ORIGINAL ARTICLE

Motor performance and functional mobility in children with specific learning disabilities

Suhaili Ibrahim, BSc (Hons)[1], Dzalani Harun, Phd[1], Masne Kadar, Phd[1], Hanif Farhan Mohd Rasdi, Phd[1], Nur Sakinah Baharudin, BSc (Hons)[1], Evelyn Jong Tze Hui, BSc (Hons)[2]

[1]Program of Occupational Therapy, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia, [2]Program of Physiotherapy, Centre of Rehabilitation and Special Needs, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

ABSTRACT

Introduction: Limitations in motor performances among children with specific learning disabilities (SLD) can lead to impaired functional skills. Thus, this study aimed to determine the level of motor performances and functional mobility, and the influence of motor performances on the functional mobility in children with SLD.

Methods: A cross-sectional study was conducted among 148 children with SLD and their caregivers. The evaluation consisted of the Movement Assessment Battery for Children-2 (MABC-2) and the Functional Mobility domain from Pediatric Evaluation of Disability Inventory-Computer Adaptive Test (PEDI-CAT). The level of motor performances and functional mobility were determined. A linear regression was then conducted to assess the influence of motor performances that could be accounted for functional mobility scores.

Results: More than half of the children with SLD showed motor performance difficulty in manual dexterity subscale (54.7%). For functional mobility, the mean standard T-score indicated an average level of capability (49.49±15.96). A regression analysis revealed that both manual dexterity and balance were significant predictors for functional mobility. According to the regression coefficients, manual dexterity ($B=1.37$, $\beta=0.303$, $sr^2=0.077$) was found to be a stronger predictor compared to balance ($B=0.85$, $\beta=0.178$, $sr^2=0.028$).

Conclusion: Manual dexterity was found to influence functional mobility among children with SLD. Therefore, fine motor skills intervention for children with SLD should emphasize on manual dexterity training. Future studies that involve dual tasks and inclusion of typical children would give useful additional information on motor performances issues in children with SLD.

KEY WORDS:
Functional Mobility; Balance; Children; Motor Performance; Specific Learning Disabilities

INTRODUCTION

Specific learning disabilities (SLD) which is also known as specific learning disorder according to the Diagnostic and Statistical Manual of Mental Disorder 5th edition (DSM-5),[1] is a group of conditions that is not limited to difficulties in learning and using academic skills but also frequently co-occurs with delays in attention, language, and motor skills. Globally, in 2013, the incidence of SLD was reported to range between 5 and 15%.[1] In Malaysia, there were 314,000 children with SLD in 2010[2] with a prevalence of 10.8% in 2011.[3] As the numbers had increased remarkably by twofold in 2015,[4] substantial attention is needed to address this issue.

Studies have shown that children with SLD exhibit problems in motor performance in terms of fine motor, gross motor, and balance.[5-8] Typically, these children have fine motor problem with difficulties in bimanual coordination, manual dexterity, and fine motor skills.[9] Their gross motor performance is poorer compared to typical children according to studies on locomotion and non-locomotion skills.[9,10] Numerous studies reported that they have motor impairment especially in motor coordination and balance.[11-15] There was a direct evidence of abnormal cerebellar activation patterns during motor tasks as reported in a study comparing groups of dyslexia adults with normal adult population.[12] The high range of incidence for cerebellar impairment in children with SLD (59-80%) could potentially explain their problems in motor performance.[13,15]

However, studies regarding motor performance in children with SLD showed inconclusive findings especially in balance task. Whilst a number of studies reported motor performance difficulties in children with SLD, other studies found otherwise. For instance, Poblano et al., found no balance deficit among children with SLD who have absence of co-morbid diagnosis and motor-impairment during balance testing using posturography.[16] A study by Ramus et al., on motor deficit in children with SLD found mixed finding, i.e., 50% have no motor deficit and another 50% have motor deficit due to secondary diagnosis (e.g., attention-deficit hyperactivity disorder or developmental coordination disorder).[15] Understanding of motor performance in children with SLD is essential as it can affect the academic performance of children such as reading, mathematics, and language.[17,18] Specifically, 50% of children who exhibited reading problem had a below age level of motor development.[5] Similar finding also seen in a study on the association between motor impairment and difficulties in daily life and school activities.[19-21]

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Corresponding Author: Dr Dzalani Harun
Email: dzalani@ukm.edu.my

According to the DSM-5, significant limitations in activities of daily living (ADL) is one of the SLD characteristics.[1] Functional mobility is one of the subcategories of ADL that is related to most daily living activities at home and in the community.[22,23] Mastering fundamental skills such as fine motor, gross motor, and balance is essential for children in achieving good performance in functional mobility. In considering that, pre-school early intervention strategies should focus on developing not only communication, behavioural, and socio-emotional skills but also motor skills.[24] Early intervention programme that was designed for developing motor skills yielded more benefits over exerting effort in remediating motor problems at later stages.[25] Without early intervention, functional mobility limitation in children with SLD can persist into adulthood.[26]

In Malaysia, the available literature regarding motor performance and functional mobility among children with SLD is limited.[27,28] Knowing that the motor performance can affect children's ability in daily life (e.g., functional mobility) and at school,[28] this study was conducted among children with SLD with two objectives: (1) to determine the level of motor performance and functional mobility and (2) to determine the influence of motor performance on functional mobility specific to that population.

MATERIALS AND METHODS

Design and Participants

A cross-sectional study was conducted on children with SLD aged 4-16 years old and their caregiver (n=148). The sample size was calculated using prevalence Kish formula[29] with confidence interval of 95% and 5% estimated level of precision. The prevalence of 10.8% was used referring to the study done by Hock et al.[3] In this study, the caregiver was either parents of the child or persons who are taking care of the children including grandparents and relatives. Children were recruited from 11 government schools and two centres of Dyslexia Association Malaysia (DAM), a non-government organisation in the Federal Territory of Kuala Lumpur. They were visited between January and May 2016. Selection of children was based on a study criteria checklist that was provided by the researcher to teachers for both schools and DAM. Children were excluded if they: (1) were diagnosed with other conditions than dyslexia, dyscalculia, dysgraphia and/or slow learner, (2) needed assistance during walking or using walking aids, (3) have other motor disabilities, and (4) have severe sensory problem such as deaf or blind which affects their ability in learning and in performing daily activities. The selected children and their caregiver were invited to participate in this study via invitation letters that was given through the school and DAM teachers.

Instruments

After obtaining the informed consent, caregivers were instructed to complete a socio-demographic background questionnaire that consisted questions about their children (e.g. the child's age, sex, race/ethnicity, and type of learning disabilities) and of themselves (e.g. caregiver's age, sex, race/ethnicity, and study level).

The Movement Assessment Batteries for Children – Second Edition (MABC-2) (Pearson Assessment, 80 Strand, London WC2R ORL)[30] was used to assess motor performance in children with SLD. It is one of the most widely used assessment tools by occupational therapists, physiotherapists, psychologists, and educational professionals.[31] The MABC-2 was scored by the researcher based on the motor performance done by the children. MABC-2 consists three age bands (4-6, 7-10, and 11-16 years) with different tasks respectively. Each age band comprised eight items that were divided into three subscales: manual dexterity (three items), aiming and catching (two items), and balance (three items). Tasks are performed either using preferred, non-preferred hand, or both hands depending on the task requirement. Preferred hand is the one that the child uses for writing. In manual dexterity, the best scores for items one and two refer to the fastest time taken during two trials, and item three best scores refer to the lower number of errors made in two attempts. For aiming and catching, item one and two best scores refer to the number of correctly executed catches/ throws out of ten. For balance, the best scores for items one, two and three depended on higher number of seconds, steps, and jumps/hop in two trials respectively. Total score of the MABC-2, and subscale scores and item scores are converted into percentile rank to reflect the child's level of motor performance in comparison with children in normative population. A percentile rank at or below 5th percentiles denotes a 'definite movement difficulty', percentile rank between 5th to 15th denotes 'borderline movement difficulty', while percentile above 15th denotes 'no movement difficulty'. The MABC-2 has good inter-rater reliability (0.92-1.00) and test-retest reliability (0.62-0.92).[31]

The mobility domain of the Pediatric Evaluation of Disability Inventory – Computer Adaptive Test (PEDI-CAT) (Trustees of Boston University, CREcare, LLC) was used to assess functional mobility.[23] The parents/ caregiver of the children needed to respond to the mobility domain questions from the PEDI-CAT. The mobility domain involves the ability of the child to move in different environment, for instance getting in and out of bed and getting off a public bus or school bus. It comprises 75 comprehensive items bank for functional mobility acquired across children aged between 0 and 21 years old. PEDI-CAT is easy to administer as it provides picture for each question to assist respondents in answering the questions. Standardized script is used to explain words or phrases that unclear to respondents. In this study, the caregiver reported the child's functional mobility performance using a 4-point scale (1=Unable. Can't do, doesn't know how or is too young; 2=Hard. Does with a lot of help, extra time, or effort; 3=A little hard. Does with a little help, extra time or effort; 4=Easy. Does with no help, extra time or effort, or child's skills are past this level). PEDI-CAT uses computer algorithm to pre-select items based on previous responses and asks only items relevant to the child's age. Hence, there was no fixed number of items administered for an individual child. Overall, 30 items were administered from 75 comprehensive items bank for functional mobility.[23] Normative scores are converted from raw score and presented as T-score. T-score below 30 denotes a 'definite difficulty', T-score of 30 to 70 denotes 'average difficulty' while T-score above 70 denotes 'no difficulty in functional mobility'. PEDI-CAT has

Table I: Table I. Social demographic characteristics of children with SLD

Variable	Total, n=148
Age (in years), mean (SD)	11.55 (3.76)
4 – 6	25 (16.9)
7 – 12	62 (41.9)
13 – 16	61 (41.2)
Gender, n (%)	
Male	88 (59.5)
Female	60 (40.5)
Race/Ethnicity, n (%)	
Malay	114 (77.0)
Chinese	17 (11.5)
Indian	11 (7.4)
Others	6 (4.1)
Types of learning disabilities, n (%)	
Dyslexia	82 (55.4)
Dyscalculia	1 (0.7)
Slow learner	65 (43.9)

Table II: Social demographic characteristics of caregivers

Variable	Total, n = 148
Age (in years), mean (SD)	44.19 (8.94)
Gender, n (%)	
Male	47 (31.8)
Female	101 (68.2)
Race/Ethnicity, n (%)	
Malay	113 (76.4)
Chinese	17 (11.5)
Indian	10 (6.8)
Others	8 (5.4)
Study Level, n (%)	
No Formal Education	3 (2.0)
Primary Education	12 (8.1)
Secondary Education	59 (39.9)
Tertiary Education	74 (50.0)

Table III: The total test score and three subscales scores from MABC-2 in mean percentile rank and percentages (n = 148)

Domains	Mean (SD) Percentile Rank	Frequency, n (%)		
		[a]No movement difficulty	[b]Borderline movement difficulty	[c]Definite movement difficulty
Total Test Score	22.67 (25.22)	80 (54.1)	11 (7.4)	57 (38.5)
Manual Dexterity	21.58 (26.15)	67 (45.3)	16 (10.8)	65 (43.9)
Aiming and catching	30.05 (30.28)	84 (56.8)	15 (10.1)	49 (33.1)
Balance	33.25 (28.34)	98 (66.2)	22 (14.9)	28 (18.9)

[a]above 15th percentile rank
[b]between 5th to 15th percentile rank
[c]at or below 5th percentile rank

Table IV: Linear regression analysis predicting functional mobility scores

	B [95% CI]	β	t	p	sr^2
Manual Dexterity	1.37 [0.59, 2.16]**	0.303	3.461	0.001	0.077
Aiming and Catching	0.27 [-0.37, 0.91]	0.066	0.821	0.413	0.005
Balance	0.85 [0.03, 1.67]*	0.178	2.047	0.042	0.028

N=148. CI=confidence interval, coefficient of determination (R^2)=0.20, f^2=0.25.
**p*-value <0.05, ***p*-value <0.01

good test-retest reliability of 0.958 to 0.997.[23] For normality testing, skewness and kurtosis coefficients were computed for the three MABC-2 subscales (manual dexterity, aiming and catching and balance) and PEDI-CAT mobility domain. The skewness values ranged from 0.54 to 2.50.

Ethics

Ethics approval of this study was granted by The Medical Research and Innovation Secretariat, The National University of Malaysia (NN-2016-060). Organisational approvals were obtained from the Ministry of Education Malaysia (KPMSP.600-3/2/3 Jld 7) and the State Education Department of Wilayah Persekutuan (JPNWP.900–6/1/7). Each caregiver was approached individually and was given explanation about the study. Those who agreed to participate and allowed their child to be involved in the study were given a consent form to sign.

Data Analysis

Demographic data, motor performance, and functional mobility scores was analysed using IBM SPSS Statistics. Demographic data of children and caregiver was summarised using descriptive statistics. Children's motor performance of the MABC-2 subscales and total test scores was analysed and grouped as no movement difficulty (above 15th percentile rank), borderline movement difficulty (between 5th to 15th percentile rank), or definite movement difficulty (at or below 5th percentile rank) and expressed using percentages and mean percentile rank. Children's functional mobility T-score from PEDI-CAT was analysed and grouped as no difficulty (T-score above 70), average difficulty (T-score of 30 to 70), and definite difficulty (T-score less than 30) and expressed using percentages. Multiple regression analyses were computed to explore the linear relationship between three subscales from MABC-2 (predictor variables) and functional mobility (criterion variables). A statistical significance level of 0.05 was used for all analyses. Effect size was also calculated using Cohen f^2, with 0.02 is described as small, 0.15 as medium and 0.35 as large.

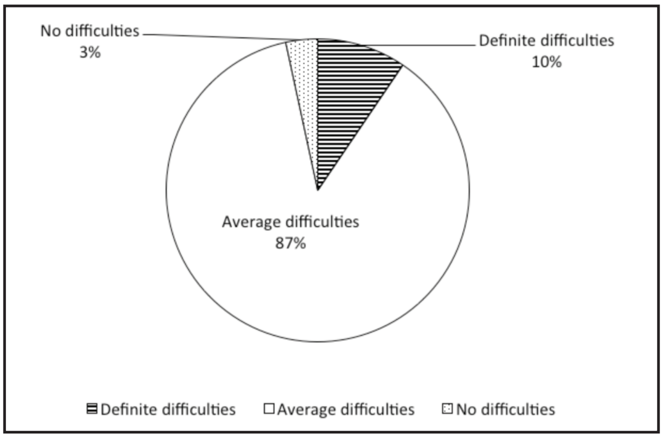

Fig. 1: Difficulties in functional mobility among children with specific learning disabilities.

RESULTS

Demographic characteristics of children and their caregivers is summarised in Table I and Table II respectively. Majority of children were male (59.5%), Malays (77%), aged between seven and 12 years old (41.9%), and diagnosed as dyslexia (55.4%). As for parents/ caregivers, majority of them were females (68.2%), Malays (76.4%), with mean age of 44.19 (SD=8.94), and had a tertiary education qualification (50%).

Motor Performance

Table III shows the mean percentile rank and the percentage of MABC-2 total test score along with its subscales (i.e., manual dexterity, aiming and catching, and balance) according to level of movement difficulties. In total test score, more than half of the children (54.1%) were found to have no movement difficulty (> 15th percentile rank). For the subscale's domain, most of the children had no movement difficulty in balance (n=98, 66.2%) compared to manual dexterity and aiming and catching. For manual dexterity, the percentage of those with no movement difficulty was almost equal to those with definite movement difficulty (45.3% and 43.9% respectively). Overall, children with SLD had movement difficulty mostly in manual dexterity compared to the other two subscales.

Functional Mobility

Figure I show the percentages of PEDI-CAT according to levels of difficulties. Children have a mean T-score of 49.49 (SD =15.96) and most of them (87.2%) were found to experience average difficulties in functional mobility (T-score between 30 and 70).

A linear regression was conducted to investigate the predictive utility, that the manual dexterity, aiming and catching, and balance subscales had on functional mobility scores (Table IV). According to the ANOVA test, the regression model has a significant predictive utility ($F(3, 144) = 12.08$, $p<0.001$). In combination, the subscales (manual dexterity, aiming and catching, and balance) accounted for 20% of the variability in the functional mobility scores. The regression analysis showed that both manual dexterity ($p=0.001$) and balance ($p=0.042$) were significant predictors for the functional mobility scores. According to the unstandardised (B) coefficients, standardised (β) coefficients, and squared semi-partial correlation (sr^2), manual dexterity was found to be a stronger predictor compared to balance.

DISCUSSION

Motor performance

The results of our analysis indicated that children with SLD showed no movement difficulties in overall total test scores referring to percentile rank. However, when looking at the percentage of total test scores, the result of this study found that most of the children showed difficulties in motor performances which consistent to the study by Vuijk et al.[7,8]

In this study regarding motor performance subscales, children with SLD were found to experience manual dexterity as the main problem. This is consistent with previous studies that reported that children with SLD have fine motor skill difficulties.[7,8] Fine motor tests typically involved multiple tasks with demands in visual, cognitive, manual dexterity, and spatial organisation (e.g., pegboard test, drawing trail, and building clocks).[32] Similarly, the children in the current study were asked to perform tasks such as drawing trails, placing or turning pegs, and treading beads where the tasks required considerable accuracy, good understanding, and good reaction time. Thus, it is suggested that children may have lack attention and concentration[5] and rely more on feedback during movement than adopting a feed-forward strategy,[33] an internal representation to pre-plan and anticipate the necessary motor sequence.

Result of this study found that children with SLD were having difficulties in the manual dexterity subscale. Interestingly, there was almost equal percentages of them were having definite movement difficulty with those without movement difficulty. In addition, a considerable percentage of them were having borderline difficulty. This result supports the fact that children with SLD have difficulty in performing fine motor skills.[7,8,32] Specifically, Vuijk et al., in his study reported that children with reading problems have higher risk of fine motor problems.[7,8] Therefore, our study suggests that intervention in fine motor skills for children with SLD should emphasize on manual dexterity tasks in order to improve their motor performance.

Our study also found that children with SLD showed good motor performance in balance compared to manual dexterity and aiming and catching. Studies by Vuijk et al., showed similar result in which children with SLD performed better in balance.[7,8] However, this result is not in line with several earlier studies that reported that children with SLD have deficits in balance. Nicolson et al., proposed two hypotheses to explain problem with balance among children with SLD: automatization deficit hypothesis and conscious compensation.[12-14] In order to detect problems with balance in children with SLD, an assessment that implemented dual task was recommended. Dual-task balancing condition involves both balancing activity and cognitive activity such as stand with two feet together and counting backwards. This is because, the children with SLD are often capable of using conscious compensation when performing a single task compare to dual tasks. In this study, balance test mostly involved single task hence, the deficits may not be detected. Moreover, studies reported that children with SLD who showed impaired balance skills were involved children with comorbidities.[15,16] Thus, the exclusion of children with co-morbidities in our study may explain this inconsistent finding. Nevertheless, debates regarding association between balance deficit and comorbid factors are still ongoing.[16,34-37] This study also suggests the need to establish a standardised assessment tool that measure the dual task-balancing in children with SLD. Previous studies usually use a portion or subtest from an outcome measure such as stand with the feet apart, and either counting backward or reading.[11,15] Hence, this is recommended for future studies.

The same discussion holds for the aiming and catching subscale, where more than half of children with SLD showed good performance in tasks involving throwing and catching ball. This study finding was consistent with the previous study done by Iversen et al., which found that there was no significant difference in ball skills using MABC between children with SLD and typical children.[38] A similar result was also reported by Jongsman et al., who compared aiming and catching skills among children with SLD, DCD and typical children.[39] Hence, these studies agreed that children with SLD were having good performance in aiming and catching.

Functional mobility

Findings of our study revealed that children with SLD had an average difficulty in functional mobility. Since to date, there is no published report available to support this finding, a comparison between studies could not be done. Our study suggests that functional mobility such as the ability to move in different environment for example, home and community, does not pose a difficulty to most children with SLD.

Predicting Functional Mobility

Current findings showed that motor performance scores affect variability in functional mobility. Manual dexterity was a stronger predictor compared to balance. This is consistent with previous findings by Case-Smith which reported that in-hand manipulation (r=-0.67) using pegs tasks showed higher association than motor accuracy (r=0.43) with PEDI mobility scores.[40] Previous study also reported that fine motor skills for example, copy design has strong association and significantly predicts phonological abilities and mathematics.[28] Our preliminary finding supports that motor performances, especially manual dexterity and balance influenced the functional mobility in children with SLD. Therefore, it is critical for the intervention of motor skills for children with SLD to emphasize on manual dexterity tasks in order to improve their functional mobility performance.

The limitation of this study was regarding MABC-2 motor performance assessment. As most of MABC-2 motor skill, especially the balance tasks items involve only a single task, motor problem in children with SLD could not be detected. Since typical children were not included in the study, comparison of motor performance and functional mobility between children with SLD and typical could not be investigated.

CONCLUSION

In conclusion, our study demonstrated that the difficulty in manual dexterity is prevalent among children with SLD. Manual dexterity is a stronger predictor rather than balance on the children functional mobility. Therefore, strategies to improve the manual dexterity performance should be emphasized in the fine motor skills intervention for children with SLD so that it will lead to improvement in functional mobility.

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