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Physical fitness of children with motor learning difficulties

Beth P. Hands
University of Notre Dame Australia, bhands@nd.edu.au

Dawne Larkin
University of Western Australia, dlarkin@cyllene.uwa.edu.au

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Physical Fitness Differences in Children with and without Motor Learning Difficulties

Beth Hands[a] and Dawne Larkin[b]

University of Notre Dame Australia[a]

The University of Western Australia[b]

Correspondence:

A/Professor Beth Hands

College of Health

University of Notre Dame

PO Box 1225

Fremantle

Australia 6959

Phone: 618-9433 0206

Email: bhands@nd.edu.au

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Abstract

Children with motor learning difficulties (MLD) tend to be less physically active than their coordinated peers and one likely consequence is a reduced level of physical fitness. In this study, 52 children with MLD aged 5 to 8 years, were compared to 52 age- and gender-matched control children across a range of health and skill related fitness components. Analyses of variance revealed significantly lower scores in the group with MLD on the tests for cardiorespiratory endurance, flexibility, abdominal strength, speed, and power than the control group. Furthermore, the group with MLD had a significantly higher Body Mass Index (BMI). These findings have implications for educators and allied health professionals working with this age group. Programs need to teach children with movement difficulties to perform tasks used in fitness assessment and also work on the development of physical fitness.

Key words: children, movement difficulties, motor learning difficulties, physical fitness

Physical Fitness of Children with Motor Learning Difficulties

Children with motor learning difficulties (MLD) experience problems with performing and mastering many basic movement skills essential for full participation in games, sports, and other recreational activities. One consequence, often overlooked, is reduced physical fitness. Physical fitness is defined as 'a set of attributes that people have or achieve that relate to the ability to perform physical activity' (Casperson, Powell, & Christenson, 1985). Two types of fitness are considered in the literature. Health-related fitness includes cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition. These components are usually associated with disease prevention and health promotion (Powell, Casperson, Koplan, & Ford, 1989) and are typically the aspects of fitness considered most important to monitor. The second type, skill-related fitness, includes agility, speed, and power. These are important for the acquisition of motor skills and for participation in sports and recreational activities (Powell et al., 1989). Both types of physical fitness have been related to general health and well being in children (Eiberg et al., 2005).

Physical activity is important for developing and maintaining many aspects of physical fitness, therefore reduced physical activity will impact on fitness in a negative way. Despite some controversy over the importance of fundamental motor skills in the maintenance of physical activity levels (Fisher et al., 2005), children with MLD often withdraw from physical activity opportunities as a consequence of their movement incompetence (Bouffard, Watkinson, Thompson, Dunn, & Romanow, 1996; Cairney, Hay, Faught, Mandigo, & Flouris, 2005b). Bouffard and colleagues put forward the physical activity deficit hypothesis after observing young children with MLD in a regular physical education class and during school recess in the school playground. In both settings, the children were more often less active and off task or disruptive than typically developing children. Consequently, children with MLD are likely to be less fit than typically developing children and therefore at risk of the many health-related consequences of low fitness (Gutin & Owens, 1999; Powell et al., 1989). Children with MLD are also more likely to select sedentary activities if they are less confronting, easier and more likely to result in positive social interactions. In the long term, the low levels of physical activity may compromise neuromuscular, musculo-skeletal and cardiorespiratory development.

To date there is limited information about fitness levels in children with MLD found in unpublished theses (Hammond, 1995), posters presented at symposia (Hands, van Geel, & Larkin, 2001), or studies that include only some components of physical fitness (Cairney, Hay, Faught, & Hawes, 2005a; O'Beirne, Larkin, & Cable, 1994; Raynor, 2001). Consistently, these studies report below average performances of children with motor difficulties on field tests of cardiorespiratory endurance (Hammond, 1995), muscular strength and endurance (Raynor, 2001; Larkin et al., 1989; Hammond, 1995), agility (O'Beirne & Larkin, 1991), speed (O'Beirne et al., 1994) and power (O'Beirne et al., 1994). Studies that investigated body composition found conflicting results. Some reported children with MLD were more likely to be overweight than children without MLD (Hay et al., 2004; Larkin et al., 1989; O'Beirne et al., 1994), whereas other studies reported no significant differences (Deschenes, 1994). In a Canadian sample of 9- to 14-year-old children, a significant weight difference was observed between the boys with MLD and a control group. This was not the case, however for the girls in the sample (Cairney, et al., 2005a). The flexibility of children with MLD is also reported variably. O'Beirne and Larkin (1991) and Hammond (1995) found that children with MLD appeared to be either hypo- or hyperflexible, that is, the distribution was bimodal.

It is necessary to monitor physical fitness in children with MLD, for several reasons. Attitudes towards, and behaviors related to fitness and physical activity are established during childhood (Pate, Baranowski, Dowda, & Trost, 1996) and all children need to be encouraged to choose to be active rather than inactive. Further, low fitness levels in children with MLD could compromise the learning and performance of motor skills which may add to the seriousness of their condition (Reeves, Broeder, Kennedy-Honeycutt, East, & Matney, 1999). Wall (2004) proposed a skill-learning gap between children with and without movement difficulties. This gap would contribute to lower performance levels on fitness tasks and therefore, lower measured fitness levels.

The purpose of this paper is to identify any differences across eight health and skill-related physical fitness tasks between a large group of children with MLD compared to a typically developing control group. In this paper, the term MLD will be used interchangeably with movement difficulties. The literature drawn from includes these terms, as well as Developmental Coordination Disorder, clumsiness, and dyspraxia to represent the specific difficulties this population experiences with consistently performing many fundamental motor skills. Movement difficulties can also be found among children with other conditions such as autism and ADHD. It was hypothesised that children with MLD would perform significantly below their coordinated peers particularly on the tasks that demanded a higher level of coordination. The results will support and extend those of previous studies and increase our understanding of the relationship between physical fitness and MLD.

Method

Participants

This study involved a group of children with MLD (n = 52) and an age-and gender-matched (± 2 months) control group (n = 52). Ages ranged from 62 to 107 months in both groups with the mean age for the experimental group at 84.4 months (*SD* = 12.9) and the mean age for the control group at 84.5 months (*SD* = 13.1). In each group there were 12 girls and 40 boys.

The group with movement difficulties attended a university-based movement enrichment program that has been running for over twenty years. Their diagnosis of MLD was based

1. A score below the cut off for mild motor difficulties on either the McCarron Assessment of Neuromuscular Development (MAND; McCarron, 1982) or the Movement Assessment Battery for Children (MABC; Henderson & Sugden, 1992), tools for identifying children with movement difficulties. Scores for either test were considered as the children formed part of a larger study that used both tools

2. Poor performance on motor skills such as running, jumping, hopping, and ball skills when observed by a movement specialist with extensive experience in motor skill assessments. The standardised tests noted above do not include qualitative analysis of these fundamental movement skills.

The control group was obtained from a mainstream metropolitan primary school.

Fitness Assessment Battery

The battery consisted of 12 items to assess a range of fitness components. Items included from the Australian Fitness Education Award (ACHPER, 1996) were: height and weight (body composition); sit and reach (hip flexibility); chest pass (muscle strength); and, multi-stage fitness test (cardio-respiratory endurance). Items included from the Australian Schools Fitness Test (Pyke, 1987) were the standing broad jump (anaerobic power) and the 50 metre run (speed). The protocol for sit-ups (muscle endurance) was from the Manitoba Physical Fitness Performance Test (Manitoba Department of Education, 1980), and finally the grip strength task was from the McCarron Assessment of Neuromuscular Development (McCarron, 1982).

Test Procedures

The assessment of the children with MLD took place during a session of the movement enrichment program. Each participant was tested individually by the first author or by a final year university student who had been trained in the test protocol. They were given verbal encouragement and support throughout the testing procedure.

The data for the control group were gathered at the school by final year university students as part of the first year of a larger longitudinal study designed to develop norms and track changes in fitness levels. The same protocol, as prescribed in each test manual, was used for both groups. Missing data for some cases occurred in the MLD group due to non-compliance, time constraints, or problems with availability of equipment. These are documented in Table 1.

INSERT TABLE 1 ABOUT HERE

Statistical Analyses

The experimental group included a sub-group of children with MLD who had co-occurring conditions such as autism and ADHD (n = 23) and a subgroup with MLD only (n = 29). A preliminary analysis showed that there were no significant differences between these two subgroups within the experimental group on any of the test variables (Table 1). To explore differences between the group with MLD and the control group, a between-groups GLM analysis of variance, with sex as a covariate to control for the impact of sex, was conducted on each fitness variable. Means and standard deviations for the experimental and control groups are provided in Table 2.

Results

For the majority of the fitness items, the descriptive statistics in Table 2 show that the fitness levels of the MLD group were lower than those of the typically developing control group. The between groups GLM ANOVA results in Table 3, show a number of significant differences, confirming that the group with MLD had a higher BMI, and lower performance levels on the sit and reach, sit-ups, standing broad jump, the 50 metre run, and the shuttle run. The *R*-square change values in Table 3 show that both the skill-related fitness items, the standing broad jump (R^2 = 27.1%) and the run (R^2 = 20.6%) are the better predictors of group differences. There were no significant differences between the groups for the two upper body tasks, the chest pass and the grip strength. The covariate, sex, was influential for only one variable, the sit and reach task. The girls were more flexible (*M*= 3.0 cm, *SD* 7.6) than the boys (*M* = -0.6 cm, *SD* = 7.9).

INSERT TABLES 2 AND 3 ABOUT HERE

Discussion

The results support and extend the findings of previous studies that have found many components of physical fitness to be significantly lower in children with MLD, with and without co-occurring conditions, when compared to typically developing children. It is of interest to note these results suggest movement difficulties, rather than other difficulties such as attention, have most impact on fitness outcomes.

Body Composition

In this study the BMI of the group with MLD was significantly higher than the control group. The higher BMI, which is attributable to increased weight, is consistent with findings from other studies (Hammond, 1995; Larkin et al., 1989; O'Beirne et al., 1994). Of the 52 children in the group with MLD, 8 had a BMI greater than 20 and 2 of these children had a BMI exceeding 25. There were 3 children in the control group with a BMI above 20 but no child exceeded 22. A higher degree of body fatness combined with lower levels of physical activity may increase the children's vulnerability to a number of degenerative diseases such as high blood pressure, heart disease, and diabetes (Gutin & Owens, 1999). Further, the additional weight of these children may increase their movement difficulties. Attempting to perform a task with less power and coordination than a child with the same bulk but better coordination will be at a significant energy cost (Hands & Larkin, 2002).

Flexibility

Overall, the group with MLD were significantly less flexible than the control group. This finding differs somewhat from prior studies (O'Beirne, & Larkin, 1991; Hammond, 1995) where children with MLD ranged from hyperflexible to hypoflexible on the sit-and-reach task. In this study the distribution of the flexibility scores for both groups were similar, except the scores of the children with MLD were significantly lower. This hypo-flexibility would reduce the child's capacity to perform some skills efficiently and could contribute to injury and long-term musculoskeletal problems. In both groups females were significantly more flexible than males. This finding supports previous evidence that girls are more flexible than boys (Michaud, Narring, Cauderay, & Cavadini, 1999).

Muscle Strength and Endurance

Abdominal strength and endurance levels measured by the number of sit-ups were significantly lower in the group with MLD than for the control group. This result provides further support for earlier studies of children with motor difficulties (Hammond, 1995; O'Beirne & Larkin, 1991). Poor abdominal muscle strength and endurance is going to compromise trunk stability during many gross motor skills, making skill acquisition and performance more difficult. From the health perspective, it may predispose the child or adult with MLD to develop musculoskeletal problems, such as lower back pain (Merati, Negrini, Carabalona, Margonato & Veicsteinas, 2004).

There were no significant differences between the two groups for upper body strength as measured by the Chest Pass and Grip Strength. Upper body strength may not be compromised by motor difficulties to the same extent as the lower body. Another contributing factor may relate to variations within the MLD group whereby some have lower limb coordination problems only compared to others who have both fine and gross fine motor problems (Parker, Wade & Larkin, 1997). Clearly, this area requires further research.

Cardiorespiratory Endurance

Cardiorespiratory endurance, measured by the Multi Stage Fitness Test, was lower in the group with MLD. This outcome is consistent with other research (Hay et al., 2004; O'Beirne & Larkin, 1989). As cardiorespiratory endurance in children is developed and maintained through regular participation in physical activity, lower fitness levels from the group with MLD are not surprising. It is likely that they have maintained low physical activity levels for longer than the other children. A study involving older children found a relationship between movement proficiency and cardiorespiratory endurance, particularly for the girls (Okely et al., 2001).

Speed and Power

Children with MLD were significantly slower, and demonstrated less speed as measured by the 50m run, than the control children. O'Beirne and colleagues (1994) found similar results for children with MLD. Performance on the standing broad jump was considerably lower for the group with MLD and was the best linear model explaining more of the variance between the groups than any of the other measures of fitness. This task, which is considered a measure of anaerobic power, requires good coordination and dynamic balance to achieve optimum performance. Since these abilities are generally low in children with MLD, it is not surprising that the measure of power was low.

Test Issues

One concern when testing fitness in populations with coordination difficulties is the reliability and validity of the test item for this group. A true measure of physical fitness in children with MLD is difficult, given that many tasks require a high degree of coordination. The difficulty children with MLD have performing some of the tasks may be due to their lack of motor competence as well as reduced fitness, thereby potentially confounding the results. Some fitness tasks require a greater degree of coordination (run, jump, sit-ups) than others (grip strength, BMI). For example the run involves precise timing, dynamic balance, correct positioning of the limbs, head and trunk control and leg power to propel the body forward. Sit-ups require complex interactions between the head, the upper body and lower limbs (Cordo & Gurfinkel, 2004). Hoare (1991) reported that the 50m run was a good predictor of coordination level which supports the notion that poor results on fitness tests represented a problem with coordination as well as fitness. On the other hand, for measures free of coordinative constraints such as BMI, the group difference is more likely to reflect factors other than motor competence. Clearly the valid measurement of children with different levels of motor proficiency requires further research.

Conclusion

Given the results of this study, fitness development activities, therefore, need to be a key focus for intervention programs. Many aspects of fitness can be improved and maintained through regular, developmentally appropriate, and task specific activities. Changes monitored across a ten week program with children with MLD have shown clear improvements (Revie & Larkin,). Such programs will reduce the potential for negative short-and long-term consequences of low physical fitness and diminish its confounding influence on motor performance.

These findings highlight the importance of further research in this area, particularly seeking clarification of the involvement of MLD in physical fitness. Longitudinal studies are needed to track the motor skill development and fitness of children with MLD. The differences in performance identified between the two groups show that the negative interaction between motor competence and physical fitness begins at a very young age.

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Table 1

Descriptive Statistics and p-values of Physical Fitness Measures for the MLD group with and with out Co-occurring Conditions.

	Unit	MLD Group (no co-occurring conditions)			MLD Group (co-occurring conditions)			
Item		*M*	*SD*	*n*	*M*	*SD*	*n*	*p*-values
BMI	kg/m^2	17.3	3.1	25	17.6	3.8	20	.81
Sit and Reach Both	cm	-1.9	7.4	29	-4.0	9.5	23	.38
Sit-ups	count	12.5	7.8	29	12.1	8.1	22	.88
Grip Strength	kg	20.0	6.7	28	17.3	6.6	23	.15
Chest Pass	cm	229.3	61.6	28	230.2	49.3	21	.95
SBJ	cm	82.0	31.9	27	80.6	35.8	23	.89
50 m Run	sec	13.8	2.7	28	13.6	2.7	23	.85
Multi Stage Fitness Test	no. of shuttles	11.4	4.0	27	10.7	4.9	21	.58

Table 2

Descriptive Statistics of Physical Fitness Measures in the Control Group and the Group with MLD.

	Unit	Control		MLD	
Item		*M*	*SD*	*M*	*SD*
BMI	kg/m^2	15.5	1.8	17.5	3.3
Sit and Reach both	cm	3.3	6.2	-2.8	8.4
Sit-ups	count	19.5	8.7	12.3	7.8
Grip Strength	kg	20.6	6.5	18.8	6.7
Chest Pass	cm	232.5	49.7	229.7	56.1
SBJ	cm	115.3	20.3	81.3	33.4
50 m Run	sec	11.4	1.7	13.7	2.7
Multi Stage Fitness Test	no. of shuttles	15.0	9.6	11.1	4.4

Table 3

General Linear Models Analysis of Variance for Fitness Test Items

	F-value for sex	F-value for group	R-square (adj)
BMI	1.26	12.52**	11.0%
Sit and Reach (both legs)	4.2*	9.84**	16.8%
Sit-ups	1.06	18.34**	15.6%
Grip Strength	0.01	1.76	0.0%
Chest Pass	0.11	0.81	0.6%
Standing Broad Jump	0.66	39.03**	27.1%
50 meter run	0.31	28.23**	20.6%
Multi-stage fitness test	2.85	6.60*	7.0%

Note. * $p < 0.05$. ** $p < 0.01$.

Author Note

Beth Hands, School of Health Sciences, University of Notre Dame Australia; Dawne Larkin, School of Human Movement and Exercise Science, University of Western Australia; Correspondence concerning this article should be addressed to Beth Hands, School of Health Sciences, University of Notre Dame Australia, PO Box 1225, Fremantle, Western Australia 6959. E-mail: bhands@nd.edu.au