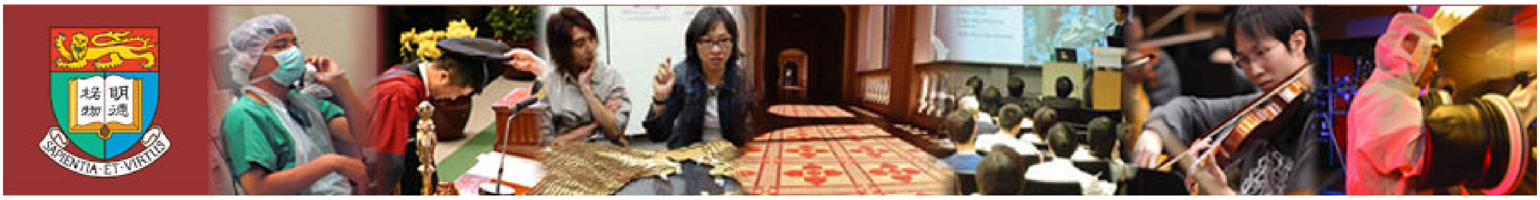

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Process-oriented evaluation of fundamental movement skills in children with cerebral palsy

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Introduction

Fundamental movement skills (FMS) are considered the essential basis for the development of more advanced and specific sporting skills[1]. High levels of FMS competence have been considered to be prerequisites to successful participation in sports and physical activities[2]. Since the ability to perform FMS has been identified as a potential factor that influences the physical activity behavior of children[3-7], it is important that this be measured using valid and reliable instruments7 for both typically developing children and children with disabilities.

The biological factors associated with a physical disability may retard the development of FMS in early childhood. The largest diagnostic group treated in pediatric rehabilitation is made up of children with cerebral palsy (CP)[8]. CP refers to a group of disorders that is caused by non-progressive disturbances in the developing brain, and is known to manifest in problems of movement and posture9. While the hallmark of CP is a delay in the development of gross motor function[10], low levels of participation in physical activities and recreation have also been observed[11-13].

FMS that are performed in an upright position include locomotor skills and object control skills[14]. Locomotor skills require overall movement of the body such as running and jumping[1,15]. Object control skills are more static in nature and involve applying force to or receiving force from objects such as kicking, catching, and throwing[16]. FMS may be measured using product-oriented or process-oriented approaches[14]. Product-oriented assessments are based on time, distance, or number of successful attempts resulting from the performance of a skill, while process-oriented assessments are concerned with how the skill was performed rather than the product result of the movement. Product-oriented measures appear to be more appropriate for children with CP since they emphasize an individual's output rather than their manner of performance based on a "normal" standard[17].

A product-oriented FMS testing strategy is crucial in further research that will examine the FMS proficiency of children with CP. As we target FMS training, validated testing procedures will be highly useful in providing outcome measures that directly relate to sports and activities that children engage in. This study aimed to validate a product-oriented measurement procedure that tests specific FMS among children with CP.

Methods

Participants

Participants included a convenience sample of 30 children with CP (17 female, 13 male) aged between 6 to 14 years (M = 9.83 years, SD = 2.5 years). Inclusion criteria were children with CP who were able to walk with or without walking aids and follow 2-step commands. Exclusion criteria included neurologic disease and any other medical conditions that limited participation. Parents provided written consent, and children gave verbal assent prior to study involvement. Ethical approval was granted by the Institutional Review Board (IRB) of the university.

FMS Assessment

Product-oriented scores

The testing procedures for the FMS assessment were adapted and modified from the protocols of the second edition of the Test of Gross Motor Development – 2nd Edition (TGMD-2)[15]. Performances of two locomotor skills and three object control skills were measured using product outcomes based on duration, distance, and number of successful attempts[14].

Process-oriented scores

TGMD-2 components that evaluate the five FMS being examined were used for process-oriented measurement. Each skill is performed for two trials, and skill performance is rated on a scale of 3-5 based on a number of qualitative criteria. The presence or absence of a criterion is scored 1 or 0. Developers of the tool have established high reliability, including internal consistency of items in the tool[15].

Criterion measure

Gross Motor Function Classification System (GMFCS) levels were used as the criterion measure. GMFCS is a classification system designed for children with CP using 5 levels that are based on differences in self-initiated movement and locomotion[10]. Level I denotes the ability to walk without any restrictions, while level II refers to walking with limitations when outdoors in the community. Level III refers to walking with assistive mobility devices, while levels IV and V describe mobility patterns where the children are in supported sitting and powered assistive technology are used.

Procedures

Individual testing sessions included the performance of the following tasks: catching, throwing, kicking, jumping for distance, and running. The sessions were conducted outdoors, on surfaces with non-slip rubber mats. Verbal instructions were given using a maximum of 2-step commands, followed by demonstrations. Five trials were done for catching, throwing, and kicking. Three trials were done for jumping and running. The data were analyzed using linear regression analysis, with GMFCS as the criterion reference. Alpha level was set at p<0.05.

Results

Eight product-oriented measures were taken to assess five FMS, and six were found to have a significant linear association with GMFCS levels ($p<0.05$). Table 1 shows the correlation coefficients (r) and the coefficients of determination (R2) between the product-oriented measures and GMFCS levels. It was found that product-oriented scores for catching, jumping, and running were able to predict a substantial variance in GMFCS levels. Three product-oriented scores were taken for kicking: number of successful attempts considering contact, number of successful attempts considering distance, and duration of performance from initiation to contact. Only the latter two measures were found to account for sizeable GMFCS variance in the participants. The product-oriented score for throwing was not found to predict the variance in GMFCS levels. The fit of the regression models were also assessed using analysis of variance (ANOVA) and were found to be significant for catching, running, two kicking measures (distance and duration), and one jumping measure (distance).

Table 1. Correlation coefficients, coefficients of determination, and regression model fit between product-oriented scores and GMFCS levels

FMS	Coefficients		Regression model fit
	r	*R*²	*Sig. (ANOVA)*
Throwing	-.253	.064	.178
Catching	-.511*	.262	.004*
Kicking (contact)	.273	.074	.145
Kicking (distance)	-.375*	.141	.041*
Kicking (duration)	.511*	.261	.004*
Jumping (distance)	-.436*	.190	.016*
Jumping (duration)	.431*	.186	.065
Running	.686*	.470	.000*

*statistically significant at $p<0.05$

Table 2 shows the correlation coefficients and coefficients of determination that were observed for the process-oriented scores and GMFCS levels. Only the two process-oriented scores for locomotion (running and jumping) were found to have significant positive associations ($p<0.05$) and accounted for a substantial variance in GMFCS levels. The fit of the regression models were also found to be significant for these locomotion skills.

Table 2. Correlation coefficients, coefficients of determination, and regression model fit between process-oriented scores and GMFCS levels.

FMS	Process-oriented		Regression model fit
	r	*R*²	*Sig. (ANOVA)*
Throwing	-.103	.011	.588
Catching	-.260	.067	.166
Kicking	-.220	.049	.242
Jumping	-.48*	.231	.007*
Running	-.440*	.194	.015*

*statistically significant at $p<0.05$

Discussion

One goal of outcome measurement is to evaluate the effects of interventions. However, rubrics for measurement of function and outcomes in children with CP are still inadequate[18]. GMFCS has been established as the principal classification system of functional ability in children with CP, and it has been used as the criterion measure for testing the validity of measures19. Measurement scales for spasticity20, manual dexterity21, and motor ability10 have been developed and validated against GMFCS, but no scale has been found to be adequate to measure FMS. Similar to other validation studies, we used the GMFCS as the criterion measure to test the validity of product-oriented measures for throwing, catching, kicking, jumping, and running skills. Our results showed that six of the product-oriented measures predicted a significant amount of variance in GMFCS, providing evidence that valid product scores have been identified in four skills for children with CP.

Process-oriented scores were found to predict significant variance in GMFCS only in locomotor skills, and demonstrated weaker associations with our criterion measure than those of product-oriented scores. This supports our proposition that product-oriented assessment may be more applicable in children with CP. However, it appears that further studies are needed to identify a valid measurement score for throwing skills. Neither product nor process scores were found to have significant associations with GMFCS, indicating the need to further examine valid methods of measuring this skill.

Conclusion

It has been argued that what an individual is able to do is more important than how the task is performed against a standard on which function is judged[17]. We used outcome measures that directly measured the task outcomes with explicitly observable data. Our findings demonstrated valid product-oriented measures for catching, kicking, jumping, and running. In the context of research, the use of tests is highly dependent on the purpose of a study[22]. The FMS measures that were validated in this study are geared for further research that would examine associations of FMS and physical activity levels of children with CP. As such, we emphasize that the measures depict the skills that children use in physical activities that may be in the form of sports and recreation.

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