Physical activity and fundamental movement skills in children with developmental coordination disorder: abridged secondary publication

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KEY MESSAGES

1. Children with developmental coordination disorder had higher body mass index and poorer fundamental movement skills (FMS) proficiency and were less likely to participate in leisure time activities, compared with their peers with typical development.
2. There was a positive association between FMS and physical activity, which was stronger in children with typical development.
3. Using an error-reduced learning paradigm, FMS training was effective in improving FMS proficiency, facilitating active behaviour, and promoting enjoyment in activity participation of children. Some effects were even sustained for 12-months.
4. The school-based FMS training has potential in promoting physical and psychological health in children with developmental coordination disorder in the long run.

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Introduction

Children with developmental coordination disorder (DCD) have poor motor coordination, which interferes with activities of daily living, academic performance, and health.[1] Compared with children with typical development (TD), children with DCD are more obese, less physically active, and at higher risk for obesity-related chronic diseases.

Children's physical activity is associated with their surrounding environments. The common correlates of physical activity in children are enjoyment and mastery of movement skills such as fundamental movement skills (FMS).[2] FMS are building blocks for developing specific sporting skills and forming lifetime physical activity patterns. Based on the International Classification of Functioning, Disability, and Health Model for Children and Youth framework,[3] this study aimed to examine the relationship between FMS and physical activity, and the immediate-, shorter-, and longer-term effects of FMS training on motor skills proficiency, physical activity, and other psychological health effects such as enjoyment. The information gained is useful in identifying effective interventions that promote physical activity and health among children with DCD.

Methods

This study was approved by the Research Ethics Committee of the Chinese University of Hong Kong. It consisted of a cross-sectional study (study 1) and a randomised controlled trial (study 2). Hong Kong Chinese children aged 6 to 10 years from three primary schools were invited to participate. With parental consent, they were screened for DCD according to the Diagnostic and Statistical Manual of Mental Disorder diagnostic criteria. Motor difficulties were confirmed by teachers and/or parents using the Movement Assessment Battery for Children-2; and the score of ≤5th percentile was defined as the cut-off for DCD.

In study 1, based on power calculation, 88 (59 boys, 29 girls) children with DCD and 100 (49 boys, 51 girls) children with TD were included. Their body height, weight, and body mass index (BMI) were measured. Proficiency of five FMS (running, jumping, catching, kicking, and throwing) was assessed using the process-oriented measures of movement form and product-oriented measures of movement outcomes (speed of running, distance of jumping, successful catching, successful goal shooting, and successful throwing). Physical activity was assessed using an ActiGraph activity monitor, and the time

spent in sedentary, light, moderate, and vigorous physical activity were calculated and then converted to percentages of monitored time. Enjoyment and diversity in each of the five activities (recreational, physical, social, skill-based, and self-improvement activities) were assessed using the Children's Assessment of Participation and Enjoyment. Higher scores indicated greater enjoyment and diversity.

In study 2, based on power calculation, 69 children with DCD and 62 age-matched children with TD from study 1 were randomly allocated to either the FMS training group or conventional physical education lessons (control) group, with four subgroups formed: FMS-DCD, FMS-TD, control-DCD, and control-TD. The same outcome measures were used. The intervention period was 8 weeks, 40 minutes per week during physical education classes at schools. The FMS training used an approach to motor learning that reduces the occurrence of errors during practice.[4] Participants were assessed at baseline, prior to intervention, and at 1 week, 3 months, and 12 months after intervention.

Generalised linear (mixed) analyses were performed with controlling for confounders. Statistical significance was set at P<0.05 for all tests.

Results

In study 1, compared with children with TD, children with DCD had higher BMI and poorer scores in both process-oriented measures (locomotor skills and jumping, both P<0.001) and product-oriented measures (speed of running, P<0.05; distance of jumping, P<0.001; successful catching, P<0.01; successful goal shooting, P<0.05) of FMS proficiency. Children with DCD also spent less % sedentary (P<0.05) and were less likely to participate in leisure-time activities (P<0.05), especially in social (P<0.01) and self-improvement (P<0.01) activities.

The DCD status was a predictor for % sedentary and % light physical activity; children with DCD tended to spend less time in sedentary and more time in light physical activity (Table 1). Sex was also a predictor, with boys having less % sedentary and higher % light physical activity and % moderate physical activity. Object control skills proficiency was a predictor for % vigorous physical activity, whereas speed of running was a predictor for % moderate physical activity.

FMS proficiency (object control skills, speed of running, and successful goal shooting) was positively associated with % moderate physical activity and/or % vigorous physical activity in children with TD only. For sex, better object control skills were positively associated with higher % moderate physical activity and % vigorous physical activity in boys, whereas better locomotor skills proficiency (faster running) was associated with higher % vigorous physical activity and less % sedentary in girls (data not shown).

In study 2, compared with baseline, the FMS training group showed significant improvements in FMS outcomes over time, with significant group × time interaction effects for jumping (B=0.759, P<0.05), locomotor skills (B=1.069, P<0.001) at 1 week after intervention, and successful throwing (B=0.955, P<0.05) at 12 months after intervention. The control group also showed similar improvements

TABLE 1. Association of physical activity levels with variables after controlling for age and body mass index in generalised linear models

Variable	Physical activity, ß (95% CI)			
	% sedentary	% light	% moderate	% vigorous
Developmental coordination disorder status (children with typical development as reference)	-0.49 (-0.95 to -0.02)*	0.51 (0.04 to 0.97)*	0.10 (-0.20 to 0.40)	-0.08 (-0.38 to 0.22)
Sex (girls as reference)	-0.63 (-1.01 to -0.25)†	0.60 (0.23 to 0.98)†	0.35 (0.06 to 0.65)*	0.16 (-0.14 to 0.46)
Fundamental movement skills proficiency				
Process-oriented measure				
Locomotor skills	-0.05 (-0.20 to 0.10)	0.03 (-0.12 to 0.18)	0.08 (-0.07 to 0.23)	0.13 (-0.03 to 0.28)
Object control skills	-0.02 (-0.18 to 0.13)	-0.03 (-0.18 to 0.12)	0.13 (-0.03 to 0.28)	0.19 (0.04 to 0.34)*
Product-oriented measure				
Speed of running, s	0.01 (-0.14 to 0.15)	0.05 (-0.10 to 0.19)	-0.18 (-0.32 to -0.03)*	-0.14 (-0.29 to 0.01)
Distance of jumping, m	-0.02 (-0.17 to 0.13)	0.01 (-0.14 to 0.16)	0.05 (-0.10 to 0.20)	0.09 (-0.07 to 0.24)
Successful catching, n	0.06 (-0.09 to 0.21)	-0.08 (-0.23 to 0.07)	0.05 (-0.10 to 0.20)	0.07 (-0.08 to 0.22)
Successful goal shooting, n	-0.05 (-0.20 to 0.10)	0.02 (-0.13 to 0.17)	0.13 (-0.02 to 0.28)	0.10 (-0.05 to 0.25)
Successful throwing, n	0.10 (-0.05 to 0.26)	-0.14 (-0.30 to 0.01)	0.09 (-0.07 to 0.24)	0.07 (-0.09 to 0.22)

* P<0.05
† P<0.01

TABLE 2. Comparisons of physical activity levels across the study groups (mean coefficient)

Effects	Physical activity							
	Weekdays				Weekend days			
	% sedentary	% light	% moderate	% vigorous‡	% sedentary	% light	% moderate	% vigorous
Intervention								
Conventional physical education lessons	0	0	0	0	0	0	0	0
Fundamental movement skills training	-1.516	1.079	0.043	0.216	-1.807	1.752	-0.230	0.222
Participant								
Children with typical development	0	0	0	0	0	0	0	0
Children with developmental coordination disorder	0.519	-0.592	0.096	-0.097	-2.391	1.762	0.504	0.105
Group × time interaction								
Fundamental movement skills training								
Baseline	0	0	0	0	0	0	0	0
1 week after intervention	-1.741	0.626	1.133†	0.050	-2.047	1.467	0.623	0.126
3 months after intervention	0.980	-2.075	1.156*	0.082	-1.096	-1.066	1.828†	0.269
12 months after intervention	-1.107	-0.920	1.920†	0.218	-4.134	2.925	1.036	0.158
Conventional physical education lessons								
Baseline	0	0	0	0	0	0	0	0
1 week after intervention	-2.694	2.256	0.456	-0.011	-3.699	3.449	0.115	0.051
3 months after intervention	-1.025	0.009	0.938*	0.254	-0.589	0.210	0.151	0.162
12 months after intervention	-2.143	1.023	1.213*	0.182	2.905	-2.810	-0.144	0.088

* P<0.05

† P<0.01

‡ Compared with baseline, children with developmental coordination disorder in the control group had a mean coefficient of 0.441 (P<0.01) at 1 week after intervention and 0.497 (P<0.05) at 12 months after intervention

in FMS outcomes over time, with significant interaction effects for jumping (B=0.890, P<0.05), throwing (B=1.280, P<0.05), and speed of running (B=0.255, P<0.05), with the control-DCD group having significantly higher scores at 1 week after intervention than at baseline (data not shown).

Significant group × time interaction effects were found in both groups (Table 2). The FMS training group had higher % moderate physical activity on weekdays at 1 week, 3 months, and 12 months after intervention; and weekend days at 3 months after intervention. The control groups also had higher % moderate physical activity on weekdays at 3 months and 12 months after intervention. There was a significant interaction effect for % vigorous physical activity at weekdays, in which the control-DCD group spending more % vigorous physical activity at 1 week and 12 months after intervention than at baseline.

All FMS and control groups showed a decrease in overall diversity of participation over time. There was an interaction effect for enjoyment of activity participation; the FMS-DCD subgroup had greater enjoyment at 1 week after intervention (B=0.514, P<0.05), 3 months after intervention (B=0.583, P<0.05), and 12 months after intervention (B=0.837, P<0.01) [data not shown].

Discussion

FMS are the building blocks of future specific skills and play an important role in the lives of children with DCD. Based on the International Classification of Functioning, Disability, and Health Model for Children and Youth framework, our findings confirmed those reporting that children with DCD had higher BMI and poorer FMS proficiency, and were less likely to participate in leisure time activities than their peers with TD. FMS were associated with physical activity, but the association was stronger in children with TD. FMS skills, such as object control skills and locomotor skills (eg, running), were predictors for physical activity. These skills should be considered when designing and implementing motor skills interventions to facilitate active behaviour.

In children with DCD, FMS training was effective in improving FMS proficiency, facilitating active behaviour, and promoting enjoyment in participation during leisure time. The errorless motor learning model, which constraints the environment to minimise errors during practice,

enables children to experience a sense of mastery and success.[5] This suggests that this type of learning model can accommodate variations of motor ability and promote feelings of success and enjoyment in physical activity participation. Some of these gains were even sustained over a 12-month period, supporting promotion of physical and psychological health in children with DCD in the long run.

Conclusions

Children with DCD have higher BMI and poorer FMS proficiency than children with TD. FMS were associated with physical activity, but the association was stronger in children with TD. FMS training appears to be an effective school-based intervention for children with DCD. The error-reduced learning paradigm appears to be a promising approach for FMS training for educators and rehabilitation professionals working with children with DCD.

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Disclosure

The results of this research have been previously published in:

1. Sit CH, Yu JJ, Wong SH, Capio CM, Masters R. A school-based physical activity intervention for children with developmental coordination disorder: a randomized controlled trial. Res Dev Disabil 2019;89:1-9.

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