Motor Performance of Children With Attention-Deficit Hyperactivity Disorder: A Preliminary Investigation

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The purpose of this study was to describe the fundamental gross motor skills and fitness conditions of children with attention-deficit hyperactivity disorder (ADHD). Nineteen children, ages 7 to 12, participated. Gross motor performance was measured by the Test of Gross Motor Development (Ulrich, 1985). Fitness variables were measured by selected items from the Canada Fitness Survey (Fitness Canada, 1985), the CAHPER Fitness-Performance II Test (CAHPER, 1980), and the 20 m Shuttle Run Test (Leger, Lambert, Goulet, Rowan, & Dinelle, 1984). Percentile scores provided individual and group profiles of performance. It was concluded that fundamental gross motor performance and physical fitness of children with ADHD are substantially below average.

Attention-deficit hyperactivity disorder (ADHD) is one of the most thoroughly researched childhood psychiatric disorders (Barkley, 1991a). Its prevalence has been estimated to be 6% in Canada (Szatmari, Offord, & Boyle, 1989; Reid, Maag, & Vasa, 1993) and between 3% (American Psychiatric Association [APA], 1987; Hollister & Csnernansky, 1990) and 20% (Shaywitz & Shaywitz, 1984) of the total school-aged population of the United States. These estimates represent a significant number of people influenced by a disorder that may continue into adulthood (Weiss & Hechtman, 1993).

Physical fitness and gross motor performance of children with ADHD have not been adequately addressed. The very essence of the term “hyperactivity” implies overactivity, which has classically characterized their movement (APA, 1987; Barkley, 1991b; Davids, 1971; Porrino et al., 1983; Tyron, 1993). Excessive movement has been viewed as problematic and, consequently, it has overshadowed the investigation of their actual fitness and gross motor performance.

Intervention studies have usually investigated the influence of medication on movement-related skills (Connors & Delamater, 1980; Conrad, Dworkin, Shai, & Tobiessen, 1971; Denhoff, Davids, & Hawkins, 1971; Millichap, Aymat, Sturgis, Larsen, & Egan, 1968; Page, Bernstein, Janicki, & Michelli, 1972) and the effects of relaxation training (Brandon, Eason, & Smith, 1986; Eason, Brandon, Smith, & Williamson, 1986; Harvey, 1997).
Serpas, 1986; Klein & Deffenbacher, 1977). Sensorimotor descriptions of these children have alluded to neurological soft signs (McMahon & Greenberg, 1977), poor sensorimotor coordination, erratic activity, and attention difficulties (Sandberg, Rutter, & Taylor, 1978; Taylor, 1986; Taylor, Schachar, Thorley, & Weiselberg, 1986a; Taylor et al., 1986b). Perceptual-motor performance studies have investigated visual motor performance (Connors & Delamater, 1980; Conrad et al., 1971; Korkman & Pesonen, 1994; Millichap et al., 1968), finger tapping (Gordon & Kantor, 1979), and predictors of motor performance (Churton, 1983).

Based on retrospective data or with a limited range of movement skills assessed, children with ADHD also have been labelled as poorly coordinated and clumsy (Ottenbacher, 1979; Stewart, Pitts, Craig, & Dieruf, 1966; Szatmari et al., 1989). Descriptions of their gross motor performance have included poor balance (Wade, 1976), poor motor abilities (Moffit, 1990), and motor clumsiness (Luk, Leung, & Yuen, 1991). Beyer (1994) has reported the most recent motor performance study where boys with ADHD, under medication, performed significantly poorer on most items of the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) than boys with learning disabilities but under no medication.

There is a legitimate need for descriptive levels of research for people with disabilities when trying to understand a condition from a movement perspective (Reid, 1989). Keogh (1978) argued the importance of distinguishing between problems of movement skill and movement behavior. According to Keogh (1978), movement behavior is defined as the identification of personal-social behaviors related to participation in movement activities, whereas movement skill is defined as the development of movement control and the ability to master motor skills in relation to other movers and the environment. Keogh (1978) believed children with hyperactivity may experience problems of movement skill, movement behaviors, or both. Yet, movement behavior problems, as typified by children with ADHD, do not necessarily infer movement skill problems.

Limited empirical data address the movement of children with ADHD. Descriptive levels of research may provide a more thorough understanding of these children by providing profiles of fitness and fundamental gross motor performance. Beyer (1994) recommended the creation of such motor profiles, and Churton (1989) recommended descriptive studies that document major motor milestones, the acquisition of motor skills, and motor effects upon self-esteem for children with ADHD. Thus, the purpose of this study was to describe the fundamental gross motor skills and fitness conditions of children with ADHD.

**Method**

**Participants**

Nineteen children, between the ages of 7 and 12, participated in the study. Fifteen children were between the ages of 7 and 10, while four other participants were 11 to 12 years old. This convenience sample included 17 males and 2 females. Past motor behavior studies, investigating children with ADHD, have not included females. In this study, genders were combined in analysis to provide representativeness of the population, where male-to-female clinical ratios are 9:1 in clinical samples (Cantwell, 1996). The children were outpatients of a special clinical center. Personal diagnostic information was not readily available, but the clinic direc-
tor verified that every child had a formal diagnosis of ADHD and met the diagnostic criteria for ADHD in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III-R) (APA, 1987). Information from the Child Behavior Checklist (Achenbach & Edelbrock, 1983) also confirmed the diagnosis. Excluded from the study were children who had a primary diagnosis of Oppositional Defiant Disorder or Conduct Disorder or who had a secondary diagnosis of Conduct Disorder or Tourette’s Syndrome. Moreover, the director indicated that IQs ranged between 80 and 100. Behavioral problems were the primary reason for acceptance into the center. According to their teachers and *DSM-III-R* diagnostic criteria (APA, 1987), the children were not affected by specific learning disabilities as their reading, writing, and arithmetic skills were not significantly behind age expectations.

The subjects constituted a relatively homogeneous group in relation to other ADHD studies. Yet, the fact that they were in a clinical center underscores the reality that they possessed some learning and behavioral difficulties. Approval of the study was granted by the McGill Faculty of Education Ethics Committee, and informed consent was obtained from the parents of the participants.

Several sampling design limitations require that the present study be considered a preliminary or pilot study. Among these were the inability to control for medication, the use of a small sample size, and the inclusion of four participants, ages 11 to 12, who were older than the age span covered by one of the instruments, the Test of Gross Motor Development (Ulrich, 1985).

Although it would have been preferable to have a sample of children who were not on medication, 17 of the 19 were receiving psychostimulant medication (Ritalin, Dextedrine, and Cylert) during the study. Three of these children also received antihypertensive medication (Clonidine). Stimulant medications typically have short half-lives and quick washout periods (DuPaul & Barkley, 1990), so it might have been possible to have the children off their medication on each assessment morning. Yet, we felt that this personal intrusion would be significant as the data collection period was long. The children would have had to refrain from medication on differing days across an eight-week data collection period, thus affecting other aspects of their daily routine. Likely, their motor behavior would be affected by medication. Gross motor performance might be expected to be better inasmuch that children, with hyperactivity on methylphenidate medication, have improved their balance (Wade, 1976). Also, endurance-type activities may have been influenced as methylphenidate produces higher resting and submaximal heart rates (Boileau, Ballard, Sprague, Sleator, & Massey, 1977) and decreases respiratory rates during exercise (Ballard, 1977).

Larger numbers of participants for a descriptive study of this type would have been preferable. Also, there would have been value in a formal control group of students without ADHD. However, our relatively strict-criteria for inclusion of participants made it difficult to locate larger numbers of individuals. The use of strict diagnostic criteria for ADHD was considered more important than other sampling concerns. This may be considered a strength by some readers and a weakness by others.

**Assessment**

Gross motor performance was assessed with the Test of Gross Motor Development (TGMD, Ulrich, 1985). The TGMD is a norm-referenced and criterion-referenced test designed to evaluate the fundamental gross motor skills of children from ages 3 to
10. An individual’s ability to meet three or four criteria of mature gross motor skills is measured. Twelve test items are subdivided into two skill areas: (a) locomotor skills (run, gallop, hop, leap, horizontal jump, skip, and slide) and (b) object control skills (two-hand strike, stationary bounce, catch, kick, and overhand throw). The TGMD is a commonly used physical education assessment test. Ulrich (1985) reported stability, internal consistency, and interscorer reliability. These coefficients were .96, .85, and .95 respectively for the locomotor subtest, and .97, .78, and .97 respectively for the object control subtest. Construct and content validities were also confirmed by Ulrich (1985).

A broad method of fitness assessment also was used, with each selected test representing a different component of fitness. Skill-related and health-related components of physical fitness are usually distinguished (Blair, Falls, & Pate, 1983). Skill-related components of physical fitness are linked to successful motor performance skills (Corbin, 1991), whereas health-related components of physical fitness are usually associated with disease prevention and health promotion (Pate, 1983, 1988). For example, Body Mass Index (BMI) has been used to assess obesity and to link individuals to increased risk of heart disease (Shephard, 1994). Since BMI is not sensitive to individual morphological differences (i.e., muscle mass, bone density, etc.), skinfold measurements also are taken to account for the distribution of body fat (Shephard, 1990). Table 1 illustrates which variables represent health-related and skill-related fitness in the study (see Chapter 13 of Sherrill, 1993, for categorization review).

However, it should be noted that the relationship between representative fitness components is complex as there is considerable overlapping due to individual capabilities, fitness types, and different levels of skill learning that can affect skill-related performance (Corbin, 1991).

Three Canadian norm-referenced fitness tests were identified for this study. Selected items from the Canada Fitness Survey (Fitness Canada, 1985), the

<table>
<thead>
<tr>
<th>Table 1 Health-Related and Skill-Related Fitness Variables</th>
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<tbody>
<tr>
<td>Health-related fitness</td>
</tr>
<tr>
<td>Height</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Body Mass Index</td>
</tr>
<tr>
<td>Sum of 5 skinfolds</td>
</tr>
<tr>
<td>Sit and reach</td>
</tr>
<tr>
<td>Total grip strength</td>
</tr>
<tr>
<td>VO₂ Max</td>
</tr>
<tr>
<td>Push-ups</td>
</tr>
<tr>
<td>Sit-ups</td>
</tr>
<tr>
<td>Skill-related fitness</td>
</tr>
<tr>
<td>Shuttle run</td>
</tr>
</tbody>
</table>

Note. CFS = Canada Fitness Survey (1985), SRT = 20 Meter Shuttle Run Test (Leger et al., 1984), CFP = CAHPER Fitness-Performance Test II (1980).
CAHPER Fitness-Performance II Test (Canadian Association for Health, Physical Education, and Recreation [CAHPER], 1980), and the 20 m Shuttle Run Test (Leger, Lambert, Goulet, Rowan, & Dinelle, 1984) were used as these tests represent the best available normative youth fitness data in Canada. The norms, included with each test, were considered as gender- and age-matched controls for direct comparison for the children with ADHD.

The 20 m Shuttle Run Test was designed to estimate maximal aerobic power, or cardiovascular endurance, and is valid and reliable for use with children (Leger et al., 1984). The authors reported a correlation of .71 to predict maximal aerobic power (VO$_2$ Max) from maximal speed (km/hr) and .89 for test-retest reliability (Leger et al., 1984). Because tape recorders are used for such tests, Leger and Rouillard (1983) reported playback speed to be generally reliable and accurate if monitored. Playback speed was verified before each administration of the 20 m Shuttle Run Test.

**Procedures**

Selected items from the three tests were administered individually over an eight-week data collection period. They were administered during the morning as the performance of children with ADHD may be optimal at this time (Zagar & Bowers, 1983). Also, they performed at their own pace and were not unduly coerced to move quickly. Moreover, the simplicity of the tasks helped control for the likelihood of the associated effect of response inhibition (Barkley, 1994; Barkley, Grodzinsky, & DuPaul, 1992; Barkley, 1991b). All tests' directions were followed precisely. However, an additional demonstration with instruction was provided at pretrial, if a participant did not understand, to aid in sustained responding to tasks (Douglas, 1972, 1980a, 1980b, 1983).

Positive encouragement followed both successful and unsuccessful task completion to facilitate learning experiences (Douglas, 1972, 1980a, 1980b, 1983) and to control for learned helpless responses linked with failure experiences (CAHPER, 1980; Milich & Okazaki, 1991). In this study, positive encouragement consisted of verbal praise after every trial for each participant.

During two mornings of the first week, all participants were measured for Height, Sum of Five Skinfolds, Flexibility, and Total Grip Strength. Participants were weighed during the first two weeks. These measures were taken at the beginning of the study to control for any conditioning or time of day effect. Due to the number of dependent variables and the length of time commitment, it was necessary to use a counterbalanced Latin-Square testing order to avoid practice effects for the remainder of the test items. All children were tested individually by the first author with a trained assistant in an isolated gymnasium.

Standard procedures provided in the TGMD (Ulrich, 1985, p. 5) were adhered to and included: (a) an accurate verbal account and demonstration of each test item, (b) one practice trial to ensure understanding, and (c) the provision of one additional demonstration if the student did not appear to understand the task. Interrater reliability was established for this test through the use of an observer who was trained by the primary author. Training consisted of two elementary school-age males demonstrating the skills of the TGMD while the strengths and weaknesses of their performance were pointed out to the assistant. The first author and the observer discussed, at great length, the particular points to observe for each skill. This trained graduate student was present for all trials in both test and retest conditions.
Anthropometric (Height, Weight, Body Mass Index, and the Sum of Five Skinfolds), flexibility (Sit and Reach Test), muscular strength (Total Grip Strength), and muscular endurance (Push-ups and Sit-ups) measures followed the procedures of the Canadian Standardized Test of Fitness (Fitness Canada, 1986). Resulting data were compared with the normative data of the Canada Fitness Survey (Fitness Canada, 1985). Agility (Shuttle Run) and explosive leg power (Standing Long Jump) measures followed the procedures and were compared with the normative data of the CAHPER Fitness-Performance Test II (CAHPER, 1980). The primary author and two graduate students, who both possessed degrees in Exercise Science, collected the fitness data. The Sum of Five Skinfolds was collected by the graduate student who had the most experience and training with skin calipers while the other student conducted all trials for Height and Hand Grip Strength. The primary author conducted all of the flexibility and weight tests.

The 20 m Shuttle Run Test begins by walking within a 20 m marked distance at a preset pace. Subjects have to travel the 20 m and touch the line at or before a signal on the preset tape recording. The rate of the signal increases for each minute into the test. Therefore, the pace progressively increases each minute. Ultimately, the participants have to run between the lines to keep up with the pace of the signals. The longer one stays at pace, the greater the cardiovascular endurance. The test is finished when the participant can no longer reach the 20 m line within two strides on consecutive signals or if the participant displays dizziness, chest pain, nausea, severe fatigue, severe pain or weakness in the limbs, mental confusion or other worrisome symptoms (Leger et al., 1985). The last number called on the tape is the last stage level or raw score obtained.

Each child wore a Pulsar heart rate monitor, which provided heart rate data throughout the 20 m Shuttle Run Test. The children performed at 88.5% of their maximal heart rates (MHR = 220–age), with a range of 78.8 to 95.7% of MHR, suggesting considerable exertional efforts and sufficient motivation. Generally, motivation was good as the children were receptive to the entire study.

Statistical Analysis

Statistical analyses involved converting raw scores to percentile scores to provide individual and group profiles of performance. Descriptors, included in the administration document of the Canadian Standardized Test of Fitness (Fitness Canada, 1986), also were used to describe the performance of the children. These descriptors, expressed in percentages, are Excellent (85 to 95), Above Average (65 to 80), Average (45 to 60), Below Average (25 to 40), and Poor (5 to 20) (Fitness Canada, 1986).

Bouffard (1993) suggested performing a global analysis of raw data to respect the person as the basic unit of analysis. He cited two problems inherent in adapted physical activity research: small sample size and heterogeneity of subjects (Broadhead, 1986; Watkinson & Wasson, 1984). Bouffard argued that general principles or universal laws about people may not be discovered when a group analysis is performed on subjects who are considered a part of a heterogeneous population and are affected by person by treatment interactions (Bouffard, 1993). Children with ADHD constitute a heterogeneous group (Barkley, 1994; Szatmari et al., 1989) who can display variable task performance (Barkley, 1990). Also, the motor skill levels of 7 year olds and 12 year olds are generally different (Keogh & Sugden,
1985, p. 180). Therefore, much information can be gained with the use of a single subject analysis in addition to group analysis.

Group means of fitness and gross motor performance also were calculated. Mean percentile scores were calculated for each dependent variable. Scores below the 25th percentile were considered as illustrating problems in motor performance or fitness, following the recommendation of Blair et al. (1983). Posthoc chi-square Goodness-of-Fit tests were conducted for each variable to verify if the children’s scores were proportional to the expected “normal” population.

Results and Discussion

Reliability

Intraclass correlations for stability were obtained, using a One-Way ANOVA Random Model (Safrit, 1976), for the following variables: Gross Motor Development Quotient (.87), Locomotor Skills (.89), Object Control Skills (.60), Push-ups (.97), Shuttle Run (.89), Sit-ups (.95), Standing Long Jump (.23), and the 20 m Shuttle Run Test (.94). Because of its low stability coefficient, Standing Long Jump was excluded from further data analysis.

Failure to retest for Height, Weight, Body Mass Index, Skinfold Thickness, Flexibility, and Total Grip Strength may have been a design weakness. The reliability of these measures was assumed because of time limitations.

Interrater reliability was determined by percentage of agreement for total scores on each criterion for both the Locomotor Skills (26) and Object Control Skills (19) subtests, and for the Gross Motor Development Quotient (45). Interrater reliabilities for the Test of Gross Motor Development were 90.5% (Locomotor Skills), 93.9% (Object Control Skills), and 91.3% (Gross Motor Development Quotient).

Aggregate Data

As a group, the performance of the children in fitness and fundamental gross motor skills was below average when compared to the norms of children of similar age and gender (Table 2). The below average gross motor performance of the group was apparent as the two variables (Locomotor Skills and Object Control Skills) were below the 40th percentile. These data support literature which suggests that children with ADHD may be inefficient movers (Beyer, 1994; Luk et al., 1991; Moffit, 1990; Ottenbacher, 1979; Stewart et al., 1966; Szatmari et al., 1989; Wade, 1976).

The fitness data also indicated low cardiovascular fitness and poor overall fitness conditions. The children performed below the 25th percentile on 3 of 9 variables (VO, Max, Shuttle Run, and Sit-ups) and below the 40th percentile on two additional variables (Flexibility and Push-ups). The children also exhibited high adiposity, as the 75th percentile score reflects excess body fat.

Individual Data

Individual percentile data for specific test items are listed on Table 3. It is readily apparent that, in general, the children performed poorly, as 61.6% of possible outcome scores (93/151) fell at or below the 25th percentile. Intersubject variability was observed for every factor of this study, with the exception of maximal aerobic
Table 2  Aggregate Percentiles and Descriptors of Each Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentile</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health-related fitness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>46.6</td>
<td>Average</td>
</tr>
<tr>
<td>Weight</td>
<td>52.0</td>
<td>Average</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>52.5</td>
<td>Average</td>
</tr>
<tr>
<td>Sum of 5 skinfolds</td>
<td>75.0</td>
<td>Above average</td>
</tr>
<tr>
<td>Flexibility</td>
<td>33.7</td>
<td>Below average</td>
</tr>
<tr>
<td>Total grip strength</td>
<td>67.1</td>
<td>Above average</td>
</tr>
<tr>
<td>VO₂ Max</td>
<td>5.7</td>
<td>Very poor</td>
</tr>
<tr>
<td>Push-ups</td>
<td>35.7</td>
<td>Below average</td>
</tr>
<tr>
<td>Sit-ups</td>
<td>20.9</td>
<td>Poor</td>
</tr>
<tr>
<td>Skill-related fitness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shuttle Run</td>
<td>24.0</td>
<td>Poor</td>
</tr>
<tr>
<td>Motor performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locomotor skills</td>
<td>22.3</td>
<td>Below average</td>
</tr>
<tr>
<td>Object control skills</td>
<td>33.4</td>
<td>Average</td>
</tr>
</tbody>
</table>

power (VO₂ Max), total grip strength, and locomotor skills. Variable performance was expected (Barkey, 1990) but so many low scores were not anticipated.

Chi-square analyses were conducted to determine if the pattern of scores reflected significant differences from an expected distribution of scores falling below the 25th percentile. These analyses revealed that scores from 6 of 8 variables were significantly different than what could be expected in the “normal” population: Flexibility (χ²[1, 19] = 8.2, p < .005); VO₂ Max (χ²[1, 18] = 40.5, p < .001); Shuttle Run (χ²[1, 19] = 11.1, p < .001); Sit-ups (χ²[1, 19] = 18, p < .001); Object Control Skills (χ²[1, 19] = 11.1, p < .001); Locomotor Skills (χ²[1, 19] = 22.1, p < .001). Significant differences were not found for only two variables: Total Grip Strength (χ²[1, 19] = .6, p > .3) and Push-ups (χ²[1, 19] = .7, p > .3). The data point to more lower scores than expected by chance, suggesting therefore that our participants represent a unique sample of children as there is high probability the differences were not due to chance.

Following the logic of Blair et al. (1983), poor performance was defined as scoring below the 25th percentile. We found a consistent pattern on at least 7 of the 8 testing variables. Participants 8, 9, 12, 13 were identified as poor performers who generally had low scores for maximal aerobic power, fitness skills, and motor performance. There were no high-achieving performers, arbitrarily defined as those scoring above the 75th percentile on at least 7 of the 8 testing variables. Notably, Participant 11 scored above the 75th percentile on 6 of the 8 variables.

Two other interesting patterns may be observed. Participants 1, 2, 3, 4, 5, 7, who performed below the 25th percentile criterion for locomotor skills, also did so for VO₂ Max and Shuttle Run. Children, who scored below criterion for both gross motor skill categories, also performed more fitness skills below criterion (Mean = 3.89) compared to those with only one gross motor skill below criterion (Mean = 3.25). Similarly, we found that children, with poor locomotor skills, performed more fitness
### Table 3 Individual Percentile Data

<table>
<thead>
<tr>
<th>Subject</th>
<th>Gender</th>
<th>Age</th>
<th>Medication</th>
<th>FL</th>
<th>TG</th>
<th>VO$_2$</th>
<th>PU</th>
<th>SR</th>
<th>SU</th>
<th>OC</th>
<th>LOCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>7</td>
<td>R, 10mg</td>
<td>5.0</td>
<td>85</td>
<td>1.7</td>
<td>7.5</td>
<td>10</td>
<td>0</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>7</td>
<td>R, 25mg</td>
<td>12.5</td>
<td>25</td>
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<td>60</td>
<td>84</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
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<td>7</td>
<td>R, 30mg</td>
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<td>100</td>
<td>3.5</td>
<td>40.0</td>
<td>22.5</td>
<td>20</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>8</td>
<td>R, 12.5mg</td>
<td>50.0</td>
<td>40</td>
<td>5.6</td>
<td>55.0</td>
<td>7.8</td>
<td>0</td>
<td>63</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>8</td>
<td>R, 40mg</td>
<td>50.0</td>
<td>100</td>
<td>8.9</td>
<td>55.0</td>
<td>20.0</td>
<td>10</td>
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<td>9</td>
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<tr>
<td>6</td>
<td>M</td>
<td>8</td>
<td>R, 20mg</td>
<td>21.3</td>
<td>92.5</td>
<td>1.6</td>
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<td>30.0</td>
<td>22.5</td>
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</tr>
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<td>M</td>
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<td>M</td>
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</tr>
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<td>F</td>
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Note. FL = Flexibility; TG = Total Grip Strength; VO$_2$ = Maximal Aerobic Power; PU = Push-ups; SR = Shuttle Run; SU = Sit-ups; OC = Object Control Skills; LOCO = Locomotor Skills; R = Ritalin; D = Dexedrine; Cl = Clonidine; Cy = Cylert; * = participant refused to perform test.
skills below criterion (Mean = 3.93) than those with poor object control skills (Mean = 3.25) after collapsing across object control or locomotor scores. These patterns suggest that there may be a complex interplay between gross motor performance and physical fitness. It seems the better the gross motor performance level, the better the fitness level and vice versa.

The aggregate and individual data are very similar. However, as Bouffard (1993) suggested, we would have discovered the overall poor movement characteristics for the children using a traditional aggregate-type statistical approach but may not have found the patterns of poor individual performance. Simply, the aggregate data illustrated movement problems but the enormity of these problems was far more striking in the individual data. It seems clear that, for the majority of children with ADHD, the overactivity that so often characterizes their movement is not beneficial for their performance of motor skills or fitness tasks. Thus, they may be described as having problems in both movement behavior and movement skills (Keogh, 1978). Identification of individual patterns may enable future researchers to determine ADHD movement clusters and teachers to modify their instruction to common individual needs. These findings support the continued use of single-subject theory in future research for children with ADHD.

Although this study was not designed to evaluate the extent of their physical activity participation, the low levels of physical fitness (i.e., above average amounts of skinfold thickness, average Body Mass Index, and very poor aerobic power) indicate that some children with ADHD may be “at risk” for hypokinetic diseases (i.e., arteriosclerosis, cardiovascular disease, obesity, high blood pressure, and high cholesterol levels). Low participation and poor health-related fitness have been associated with the hypokinetic diseases (Pate, 1983, 1988). Thus, the identification of people with excess body fat is important in order to pinpoint those at an above-average risk of ischaemic heart disease (Shephard, 1990). Most fitness variables in the study were described as either below average, poor, or very poor. Of course, more research is necessary to verify if any causal relationship exists between poor fitness conditions and cardiovascular disease for children with ADHD.

Furthermore, there is likely a complex relationship between motor performance, physical fitness, and physical activity. Bouffard, Watkinson, Thompson, Causgrove Dunn, and Romanow (1996) have suggested an activity deficit hypothesis that should be considered. Poor motor performance and physical fitness may be a result of a lack of sustained effort and practice which, in turn, may lead to low levels of self-esteem and consequently to a lack of participation (Wall, 1986; Wall, McClements, Bouffard, Findlay, & Taylor, 1985). Reduced levels of participation in physical activity would then have an additional and negative effect on physical fitness and health, and the vicious cycle would continue.

Researchers and programmers in special education, physical education, therapeutic recreation, and recreation should recognize the gross motor and fitness needs of children with ADHD. Individualized assessment, treatment, and participation merit much consideration.

**Conclusion**

The fitness and fundamental gross motor performance of the children in this study were found to be below average when compared to the norms of the Test of Gross
Motor Development (Ulrich, 1985), the Canada Fitness Survey (Fitness Canada, 1985), the CAHPER Fitness-Performance II Test (CAHPER, 1980), and the 20 m Shuttle Run Test (Leger et al., 1984). Low VO₂ Max and poor overall fitness conditions were clearly identified with the children. Within the acknowledged limitations of this preliminary research, the findings should be of importance to researchers, parents, physical educators, and health-care professionals.

References

Harvey and Reid


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Authors' Note

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