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# Balance and Motor Skills among Preschool Children Aged 3 to 4 Years Old.

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## ABSTRACT

Balance and motor skills are essential prerequisites for physical development of a child. The aims of this study were to measure anthropometrics, postural balance and motor skills; and examine their correlation among healthy preschool children. Forty nine healthy preschool children aged between 3 to 4 years old participated from PERMATA preschool organization. Pediatric Balance Scale and Peabody Development Motor Scale-2nd Edition (PDMS-2) were administered to measure balance skills for both fine and gross motor skills respectively. Mann-Whitney U test demonstrated that there was no significant difference in balance (p=0.72) and motor skill (p=0.33) between boys and girls. Spearman correlation coefficient demonstrated that there was significant correlation between balance skills with height (r=0.45, p=0.001) and body mass index(r=0.47, p=0.001). No significant correlation was found between balance skills and motor skills (r=0.11, p=0.44). The present study suggests that balance skills in healthy preschool children aged 3-4 years old are correlated with their physical growth such as height and weight but not motor skills.

**Keywords: Balance skills, Motor skills, Preschool children, Physical development**

## INTRODUCTION

Motor and balance skills are part of the prerequisites for physical function and sports performance.[1,2] Most motor skills are acquired by children during the period of preschool.[2,3] Both motor and balance skills are also fundamentals of physical developmental milestone in children. These skills are further polished for more complicated movements such as running, hopping and sports activities. Any impairment in motor and balance skills may increase the risk of falls and injuries even in healthy children during sports activity participation.[1,4]

"Motor" is defined as motion or relating to the movements of muscle.[5] Motor skills can be categories into two major groups which are gross motor skills and fine motor skills. "Gross motor skills" refers to large physical movements of the whole body.[6] On the other hand, "Fine motor skills" means smaller movements, mainly movements in hands and fingers. Fine motor movements are more challenging for the preschool children compared to gross motor movements.[7]

Balance of an individual is gained when the centre of mass is kept within base of support.[8] One has to maintain their body in postural balance in order to prevent from falling. Specifically, balance is divided into static balance and dynamic balance. Static balance is gained when static posture is kept while resting.[9] Dynamic balance is obtained when stability of the body is maintained during movement performance.[10]

Both motor and balance competency in children is dependent on multiple factors. For example motor ability has been demonstrated to be higher in children who were more physically active, had smaller body mass index (BMI) and were less sedentary.[11] Similarly, boys with better motor performance recorded faster time and further distance in running and jumping respectively.[12] Difference in the onset of puberty was advocated to have resulted in inconsistent motor performance levels among children aged 13 years old.[13]

As for balance, age ($r_s$=0.689), height ($r_s$=0.650), and weight ($r_s$=0.642), have been reported to be moderately correlated with the Pediatric Balance Scale (PBS) score.[8] However, BMI was weakly correlated with the PBS score ($r_s$=0.182). In younger children, a higher variability of the PBS score was found. Previous study reported that the balance test was mastered by girls, ($t$(391)=-2.07, p=0.039) while boys scored better in figure-8 dribbling test ($t$(350)= -5.02, p<0.001).[14] Even though it is understood that older children perform better in balance test, there is still limited understanding on the relationship between anthropometric data and the balance skills of preschool children.[8]

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To date, there is no information on the balance and motor skills among healthy preschool children in Malaysia. Motor development varies among children from different regions.[15] There are also limited facts regarding the relationship between anthropometric data, balance skills and motor skills status among healthy preschool children. Hence, the main aims of this study was to measure anthropometric measures, static and dynamic postural balance, gross and fine motor skills and examine their correlation among healthy preschool children aged 3 to 4 years old.

## MATERIALS AND METHOD

This cross sectional study was carried out at Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia. The participants were healthy preschool children aged between 3-4 years old, recruited from PERMATA preschools at Putrajaya and Dengkil. The children were excluded if they were younger than 3 years old and older than 4 years old, unable to follow commands in Bahasa Malaysia, English or Mandarin, and diagnosed with any disability or illness by a pediatrician. Demographic data of the children and parents were taken and recorded.

Gross and fine motor skills were assessed using 7 tests from Peabody Developmental Motor Scale 2nd edition (PDMS-2),[16] that included standing on tip toes, running speed and agility, buttoning, unbuttoning, touching fingers, building tower and stringing beads. The PDMS-2 tests were performed once based on its purchased protocol. These tests are suitable to determine motor skills level of children from 0-83 months and are reported to help in detecting small changes in their motor development.[17] PDMS-2 is reported to have excellent test–retest [ICC=0.923], inter-rater [ICC=0.972], and intrarater [ICC=0.896-0.998] reliability.[17] During the test, the children were requested to perform certain movements or tasks with the same trained final year physiotherapy undergraduates rating the same tasks according to the score criteria for all children. Children who were able to complete the motor tasks were given a score of 2, a score of 1 if they partially completed the tasks and a score of 0 if they were unable to perform the tasks.

Balance skills was assessed using the Pediatric Balance Scale (PBS) that consisted of 14 subtests which included sitting to standing, standing to sitting, transfer, standing unsupported, sitting unsupported, standing with eyes close, standing with feet together, standing with one foot in front, standing with one foot, turning 360 degrees, turning to look behind, retrieving object from floor, placing alternative foot on stool and reaching forward with outstretched arm.[18] Score from 0-4 on the children' performance was rated as in the PBS sheet[18] by the same physiotherapy assistants for all children. The best performance of three trials was taken as the score. PBS has been reported to have a good internal consistency, [Cronbach α=.89–.97], test-retest [ICC=0.82-0.93] and inter-rater reliability[0.96-0.99] when used with school-age children with mild to moderate motor impairments.[18]

Prior to the tests, participants' parents were given verbal and written information on the study procedures and consent was obtained. Ethical approval was obtained from the Secretariat for Research and Ethics of Universiti Kebangsaan Malaysia.

### Analysis

The data was analyzed using Statistical Package for Social Sciences version 19.0. Descriptive data was presented using mean and standard deviations. Between-gender comparisons were done with the use of Mann-Whitney U test. Spearmans correlation coefficient was used to examine the correlation between the score of the anthropometry data, motor skills and balance.

## RESULTS

A total number of 49 children (30 boys, 19 girls) aged between 3 to 4 years old were involved in this study. Table 1 shows the descriptive data of the participants. Table 2 shows the correlation between anthropometric data with motor skills (PDMS-2) and balance (PBS) scores. Spearman correlation test was used to analyse the data as the data were not normally distributed.

The subjects' height was positively correlated to their weight($r=0.39$, $p=0.05$), which means shorter children had lesser body weight. The height was significantly correlated with the total score of PBS($r=0.45$, $p=0.01$). Taller children had better performance in the PBS. Besides, the children with heavier body weight had larger BMI ($r=0.77$, $p<0.01$). There was a negative correlation between BMI and the total score for PBS ($r=-0.47$, $p<0.01$). Children with lower BMI, scored better in the balance test. There were no significant correlation between time spent on physical activities, with motor skills and balance skills.

Mann-Whitney U test showed that there was no significant difference between the boys and girls in terms of the motor skills ($p=0.33$) and balance skills ($p=0.72$). Hence, the data is depicted by combining the data of both boys and girls.

**Table 1:** Demographic data of the participants

| | **Mean(Standard Deviation )** | **Range** |
|---|---|---|
| **Height (cm)** | 97.31±5.34 | 91.9 -102.6 |
| **Weight (kg)** | 14.72±3.58 | 11.14-18.30 |
| **Body Mass Index(kg/m²)** | 15.59±3.90 | 11.69-23.39 |
| **Pediatric Balance Scale** | 49.35±3.96 | 33-56 |
| **Peabody Developmental Motor Scale** | 10.29±1.74 | 3-12 |

**Table 2**: Correlation between anthropometric data, motor skills (PDMS-2) and balance (PBS) total scores.

| | Height (cm) | Weight (kg) | BMI (kg/m2) | Motor Skills(PDMS-2) | Balance Score (PBS) |
|---|---|---|---|---|---|
| Height (cm) | 1.00 | .39** | -.19 | .08 | .45** |
| Weight (kg) | - | 1.00 | .77** | .06 | -.17 |
| BMI (kg/m2) | - | - | 1.00 | -.06 | -.47** |
| Motor Skills(PDMS-2) | - | - | - | 1.00 | -.11 |
| Balance Score (PBS) | - | - | - | - | 1.00 |

**correlation is significant at the level of 0.05

## DISCUSSION

This study provided information regarding balance and motor skills among preschool children aged 3 to 4 years old. The results demonstrated that there were no significant correlation between balance and motor skills among preschool children aged 3 to 4 years old (Table 2). Height was found to be positively correlated with balance. BMI was negatively correlated with balance.

In present study, mean total score of the PBS was 49.35 ± 3.961, where the minimum score achieved was 33 and the maximum score was 56. Earlier study reported that the mean PBS total score was 46.0±6.55 with total PBS score range of 28 to 53 for children aged 3 years to 3 years 5 months old.[8] As for the children aged 3 years 6 month old to 3 years 11 months old, mean PBS total score was 48.5±5.02, total score ranged from 30 to 54.[8] The mean PBS total score in present study was slightly higher than the previous study.[8] One of the possible reasons may be due to the fact that children in present study had lower mean BMI compared to the previous study.[8]

Positive correlation between height and total score of PBS is consistent with the results of other studies.[8,9] Balance performance using PBS was reported to have a moderate correlation (r=0.650) with height in children aged 2 years 4 months to 13 years 7 months.[8] Height was also found to be significantly correlated to Functional Reach Test which is a dynamic balance test, Timed Up and Go, and the Bruininks Oseretsky Test of Motor Proficiency Running Speed and Agility performed in children aged 5 to 13 years old.[9]

PBS scores were also negatively correlated with the children's BMI in the present study. This results are corroborated with previous studies in children between age 5 to 21 years old using Bruininks Oseretsky Test of Motor Proficiency and Movement Assessment Battery for Children.[19,20,21] Although small, significant correlation (r=0.182) was also demonstrated between BMI and PBS score in a wider range age of children.

The score gained, ranged from 3 to 12 marks for the total 7 motor test administered (5 fine motor and 2 gross motor). Approximately 30% of the children scored 11 marks out of 14. Comparison of these results with other studies is not suitable. Only few PDMS-2 subtests were administered instead of the entire PDMS-2 which consists of 151 gross motor tests and 98 fine motor tests. The assessment of fundamental movement skills (FMS) among children aged 3-5 years old was done using Test of Gross Motor Development II (TGMD-2).[22]The researchers reported that

mean locomotor score for boys and girls aged 3-5 years old was 20.24±7.72 and 26.38±7.5 respectively. Mean object-control score for the boys was 20.60±6.14, 22.0±6.8 for the girls. Eight FMS (4 locomotor and 4 object control skills) of 425 children aged 3.0-10.11 years old was assessed using TGMD-2.[23] Mean total FMS score for boys and girls were 42.83±1.50 and 42.64±1.19 respectively.[23]

There was no significant correlation recorded between BMI and gross and fine motor skills in the present study. Similarly, BMI was found to be not correlated with motor fitness in children aged 6 to 12 years old.[12] In contrast, BMI of children and adolescents aged 9-19 years old was shown to have significant correlation with fundamental motor skills (9-10 years old boys OR=2.32, Girls OR=2.48) and locomotor skills (9-10 years old boys OR=3.14, girls OR= 3.26).[24]The difference in age group and different motor test that was administered in these studies may be the reasons for the contrary result.

Height and weight were reported to be predictors for balance using Functional Reach Test among children aged 3-5 years old without known disability.[25] In addition, weight was the only significant predictor for the functional reach performance in 3-5 years old children.[25] Weight was also found to the strongest predictor for balance among 3-4 years old children, but no anthropometric data emerged as significant predictors for balance for 5 year old children.[25] Increased BMI caused increased in postural instability.[26] One would respond slower to external perturbation if their body mass was increased by 20%. No significant differences of gender were demonstrated on balance, gross and fine motor skills. These results are supported by results of other similar studies in children. Gross and fine motor skills test selected from Bruininks Oseretsky Test of Motor Proficiency and balance was also found to have no significant difference among gender in children.[27] Similarly, no correlation was demonstrated between gender and balance measured using Functional Reach Test in children aged 3 to 5 years old.[25] Moreover, it was suggested that there was no significant difference among the boys and girls in the balance skills tested using straight leg raise test and tandem walking, selected from Movement Assessment Battery for Children test.[28]

On the contrary, in a different age groups some studies reported that girls aged between 7-14 years old performed better than the boys in the balance test.[14,29,30,31] Girls were reported to have better balance skills while boys had better manipulation skills among children aged 4.5 to 6 years old.[2,14] These studies suggest that there may be gender differences in the balance and motor skills among older children.

This study adds to the controversial results in the literature regarding gender differences in balance and motor skills among children. The possible reasons for conflicting findings regarding this matter may be the different age groups of children and outcome measures used in the various studies. In support of this, there was no significant correlation between gender and the timed motor performance.[32] It was deduced that both boys and girls have similar physical and biological characteristics during the pre-puberty period in early childhood.[33] This may explain the present study results demonstrating no significant difference between gender among preschool children on their balance and motor skills.

The results of this study should be applied with caution as the sample size is considered to be small for such studies, and it is localised to children in only one geographical area. However, this is the first study to provide information regarding correlation between balance using PBS and motor skills in children aged 3 to 4 years old. We found that PBS was feasible to be used for children aged 3 to 4 years old. Future similar studies should consider testing the reliability of PBS among children aged 3 to 4 years old. Also larger sample size with normally distributed ethnicity is recommended for representation of balance and motor skills of Malaysian children. Further studies should also be considered to investigate the influences of other factors such as cognitive, mental and behavioural on balance and motor skills of children.

## CONCLUSION

In conclusion, this study suggests that balance skills in healthy preschool children aged 3-4 years old are correlated with their physical growth such as height and weight. However, no significant correlation was demonstrated between balance and motor skills in these children. The data of this study may be beneficial as reference for health care professionals in Malaysia when assessing the Malaysian children for developmental delay. Clinically, similar balance training can be utilized in children aged 3-4 without considering gender differences.

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