Correlation between One Leg Stand Test and Paediatric Balance Scale in children aged 7-12 years

Nurul Kusuma Wardani[1], *Martha Kurnia Kusumawardani[1], Juwita Arum Mayangsari[2], Sri Mardjiati Mei Wulan[1]

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Abstract

Objective: To analyse the correlation between One Leg Stand Test (OLST) and Paediatric Balance Scale (PBS)

Study design: Analytical cross-sectional study

Place and duration: Mojo 3 Elementary School, from July to October 2019

Method: One hundred and ninety-three children aged 7-12 years were included in the study. Each age group was given OLST and PBS examination. Statistical analysis was done with nonparametric correlation Spearman's rho test

Results: There was significant correlation between OLST and PBS in the 7-year age group and the 8-year age group but not in other age groups.

Conclusions: There was correlation between OLST and PBS in elementary school children in the 7 and 8 year-age groups but not in other age groups

(Key words**:** Postural balance, Paediatric, Child Health, Child well-being index)

Introduction

Balance is important for children to achieve capability and functional independence in Activities of Daily Living (ADL). Capability is the ability of a child in limited situations which is different from actual daily living[1]. Balance is achieved with complex integration from several body systems including vestibular, visual, audio, proprioceptive and higher premotor level. Balance system is complex, so that several balance tests are needed[2]. Static balance is the attempt to keep the stability of centre of gravity (COG) within base of support, which requires little muscular activity. Dynamic balance is the ability to maintain COG within base of support, which requires higher neuromuscular activity. Functional balance is the integration of static and dynamic balance training to maintain or to improve ADL and Quality of Life (QoL)[1]. Thus, we hypothesised that there is a correlation between static balance with OLST and functional balance with PBS in children aged 7-12 years.

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Balance test is an important element to evaluate children in elementary school since it can predict an individual's ability to function in several environments such as home, school and society. There are several tools to assess balance. Static and dynamic balance are needed at all ages for a person to have optimal function[3]. One Leg Stand Test (OLST) assesses static balance and needs minimal equipment[4]. Paediatric Balance Scale (PBS) consists of 14 items to assess functional balance in children[5]. PBS is modified from the Berg Balance Scale and can be used to predict motor capacity and functional ability in children[6,7]. Besides, it can be used in school age children[8]. Research by Theodora S, *et al*[9] in 2019 was inspired by the high number of falls in young adults. That study, using the Closed Eyes Crossed Arms One Leg Stance (CECAOLS) method is carried out with case control measurements using a treadmill as a dynamic balance exercise on 2 groups of subjects. That study aimed to determine the level of balance in children so as to monitor and prevent the number of falls as well as other incidents and health problems[9].

Objective: To find out if there is a correlation between OLST and PBS in elementary school children

Hypothesis: There is a positive correlation between OLST and PBS in elementary school children

Method

An analytical cross-sectional study was carried out on students aged 7-12 years of both genders in Mojo-3 Elementary School from 1st September to

[1]*Lecturer,* [2]*Medical Officer, Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia*
**Correspondence:* marthakurnia@staf.unair.ac.id
https://orcid.org/0000-0002-3661-0236

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31st October 2019. There was a total of 858 students aged 7-12 years in Mojo-3 Elementary School.

Sample size: Cluster sampling was used.
n = 28.686 ~ 30
n + 10% (drop out probability) = 33 per group age
n total = 198
Based on this method, there were 33 children in each age group so that a total of 198 students were chosen as the study sample. Children with any cardiovascular or neuromuscular diseases that could affect balance and children with any injury to lower extremities that could affect the assessment were excluded from the study. After exclusions, 193 students consisting of 95 male and 98 female students were examined (Figure 1).

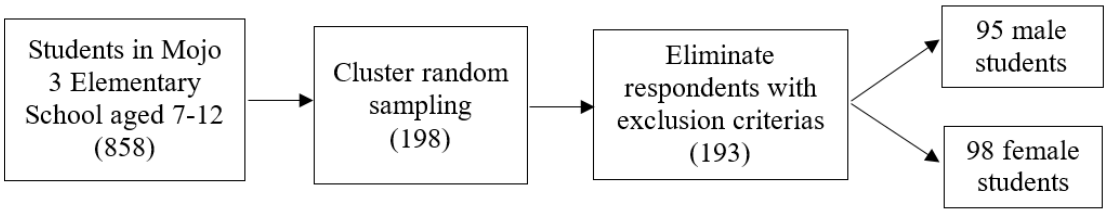

Figure 1: ***Sampling Flow Diagram***

Each student underwent height and weight examination. OLST and PBS assessments were applied to each subject. OLST assessment was conducted initially while PBS was carried out after the children took a rest.

OLST was used to assess static balance. Students were instructed to keep their balance on the preferred leg with their eyes open and to cross their arms over the chest. Counting of time started as they lifted their foot and ended when they unfolded their arms, moved weight bearing to the other leg or a maximum of 45 seconds had passed. The test was given 3 times and the average was recorded. Good balance means that they can maintain their balance on one leg for 45 seconds[4].

PBS was used to assess functional balance which consists of 14 tasks similar to ADL. The items are scored on a five-point scale (0, 1, 2, 3 or 4), zero when unable to perform the activity without assistance and four when able to perform the task with complete independence. The score is based on the time for which a position can be maintained, the distance to which the upper limb is capable of reaching in front of the body, and the time needed to complete the task. The maximum score is 56 points[5].

Ethical issues: Approval for the study was obtained from the Health Research Ethics Committee, Universitas Airlangga School of Medicine, Surabaya, Indonesia. (No. 247/ EC/ KEPK/ FKU/ 2019. Written informed consent was obtained from the parents of the children participating in the study.

Statistical analysis: Komolgorov-Smirnov test was used to see if the data were normally distributed. Since the data were not normally distributed, the nonparametric correlation Spearman's rho test was used in this study.

Results

Table 1 shows the demographic data of the study population. Mean OLST in children with different age groups fluctuated whilst the mean PBS in children with different age groups from 7 to 12 increased

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Table 1: ***Demographic data***

Age in years	Mean height (cm)	Mean weight (kg)	Mean OLST (seconds)	Mean PBS score
7	117.87 ± 5.54	22.93 ± 5.11	13.78 ± 13.08	55.56 ± 0.75
8	124.06 ± 6.12	24.39 ± 6.06	7.93 ± 4.12	55.45 ± 1.09
9	127.59 ± 8.17	27.75 ±10.05	13.46 ± 8.18	54.78 ± 1.89
10	136.343 ± 6.78	35.12 ± 10.07	11.68 ± 9.74	55.87 ± 0.33
11	140.18 ± 7.90	37.03 ± 9.23	9.12 ± 8.23	55.96 ± 0.17
12	141.58 ± 7.69	37.06 ± 9.86	7.09 ± 3.80	55.96 ± 0.17

OLST: One Leg Stand Test, PBS: Paediatric Balance Scale

Table 2 shows the correlation between OLST and PBS. Based on the result of nonparametric correlation Spearman's rho test (95% confidence interval), there was no significant correlation between OLST and PBS in the 7-12 year age group (p = 0.53). Table 3 shows that there is a significant correlation between OLST and PBS at ages of 7 years and 8 years but not at other ages.

Table 2: ***Correlation between One Leg Stand Test (OLST) and Paediatric Balance Scale (PBS)***

			OLST	PBS
Spearman's rho	OLST	Correlation coefficient	1.000	0.139
		Significance (2-tailed)		0.053
		Number	193	193
	PBS	Correlation coefficient	0.139	1.000
		Significance (2-tailed)	0.053	
		Number	193	193

Correlation is significant at the 0.01 level (2-tailed)

Table 3: ***Correlation between OLST and PBS per age group using Spearman's Rho Test***

Spearman's Rho		OLST Significance (2-tailed)	PBS Significance (2-tailed)
Age 7 years	OLST	-	0.000
	PBS	0.000	-
Age 8 years	OLST	-	0.005
	PBS	0.005	-
Age 9 years	OLST	-	0.219
	PBS	0.219	-
Age 10 years	OLST	-	0.066
	PBS	0.066	-
Age 11 years	OLST	-	0.757
	PBS	0.757	-
Age 12 years	OLST	-	0.956
	PBS	0.956	-

OLST: One Leg Stand Test, PBS: Paediatric Balance Scale
Correlation is significant at the 0.01 level (2-tailed)

Discussion

Human motor development is characterized by variation and adaptive developmental ability. Ability to maintain balance is linear with maturation of cerebral connectivity, thought to be the foundation of adaptive ability. This will make children learn the most appropriate behaviour in any circumstance[10]. In children, balance skill develops from birth through learning, playing and maturation as they start stand and walk[11]. Balance is related to basic movements, one of which is the ability to walk well. The six-minute walk test (6MWT) research by Kusumawardani MK, *et al*[12] in 2020 showed the relationship between the height of children aged 7-8 years and 6MWT[12]. Ability to maintain posture and balance in 7-8-year-old children is rapidly developed. Strategy to maintain balance in a 9-10-year-old girl is almost the same as in an adult. Some studies state that children more than 10 years old will have the same balance strategy, although other studies refute it[13]. In this study, it was found that the ability of all ages (7-12 years) for static balance was poor but for dynamic balance was good. The ability of all ages (7-12 years) for static balance was poor but for dynamic balance was good as shown in Table 1 where the OLST value is poor but the PBS value is nearly normal.

Table 3 shows that there is a significant correlation between OLST and PBS at ages of 7 years and 8 years but not at other ages. Research by Victorio LVG, *et al*[14] in 2020 showed that children aged 7-8 years have the centre of pressure (COP), oscillation velocity and anteroposterior (OV_AP), and oscillation velocity and mid-lateral (OV_ML) that are better in postural control than those aged 9-10 years. Result of the study showed that age was the most influential factor of COP (21%), OV_AP (24%), and OV_ML (39%). A study by Rival C, *et al*[15] assessed the time course to adapt and maintain static balance by children aged 6, 8 and 10 years. It showed that the range of the COP decreased non-monotonically, after increase in 6-8 years[15]. A study by Mani H, *et al*[16] also showed similar result. COP–COM distances in the 5–6 years and 7–8 years groups were significantly increased during the acceleration phase when compared to those in the adult group.

Data showed that the mean OLST in children of different ages fluctuated but the mean PBS in children of different ages from 7 to 12 increased. Our study indicated that there was no significant correlation between OLST and PBS ($p = 0.053$) as shown in Table 2. This is similar to a study by Humphriss R, *et al*[17] who found that there was either no correlations between dynamic and static functional balance tests or that they correlated in an unexpected way. That study used Balance Beam Walking (BBW) for dynamic balance and tandem stance and OLST for static balance due to the difference of mechanisms involved in static and dynamic balance control[14]. De Kegel A, *et al*[18] on the other hand, did find correlation between static

and dynamic balance. That study used OLST, BBW and One Leg Hopping. These conflicting results might suggest that static and dynamic balance control are part of the same construct, but the extent to which both aspects of balance control contribute to the performance on a given task appear to depend on the task constraints; for example, the speed of movement will differ between walking forward or backward. In addition, the static aspects of balance control in slow movements might be more dominant than in fast movements. This shows that single-item balance tests do not evaluate the complete construct of functional balance, and can only be used if different tests associated to other tasks are combined[15].

Conclusions

This study concluded that there was correlation between OLST and PBS in elementary school children in the 7 and 8-year age groups but not in other age groups.

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