, these preschools were selected because they were substantially different. The strength of the study, however, was that the PE lessons were taught by 25 different teachers; thus, there was va-

riety in the content of lessons as well as the way they were conducted.

Meanwhile, sedentary living is a worldwide problem (World Health Organization, 2004), and is recommended that children should accrue at least 60 minutes of structured PA daily. PE is the only venue available for all children to engage in PA, become physically fit, and learn important movement skills. It is important to assess PE in order to determine how active children are in lessons and to identify modifiable factors that may improve them. Future studies should not only investigate how lessons impact in-class opportunities for PA and learning skills but also assess lesson factors that may promote PA beyond the lessons. Also, given the importance of teacher effectiveness in promoting children's PA levels during PE (e.g., McKenzie & Lounsbery, 2013), preschool teacher preparation programs need to provide quality training on effective instructional strategies and practice in leading structured physical activities.

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