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Physical Activity Correlates for Children With Autism Spectrum Disorders in Middle School Physical Education

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This study examined potential correlates that might influence physical activity (PA) of adolescents with autism spectrum disorders (ASD) in physical education. Students with (n = 19) and without (n = 76) ASD wore an accelerometer during physical education. Data were collected in 38 physical education lessons. The results showed that (a) students with ASD were less physically active than their peers, (b) their PA was related positively to their social interaction with peers, and (c) their moderate to vigorous PA depended on PA content, physical environment, and instructor-related characteristics. The findings suggest a need for additional studies on the relationship between the needs of adolescents with ASD and the content offered in physical education so as to inform school policies and help to remove barriers to promoting PA among this population.

Key words: adolescents, disability, health, inclusion

Individuals with autism spectrum disorders (ASD) demonstrate (a) restricted, repetitive, and stereotyped patterns of behavior, interests, and activities, and (b) impairments in social interaction and communication (American Psychiatric Association [APA], 1994). For example, they have difficulties understanding social cues, making eye contact, playing social games, engaging in sharing/turn-taking and reciprocal conversation, and making friends. Furthermore, they generally demonstrate poor motor skills (Green et al., 2009), including locomotor and object control skills (Berkeley, Zittel, Pitney, & Nichols, 2001), reach-to-grasp tasks that include movement execution and planning (Mari, Castiello, Marks, Marraffa, & Prior, 2003), and graphomotor skills (Mayes & Calhoun, 2003). These social and behavioral deficiencies and perhaps motor skill impairments may prevent individuals with ASD from participating with their peers in school-based exercise and physical activities and expose them to the risk of developing secondary health problems.

Physical activity (PA) engagement has been identified as an important goal of physical education in the United States (National Association for Sport and Physical Education, 2004) and most other countries (Puhse & Gerber, 2005; World Health Organization, 2004). Keeping students physically active in physical education in order to receive health benefits is critically important in Taiwan, because a limited recreational market base and small sports industry provide limited opportunities for PA outside of school. Furthermore, many Chinese parents regard academic achievement as the single most important indicator of success for their children (Yu, Chan, Cheng, Sung, & Hau, 2006), and therefore engaging in PA after school hours is often discouraged because it is believed that PA drains energy and affects academic concentration (Yu et al., 2006). All these factors make school physical education the primary opportunity for the promotion of students' PA. However, no national consensus has been found to guide PA promotion and education about students' PA levels during physical education. Nevertheless, we believe that it can be beneficial for researchers, when comparing data with studies conducted in the U.S. and other countries, to use the guideline set by the U.S. Department of Health and Human Services (2000), which says that students should engage in PA for 50% of lesson time.

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Studies using either accelerometers (Gidlow, Cochrane, Davey, & Smith, 2008; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008) or direct observation (Chow, McKenzie, & Louie, 2009; McKenzie et al., 2006) have assessed PA in adolescents without disabilities. It is a concern that students in these studies did not achieve 50% of physical education class time in PA (Chow et al., 2009; McKenzie et al., 2006), that PA appeared to be lower during the school day than that outside of school (Gidlow et al., 2008), and that PA decreased significantly between the ages of 9 and 15 years (Nader et al., 2008). Limited studies on PA in students with disabilities revealed that their PA time in physical education tended to be far less than the recommended 50% of lesson time. For example, Lieberman, Dunn, van der Mars, and McCubbin (2000) found that children with hearing impairments engaged in moderate-to-vigorous physical activity (MVPA) only 22% of physical education class time, and Faison-Hodge and Porretta (2004) found that children with intellectual disabilities spent only 23% of lesson time in MVPA. Low engagement in MVPA during physical education for children with disabilities has also been reported (42%; Sit, McManus, McKenzie, & Lian, 2007). (Prior studies revealed little participation in vigorous or very vigorous physical activity, so the majority of researchers combined these categories with moderate physical activity and reporteed them as MVPA.)

Similar findings have been reported in studies on ASD. Pan and Frey (2006) reported that youths with ASD were less active than previous reports on peers without disabilities (Trost et al., 2002), and a decline in PA with age was also observed. In contrast, Rosser-Sandt and Frey (2005) reported no differences in PA in 5–12-year-old children with and without ASD in various PA settings, including in physical education. Both groups were more active during recess compared to after school, and students with ASD were similarly active in recess and physical education. In addition, Pan (2008) compared the MVPA of students with and without ASD (ages 7–12 years) during inclusive physical education and recess in Taiwan. The results indicated that students with and without ASD both spent a higher proportion of time in MVPA during physical education than during recess, and no significant differences existed between group PA levels. All the aforementioned studies examined the MVPA of students with ASD, but the findings are inconclusive. In these studies, the environmental or personal factors remained unexplored. It is the intention of this study to focus on identifying environmental correlates that might influence the PA of adolescents with ASD in physical education.

Environmental factors that may influence PA in physical education include physical environment (e.g., outdoors vs. indoors), instructor-related characteristics (e.g., gender, major), and subject matter content. A higher percentage of MVPA has been found in lessons taught by male teachers (36.5% vs. 32.7%), but the results were confounded by subject matter content and students' gender (Chow et al., 2009). Environmental variables such as using more space per student has been positively associated with student PA levels. More space is usually available for physical education classes located outdoors than indoors, and U.S. studies have found that outdoor lessons are more physically active than indoor lessons (McKenzie et al., 1995; McKenzie, Marshall, Sallis, & Conway, 2000).

Disability itself can be a factor that affects PA behavior. Individuals with ASD have difficulty with social interaction and communication. They were likely to prefer playing by themselves, or playing something with low communication or interaction demand, or disengaging themselves from activities in physical education (Wolfberg, 1999). Pan (2009) examined the associations of age, social engagement, and PA in 25 children with ASD, ages 7–12 years. Physical activity was measured using a uniaxial accelerometer, and social engagement behavior (interaction and noninteraction with adults and peers) was assessed using a direct observation assessment. The results indicated that the children with frequent social engagement with adults (teachers) had displayed higher levels of PA.

Because PA declines rapidly during adolescence (Trost et al., 2002), research is needed to determine whether the unique characteristics associated with ASD and environmental factors place adolescents with ASD at greater risk for inactivity compared to peers without disabilities when they have equal opportunities to be active. The purpose of the present study was to assess, during inclusive junior high school physical education lessons, the PA of adolescents with ASD and the environmental and personal correlates that might influence PA during physical education. It was hypothesized that adolescents with ASD would be less active than their peers in physical education, and their MVPA would be related to PA content, lesson location, instructor-related characteristics, and social engagement skills.

Method

Participants and Settings

With their parents' permission, students with ASD (all boys, $N = 19$; M age = 14.19 years, $SD = 0.82$) and their typically developing peers ($N = 76$, M age = 14.10 years, $SD = 0.80$) from nine Taiwanese junior high schools volunteered to participate in the study. [Informed consent was obtained from all human research participants. All nine schools provided two 45-min physical education lessons per week. During the time of study, a total of 38 lessons were taught to 19 classes by 11 physical education specialists (7 women and 5 men) and 8 nonspecialists in physical education (4 women and 4 men). The content

across all nine schools was categorized into three activity groups. Team activities (18 lessons) included basketball, volleyball, tag games, baseball, and other ball games. Individual activities (14 lessons) consisted of badminton, table tennis, boccia ball, tennis, and personal fitness activities. Fitness testing and free play (6 lessons) were lessons in which students were tested on personal fitness and played self-structured games while waiting to be tested. Approximately 57.89% of the lessons were taught outdoors (n = 22), 15.79% were indoors (n = 6), and 26.32% used both spaces (n = 10).

ASD was diagnosed through medical and psychological assessment by experienced and knowledgeable physicians in the public hospitals (Taiwan Executive Council, 2009). The diagnoses were conducted following the criteria for autism in the *Diagnostic and Statistical Manual of Mental Disorders* (APA, 1994).

Variables and Measures

Physical Activity. PA levels and patterns were assessed using GT1M ActiGraph (Manufacturing Technology, Inc., Fort Walton Beach, FL), a uniaxial accelerometer that measures vertical acceleration of human motion as well as steps. The accelerometer has been used extensively and reported as a valid objective measure of PA in youth (Trost et al., 1998). It has also been used in research on youths with ASD (Pan, 2008; Pan & Frey, 2006).

Participants wore the accelerometers for two physical education lessons 1 week during their regular school schedules. At the start of each physical education lesson, the accelerometers were attached by a research assistant to the adolescents, and the participants were then asked to follow their regular routine. The accelerometers were removed at the end of the physical education lesson, and the data were immediately downloaded. Consistent with previous studies, the accelerometer was worn over the right hip with an elastic belt.

The accelerometers were programmed to collect data in 10-s intervals. Activity counts were analyzed to determine counts per minute (CPM). To analyze the amount of time the adolescent spent at different levels of intensity, age-specific count cutoffs corresponding to moderate, vigorous, and very vigorous intensity levels were used (Freedson, Melanson, & Sirard, 1998). These cutoffs correspond to 3–5.99, 6–8.99, and ≥ 9 metabolic equivalents (METs), respectively. The frequency of continuous 5-, 10-, and 20-min MVPA at an intensity greater than or equal to 3 METs was also calculated. To control for differences in monitoring the actual length of the physical education lesson, the relative (percentage) time spent in moderate PA (MPA%), vigorous PA (VPA%), MVPA (MVPA%), and step counts per minute were calculated and used in the subsequent analyses.

Social Engagement. For the current study, social engagement was divided into two types (with adults and peers) and two forms (social interaction and social initiation). Social interaction was defined as any verbal or gestural behavior directed toward the participant with ASD within 5 s after an initiation or an ensuing response. Interdependent play, mutual organization, gestures, and talking together are examples of social interaction. Data were collected in 10-s intervals, followed by 10 s to record behavior using the partial interval-based recording system (van der Mars, 1989). With this procedure an observer recorded occurrence or nonoccurrence of social interaction at the designated time intervals. Social interaction tallies (frequencies) were used for analysis. Percentages were calculated by dividing the total number of intervals in which the behavior occurred by the total number of intervals observed, multiplied by 100.

Social initiation was defined as the participant with ASD starting an interaction with a peer or peers, or with an instructor, with whom there had not been an interaction during the previous 5 s. Giving information and affection, initiating an activity with another person, calling attention of another to an object or activity, and requesting assistance or information from another are examples of social initiation. For data collection on social initiation, event recording occurred within an observe-record format, in which 10 s were allotted for observation and 10 s for recording. The rate of social initiation was used for data analysis because it reflected the proficiency of social initiation participants performed (Hsu, 2003). It is calculated by dividing the recorded total frequency by the length of observation (measured in minutes). Each participant was video-recorded in all lessons he attended. The social interaction and initiation behavior were coded by the trained observers by viewing the video recordings.

Interobserver Agreement. This was calculated by dividing the number of agreed behaviors by all coded occurrences and multiplying by 100 for each category. Before the study began, three observers were trained by the primary researcher to use systematic observation methods and the social engagement coding instrument. Each observer was required to become familiar with the observation methods and behavioral definitions. During the training sessions, the observers practiced coding the social engagement patterns by watching the behavior of children with ASD in the video recording. When a question arose about how to record a specific behavior, the primary researcher and the observers discussed the behavior until all agreed on an appropriate code. An 85% or greater interobserver agreement (Lee, Odom, & Loftin, 2007; Loftin, Odom, & Lantz, 2008) was reached in each observation category before data collection. A periodic check of interobserver agreement was conducted throughout the data collection, and continuous training was provided to all observers during the study to maintain the 85% agreement rate.

Statistical Analysis

Descriptive analyses were conducted for each PA variable in students with and without ASD. Descriptive analyses were also calculated for each social engagement variable in students with ASD. Due to the small sample size (unbalanced groups), the nonparametric Mann-Whitney *U* tests and the Kruskal-Wallis tests were used to compare student PA. Spearman rank order coefficients were calculated to assess correlations between PA and social engagement variables in students with ASD.

Results

Physical Activity Between Students With and Without ASD

The mean lesson length was 40.50 min. Table 1 reports PA level descriptions. Students with ASD seemed to be less physically active during physical education than their peers without disabilities. However, there were no significant differences for all PA variables between groups except steps/min. The steps/min for students with ASD was significantly lower than for their peers without disabilities (effect size, Cohen's d = -0.60).

Comparison on Environmental Factors

In Table 2, PA levels are reported by the environmental factors. Significant differences were found among three PA contents for the proportion of student MVPA. Fitness testing and free-play activities provided higher MVPA percent than team activities (effect size, Cohen's d = 0.74) and individual activities (effect size, Cohen's d = 1.55). Comparisons between the two instructor-related variables revealed that (a) students with male teachers were less active than those with female teachers (effect size, Cohen's d = -0.50), and (b) students taught by certified teachers were less active than those taught by noncertified teachers (effect size, Cohen's d = -0.91). For the physical environment, the proportion of MVPA was substantially greater outdoors than indoors (effect size, Cohen's d = 0.71) and in combined spaces (effect size, Cohen's d = 0.78).

PA and Social Engagement

Table 3 shows the social engagement patterns during physical education in students with ASD, who seemed to engage in relatively greater amounts of social initiation and social interaction with peers compared to behaviors with adults. Table 4 shows the Spearman correlation coefficients between each social engagement behavior and PA patterns in students with ASD. Social initiations with peers during physical education positively correlated with CPM, steps/min, and MVPA%. Social interactions with peers during physical education positively correlated with CPM, MPA%, VPA%, and MVPA%. None of the social initiations and interactions with adults was correlated with any PA variable.

Discussion

This is the first investigation to examine PA behaviors and correlates that may affect the PA of adolescents with and without ASD during inclusive physical education in Taiwan. The results indicate that the steps of adolescents with ASD were less than their peers without disabilities during physical education. Physical activity content, lesson location, and teacher-related characteristics were associated with student MVPA. Frequent social initiation and interaction with peers were associated with MVPA levels of PA in adolescents with ASD.

Table 1. Physical activity levels and patterns during physical education

	ASD (n = 19)				Non-ASD (n = 76)					
	M	*SD*	*Mdn*	Range	*M*	*SD*	*Mdn*	Range	Z	*p*
CPM	1,603.63	688.43	1,522.50	2,142.07	2,088.74	1,117.43	1,904.90	9,295.73	-1.89	.059
Steps/minute	34.03	14.48	33.40	52.18	43.65	17.67	43.06	113.27	-2.26	.024
MPA%	20.39	7.79	19.16	30.82	23.31	6.80	22.86	31.41	-1.80	.073
VPA%	16.34	9.97	17.53	33.35	21.3	12.83	18.23	76.28	-1.23	.219
MVPA%	36.73	16.11	34.42	54.52	44.63	14.98	43.1	73.27	-1.69	.090
5-min MVPA (bouts)	0.11	0.27	0.00	1.00	0.20	0.60	0.00	3.00	-0.04	.970
10-min MVPA (bouts)	0.00	0.00	0.00	0.00	0.04	0.21	0.00	1.50	0.88	.381
20-min MVPA (bouts)	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.50	0.71	.477

Note. ASD = autism spectrum disorders; *M* = mean; *SD* = standard deviation; *Mdn* = median; CPM = counts per minute; MPA = moderate vigorous physical activity; VPA = vigorous physical activity; MVPA = moderate-to-vigorous physical activity.

Student Physical Activity Levels

Students with and without ASD during inclusive junior high school physical education spent approximately 37% and 45% of lesson time in MVPA, respectively. Students with ASD in junior high school were less active than students with ASD observed during elementary school physical education in Taiwan using accelerometry (46%; Pan, 2008) and special school students in Hong Kong measured using the SOFIT instrument (42%; Sit et al.,

Table 2. Percentage of moderate-to-vigorous physical activity for all students based on environment, instructor-related characteristics, and lesson content

	M	*SD*	*Mdn*	Range	Z or χ^2	*p*
Physical environment						
Outdoor (*n* = 55)	47.59	16.00	48.19	75.73	13.57	.001
Indoor (*n* = 15)	37.85	11.05	38.89	45.24		
Combined (*n* = 25)	36.19	13.23	32.53	55.95		
Instructor-related characteristics						
Gender						
Male (*n* = 55)	39.96	16.95	37.50	75.73	-2.56	.011
Female (*n* = 40)	47.30	12.08	46.94	54.32		
Major						
Physical education (*n* = 55)	37.58	13.29	36.89	63.67	-3.98	.001
Not physical education (*n* = 40)	50.59	15.18	49.60	68.86		
Physical activity content						
Team activities (*n* = 45)	44.58	15.80	44.09	72.32	18.09	.001
Individual activities (*n* = 35)	35.92	12.45		35.71	63.67	
Fitness testing and free-play (*n* = 15)	55.11	12.31	53.57	43.77		

Note. *M* = mean; *SD* = standard deviation; *Mdn* = median; *n* = number of students.

Table 3. Social engagement behaviors during physical education in adolescents with autism spectrum disorders

	Initiation (per minute)				Interaction (%)			
	M	*SD*	*Mdn*	Range	*M*	*SD*	*Mdn*	Range
Adults	0.04	0.07	0.03	0.30	5.26	3.92	4.94	14.15
Peers	0.19	0.17	0.14	0.66	26.88	17.37	24.37	62.43
Total	0.23	0.18	0.18	0.68	32.14	18.25	30.49	62.69

Note. *M* = mean; *SD* = standard deviation; *Mdn* = median.

Table 4. Spearman rank-order coefficient for the physical activity and social engagement variables during physical education in adolescents with autism spectrum disorders

	Initiation			Interaction		
	Adults	Peers	Total	Adults	Peers	Total
CPM	.20	.55*	.42	-.12	.55*	.46*
Steps/min	.17	.48*	.42	-.36	.37	.26
MPA%	.40	.38	.36	-.09	.54*	.51*
VPA%	.19	.43	.30	-.01	.54*	.47*
MVPA%	.26	.54*	.45	-.05	.59**	.52*
5-min MVPA	.15	.05	.09	-.00	.23	.22

Note. CPM = counts per minute; MPA = moderate physical activity; VPA = vigorous physical activity; MVPA = moderate-to-vigorous physical activity; *n* = 19.
*$p < .05$.
**$p < .01$; two-tailed.

2007). However, they were more active than those with hearing impairments (22%; Lieberman et al., 2000), developmental delays (33%; Stanish & Mozzochi, 2000), and intellectual disabilities (23%; Faison-Hodge & Porretta, 2004). Overall, adolescents without disabilities in the present study spent more time in MVPA than their U.S. counterparts (17%; McKenzie et al., 2004). However, their PA levels did not meet the 50% of physical education time criterion.

Environmental Factors

Consistent with previous research (Chow et al., 2009; Kulinna, Martin, Lai, Kliber, & Reed, 2003), the PA levels of students during physical education varied substantially depending on the physical education content. Students in fitness testing and free-play lessons were substantially more active than those in both team and individual activities. They were physically active at least 50% of the time during the fitness testing and free-play content. The data lead us to speculate that students spent a lot of class time practicing the test items before the actual test. When students were waiting for their turn to take the test, they were more likely to be active and practicing for the test. It is also reasonable to speculate that when students were allowed to choose activities after testing, they were likely to be active. Therefore, fitness testing and unstructured free-play lessons may have boosted the PA levels of all students. Teachers might take into consideration the choice of PA content they offer to provide students with substantial amounts of PA.

As expected, the students who engaged in outdoor physical activities were more active than those engaged in indoor lessons. This finding was consistent with McKenzie et al.'s studies (1995, 2000), suggesting that outdoor lessons are usually higher in intensity due to the larger space available. Also, physical activities themselves (e.g., fitness testing and free-play vs. team activities vs. individual activities) are likely contributors to students being more active in outdoor lessons. Providing more outdoor lessons or selecting PA content that is more active might help to promote students' PA levels in both locations.

Furthermore, we analyzed the potential PA differences resulting from teacher gender, and the results showed that the MVPA percent was higher in lessons taught by female teachers. This finding was inconsistent with large studies in the United States (McKenzie et al., 2006; McKenzie et al., 2000) , which indicated that there were no differences in student PA levels by teacher gender. Male teachers in the present study should be taught strategies that would increase the amount of MVPA. However, because both female and male teachers were told to remain on their normal physical education schedule during the day of monitoring, additional studies should be made on other variables such as instructor behaviors as the dependent measure, because physical education has many additional objectives other than MVPA enhancement.

Finally, the finding that noncertified teachers provided more PA was unexpected and disappointing. This is inconsistent with the McKenzie et al. study (1995), which indicated that certified physical education teachers provided a similar proportion of lesson time in MVPA but a greater proportion of lesson time for skill drills than noncertified physical education teachers. When students spend more time in nonfitness lessons such as skill drills, they are more likely to be off task, standing, or waiting for a turn (Kulinna et al., 2003). Therefore, it is reasonable to assume that certified teachers in the current study placed a higher value on skill-related movements, while noncertified teachers placed a higher value on accumulation of PA. Clearly, the impact of teacher specialty will have an effect on the PA behavior of students. Again, modifiable factors such as teacher behaviors, lesson contexts, and instructional objectives should be considered in the future.

PA and Social Engagement

The ASD students' social initiations with typically developing peers during physical education were positively related to all PA variables except 5-min MVPA. Their social interactions with peers were positively related to CPM, MPA%, and MVPA%. This suggests that interaction with their normal peers may offer appropriate behaviors, modeling, and prompts that led to increased PA in the students with ASD. The findings seem to support the inclusion strategy, in which students with disabilities are mainstreamed in general physical education classes to study with their peers without disabilities. A specific strategy along this line could use students without disabilities as teacher assistants, peer tutors, and support personnel in the mainstreamed classes. Through mainstreaming, the physical education environment may be more stimulating and motivating, giving students with ASD increased opportunities to develop physical and social skills.

Conclusion

Overall, the PA levels of students during physical education varied substantially with the content taught and the physical environment in which the lessons were taught. The findings of the current study showed that (a) the number of steps of students with ASD was less than their same-age peers without disabilities, (b) aspects of the instructor-related characteristics and physical environment were related to adolescents' PA during physical education, and (c) social initiation and interaction behaviors were positively related to the PA levels of students with ASD. The current study also identified teacher, environment, and content characteristics as important correlates to the PA of students with ASD during physical education. These findings call for rigorous studies to further explore these

variables and their impact on improving PA for adolescents with and without ASD. In addition, these findings are important because they point to sets of variables for which meaningful intervention strategies may be developed to help students with ASD grow successfully into a productive adulthood.

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Authors' Notes

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