InjET

International Journal of Education and Training
http://www.injet.upm.edu.my

Effects of Fundamental Motor Skill Intervention on the Development of Locomotor Skills, Object Control Skills and Gross Motor Skills among Ten-Year-Old Children

Norfaridah Mohamad Khannas, Borhannudin Abdullah & Mohd Rozilee Wazir Norjali Wazir

Department of Sport Studies, Faculty of Educational Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

ABSTRACT

This study is aimed at determining the effects of an intervention program on the developmental level of locomotor skills, object control skills, and gross motor skills of ten-year-old urban children. The design of this study was quasi-experimental pre- and post-test for a balanced group. Stratified random sampling and simple random sampling were used to select a total of 60 Year 4 students in the urban school category. The treatment group used an intervention program based on fundamental motor skills, while the controlled group used a regular physical education program. Data on locomotor skills, object control skills, and gross motor skill development were obtained from video recordings using the Test of Gross Motor Development Second Edition (TGMD-2) instrument. Results of the Multivariate Analysis of Variance (MANOVA) showed that there was no significant difference for the mean of gross motor developmental quotient (GMDQ) for the pre-test, while the post-test reported a significant difference for the mean of GMDQ between the treatment and controlled groups. The analysis revealed that there were significant differences for the three dependent variables during the post-test, namely GMDQ, age equivalent locomotor (AEL), and age equivalent manipulative (AEM). Pairwise comparison analysis showed that the mean of the treatment group significantly exceeded the mean of the controlled group in GMDQ, AEL, and AEM scores. The intervention program based on fundamental motor skills contributed 38% in improvement in the developmental level of gross motor skills of the treated children. The intervention programs as a reference source for teachers to improve the development of children's gross motor skills.

Keywords: Locomotor Skills, Object Control Skills, Gross Motor Development, Fundamental Motor Skills

INTRODUCTION

Motor development is a behavioral change that occurs progressively throughout one's life cycle (Goodway et al., 2019). According to Slotte et al. (2017), motor development refers to the movement patterns and motor skills of children and differs according to the process they go through. Gross motor movement is a movement skill that involves force and uses more than one large muscle, such as throwing an object. Gross motor development is a process of change that occurs continuously. It can be seen in movement behaviors, namely, running, jumping, kicking, hitting, etc. (Lubans et al., 2010). Gross motor skills are also known as basic movement skills that refer to locomotor skills, object control skills (manipulative), and stability (balance). Locomotor skills include running, kicking, and jumping. Object control skills are like bouncing, catching, and kicking a ball (Logan et al., 2018).

The beginning of a child's development is through basic motor skills, whereby children can explore their potential through space (locomotor) and increase their ability to control objects (manipulative). Basic motor skills are more toward the improvement of skills in various movement situations. Children's motor abilities are enhanced through a variety of basic movements to achieve their success to more specific movement phase levels (Goodway et al., 2019).

* Corresponding author: faridahkhannas@gmail.com
eISSN: 2462-2079

The Physical Education Primary School Standard Curriculum is formulated so that students can perform basic skills with the correct behavior according to the concept of movement, develop abilities in motor skill movement, and identify the correct limb position while performing movements (Department of Curriculum Development, 2018). The Primary School Standard Curriculum for Physical Education aims to build students into fit and healthy individuals as well as skilled, knowledgeable, and practicing good values through physical activities toward well-being (Ministry of Education, 2013).

According to Muhammadi et. al., (2018) motor development programs have a greater impact on the improvement of object control compared to school activities. The researchers found specific leg exercises can build improvement in leg movement patterns to more specific ones. The study is in line with the study conducted by Deli et al., (2006) also found that interventions in the form of music and movement programs can improve children's performance in running, jumping, standing long jump, and the side-legged jump.

The development of locomotor and object control skills of children should be at a good level (Ulrich, 2000). The study seeks to detect whether there are development and improvement of gross motor skills in children's ability to perform locomotor activities and object control skills according to their age. Gross motor development should be carried out in chronological age (Ulrich, 2000).

The quality of life of the people in Malaysia also affects the growth of children's physical development in a place where urban area is a gazetted area with a population of 10,000 people or more and rural areas have a population of fewer than 10,000 people and the areas are not gazetted (Department of Statistics Malaysia, 2019). Draper et al. (2012) found that the level of development of basic motor skills of seven, eight, and nine-year-old rural children is better than that of urban children. The findings of this study are also supported by Singh and Lian (2018) who discovered that there are differences in gross motor skills of rural and urban seven-year-old children, whereby the mean of rural children is higher than the mean of urban children. This indicates that the gross motor skills of urban children are at a low level.

The results of a study by Asraff & Halijah (2019) found that there was no significant difference for the level of gross motor development (GMDQ) of indigenous children aged ten years in Kelantan and Johor. The study also showed that fourth-year subjects in Kelantan experienced very significant problems compared to Johor in the three main variables of the study, namely locomotor standard score (LSC), manipulative standard score (MSS), and gross motor development quotient (GMDQ). Researchers recommend intervention programs for urban, rural and indigenous children.

Studies on the development of locomotor and object control skills in Malaysia are still lacking for the age category of ten years old. Most of the studies conducted are focused on pre-school and early school children. Therefore, the focus of the current study is to determine the effects of an intervention program based on fundamental motor skills on the developmental level of gross motor skills of ten-year-old urban children. The objective of the study is to identify the effects of an intervention program on the developmental level of locomotor, object control and gross motor skills of the treatment group and controlled group among ten-year-old urban children.

MATERIAL & METHODS

This study used a ten-week quasi-experimental method involving pre-test and post-test (White & Sabarwal, 2014). The fundamental movement skills-based module was selected as the intervention program for the treatment group, while the controlled group used a regular physical education teaching module. The fundamental movement skills- based module training content in the intervention program followed the guidelines by Gallahue et. al., (2019) implemented for eight weeks. Each training session lasted for 30 minutes. Each activity carried out includes fundamental motor skills and small side games. Both groups were taught by teachers of the same physical education subject. This study employed simple stratified and random sampling methods involving ten -year -old subjects of 69 people and the division is made according to zones, states, districts and schools. Pre-tests were conducted for the three categories of schools (urban, rural and indigeneous), after which the researcher will analyze the data to find out the school categories that show low levels in gross motor skills. School categories that show low levels in gross motor skills will be given the intervention. Next 60 students were randomly selected for the study group. A total of 30 students were involved in the treatment group and another 30 students were included in the controlled group. Pre-test and post-test were implemented again for the students involved in this study.

The Test of Gross Motor Development Second Edition (TGMD-2) was chosen as the measurement instrument in this study because it is suitable for the age category of the selected study sample. TGMD-2 is a gross motor skill development test for children aged three to ten years and eleven months. Through the TGMD-2 test, gross motor development that is slower than the supposed age can be identified (Ulrich, 2000). Locomotor skills test

items consisted of running, juggling, side-legged jumping, bouncing, standing long jump, and side running. While the test items of object control skills included hitting a stationary ball on a tee, bouncing the ball, catching the ball, kicking the ball, throwing the ball, and rolling the ball. Each test item was given two trials for each study subject. Instructors performed a demonstration for each skill test assessed before the test was conducted. Scores were assessed based on the existence of criteria in the conduct of the study subjects. Each skill had a specific behavioral component that comprised several performance criteria. Each successful criterion shown in the subject's behavior would be given a score of "1", while a score of "0" was for the failure criterion. These scores were then summed to obtain a raw score of each component of locomotor and object control skills. The raw score subtests were converted to standard scores, age equivalent scores, and gross motor scores based on their respective norms.

Video recordings were made for each treatment in each test. Skill behavior data were obtained from the video recordings by using a Sony Handycam. The recording editing process was carried out via a Sony Vaio laptop with Windows Movie Maker software. All 12 gross motor skills tested were included in one file for each study subject according to the study subject group. The intervention program was the main thrust of this study. In this program, all the basic movement skills were collected and used as training sessions. The training content in the intervention program among ten-year-old urban children according to the guidelines set by Goodway et al. (2019) was implemented for eight weeks. The Physical Education Teaching Guide was developed based on the Physical Education Primary School Standard Curriculum by the Ministry of Education Malaysia. It was designed to provide equivalence of activities to develop gross motor skills in line with the proposed intervention program.

Multivariate Analysis of Variance (MANOVA) and Multivariate Analysis of Covariance (MANCOVA) were conducted to observe the effects of the implementation of the intervention program. The MANCOVA analysis pre-test was used to control for scores of both groups showing no difference before the intervention.

RESULTS

Effects of the intervention program on the level of gross motor development, age equivalent locomotor skills, and age equivalent object control skills of ten-year-old urban children.

Pre-test MANOVA Analysis

Overall, the results of Wilks' Lambda Multivariate Test (Table 1) showed no significant difference between the treatment group and the controlled group during the pre-test. Based on these results, it was reported that there was no significant difference for the mean of gross motor development Wilk's $\lambda = 0.98$, $F(3,56) = 0.39$, $p>0.05$, multivariate $\eta 2 = 0.021$ between the treatment group and the controlled group.

Univariate F-test analysis revealed that there was no significant difference in the pre-test scores for the three variables, namely gross motor developmental quotient (GMDQ) [$F(1,58) = 0.20$, $p>0.05$, eta squared = 0.003], age equivalent locomotor (AEL) [$F(1,58) = 0.99$, $p>0.05$, eta squared 0.17] and age equivalent manipulative (AEM) [$F(1,58) = 0.09$, $p>0.05$, eta squared = 0.002].

TABLE 1
MANOVA Analysis of Pre-test and Post-test for Groups Gross Motor Skills

Groups (n=60)		Pre-test			Post-test		
No.	**Constructs**	**F**	***η²***	***Sig.***	**F**	***η²***	***Sig.***
1	GMDQ	0.2	0.003	0.7	33.5	0.366	0.000
2	AEL	0.99	0.17	0.3	25.6	0.306	0.000
3	AEM	0.09	0.002	0.8	11.04	0.16	0.002
	Multivariate F	0.39			11.49		
	η^2		0.021			0.381	
	Sig.			0.8			0.000

Note. GMDQ=Gross motor development quotient, AEL=Age equivalence locomotor score,AEM= Age equivalence object control score.

Post-test MANOVA Analysis

Referring to Table 1, the overall results of Wilks' Lambda Multivariate Test showed that there was a significant effect of the intervention program on the gross motor skills of the study sample. Based on the results obtained, there was a significant difference for the mean of gross motor development Wilk's $\lambda = 0.62$, $F(3,56) = 11.49$, $p<0.001$, multivariate $\eta 2 = 0.381$ between the treatment group and the controlled group. The intervention program clarified 38.1% of the variance found in the combined mean of gross motor skills.

Univariate F-test analysis indicated that there was a significant difference in the post-test score for the dependent variables GMDQ [$F(1,58) = 33.5$, $p<0.001$, eta squared = 0.366], AEL [$F(1,58) = 25.6$, $p<0.001$, eta squared = 0.306], and AEM [$F(1,58) = 11.04$, $p<0.01$, eta squared = 0.16] for both the treatment and controlled groups.

Post-test pairwise comparison analysis was conducted to identify mean pairs that showed significant differences for the treatment group and the controlled group. Referring to Table 2, the findings indicated that the treatment group significantly outperformed the controlled group in all variables, namely GMDQ (mean difference: treatment = 111.00, control = 95.10), AEL (mean difference: treatment = 10.30, control = 8.17), and AEM (mean difference: treatment = 10.68, control = 9.66). Table 2 also shows the mean difference of the treatment and controlled groups significantly in GMDQ (mean difference = 15.90, $p<0.001$), AEL (mean difference = 2.13, $p<0.001$) and AEM scores (mean difference = 1.01, $p<0.01$).

TABLE 2
Pairwise Comparison Analysis for Post-test

			Post-test		
No.	**Dependent variables**	**Treatment**	**Control**	**MD**	***Sig.***
1	GMDQ	111	95.1	15.90	0.000
2	AEL	10.3	8.17	2.13	0.000
3	AEM	10.68	9.66	1.01	0.002

Note: GMDQ=Gross motor development quotient, AEL=Age equivalence locomotor score, AEM= Age equivalence object control score, MD= Mean Difference.

MANCOVA Analysis of Gross Motor Development by Controlling Pre-test for the Study Groups

Based on the results of Wilks' Lambda Multivariate Test (Table 3), there was a significant intervention program effect for the mean of gross motor skill development Wilk's $\lambda = 0.60$, $F(3,55) = 12.07$, $p<0.001$, multivariate $\eta 2 = 0.397$ between the treatment group and the controlled group even after the pre-test scores were controlled. The intervention program clarified 39.7% of the variance found in the combined mean of the subjects' gross motor skill development. However, there was no effect of pre-test Wilk's $\lambda = 0.88$, $F(3,55) = 2.60$, $p>0.05$, multivariate $\eta 2 = 0.124$ on the gross motor development of the study subjects. on the gross motor development of the study subjects. The pre-test clarified only 12.4% of the variance found in the combined mean of the subjects' gross motor skill development. The results of this analysis indicated that the intervention program was factor in the gross motor development of the study subjects. It is reported that the intervention program was a factor in the gross motor development of the study subjects.

Univariate F-test analysis indicated that there was a significant difference for GMDQ (post) [$F(1,57) = 35.25$, $p<0.001$, eta squared = 38.2], AEL (post) [$F(1,57) = 25.45$, $p<0.001$, eta squared = 0.309], and AEM (post) [$F(1,57) = 10.67$, $p<0.01$, eta squared = 0.158] between the treatment and controlled groups. On the other hand, the pre-test scores also showed that there was a significant difference for one dependent variable, which was GMDQ (post) [$F(1,57) = 7.68$, $p<0.01$, eta squared = 0.119].

TABLE 3
MANCOVA Analysis of Gross Motor Development Based on Group by Pre-Test Control

		Groups		Groups (n=60)	GMDQ (Pre)
No.	**Variables**	**F**	η^2	**F**	η^2
1	GMDQ (post)	35.25**	0.382	7.68*	0.119
2	AEL (post)	25.45**	0.2309	3.40	0.056
3	AEM (post)	10.67*	0.158	2.49	0.042
	Multivariate F	12.07**		2.60	
	η^2		0.397		0.124

Note: GMDQ=Gross motor development quotient, AEL=Age equivalence locomotor score, AEM= Age equivalence object control score, *p<0.01, p<0.001**

Pairwise comparison analysis was conducted to identify mean pairs that showed significant differences for the mean of GMDQ (post), AEL (post), and AEM (post) for the treatment and controlled groups. Referring to Table 4, the mean of the treatment group significantly exceeded the mean of the controlled group for all dependent variables, namely GMDQ (post) (mean score: treatment = 110.78, control = 95.31), AEL (post) (mean score: treatment = 10.27, control = 8.19), and AEM (post) (mean score: treatment = 10.66, control = 9.68). The results of the analysis also showed that the mean of the treatment group significantly exceeded the mean of the controlled group in the scores of GMDQ (post) (mean difference: 15.47, p<0.001), AEL (post) (mean difference: 2.08, p<0.001), and AEM (post) (mean difference: 0.98, p<0.01). These results indicated that there was a significant effect of the fundamental motor skill intervention program in gross motor development between the treatment group and the controlled group by considering the pre-test scores.

TABLE 4
Pairwise Comparison Analysis for Post-test

		Post-Test			
No.	**Dependent Variables**	**Treatment (Mean)**	**Control (Mean)**	***MD***	***Sig.***
1	GMDQ (post)	110.78	95.31	15.47	0.000
2	AEL (post)	10.27	8.19	2.08	0.000
3	AEM (post)	10.66	9.68	0.98	0.002

Note. GMDQ=Gross motor development quotient, AEL=Age equivalence locomotor score, AEM= Age equivalence object control score.

DISCUSSION

Based on the findings of the MANOVA test, there was no significant mean difference of age equivalent locomotor skills score (AEL) and age equivalent object control skills score (AEM) between the treatment and controlled groups for the pre-test. The post-test results reported that there were significant mean differences between the treatment group and the controlled group. This explained that early intervention through an intervention program based on fundamental motor skills could help to improve the gross motor skills of the study subjects. These findings are in line with Costello and Warne (2020) who found that ten-year-old children of the treatment group involved in the basic motor skill intervention for four weeks experienced an improvement in basic motor skills as compared to the controlled group. This suggested that teachers should use the same method in teaching fundamental motor skills in a focused manner by diversifying activities to improve different skills.

Furthermore, the findings also showed that the treatment group significantly outperformed dependent variables gross motor development quotient, age aquivalence locomotor score and age aquivalence object control score as compared to the controlled group after the implementation of the intervention program. This is in line with a study conducted by Burns et al. (2017), which found that physical training programs based on gross motor skills improved motor skills at the age of six to twelve years old, which was 72.6% during the first test and then 82.4% for the test conducted after the intervention.

This intervention program also made a significant contribution to the age equivalent scores of locomotor skills and object control skills. The fundamental motor skill intervention program conducted helped to increase the age equivalent locomotor skills score of the treatment group by 4.48 years, while the controlled group using the

regular physical education program only increased by 2.65 years. There was also an increase for the treatment group in the age equivalent object control skills score of 4.44 years as compared to the controlled group with an increase of 3.35 years only. These findings are consistent with other studies by Aalizadeh et al. (2014) and Draper et al. (2012), which noted an improvement in locomotor and object control skills through interventions for the treatment group. Additionally, this study is in line with the study conducted by Abdullah et al. (2013), in which children's gross motor skills can be improved through organized and planned interventions.

The results of the study also reported that the fundamental motor skill intervention used was successful because it could demonstrate a very significant increase in age equivalent scores of locomotor and object control skills for the treatment group as compared to the controlled group using regular physical education programs. In addition, this intervention program can help reduce the delay of locomotor skills and object control skills scores, whereby after the treatment group implemented this fundamental motor skill intervention program, they were at the appropriate chronological age scores for locomotor and object control skills, as compared to the controlled group. Small games inserted into the program in each activity could potentially increase the fun and improve children's gross motor skills. The concept of teaching and learning via teaching games for understanding (TGFU) was included in the intervention program. According to Butler (2006), TGFU is a game teaching approach for comprehension that can attract children's interest and attention either inside or outside the classroom.

In addition to the intervention program factors, other factors influenced the findings of the study. The statistically controlled pre-test score factor helped to determine the main effect in this study. The results of the MANCOVA analysis showed that there was no significant effect on the mean of gross motor development between the treatment group and the controlled group after the pre-test factors were controlled. The fundamental motor skill intervention program accounted for 39.7% of the variance found in the combined mean of gross motor development of urban children after taking pre-test factors into account. This proved that the intervention program based on basic movement skills is a strong contributor to the improvement of the level of gross motor development of the study groups. Sultoni et al. (2018) reported a parallel finding that fundamental development programs affected the development of motor skills in Indonesia.

CONCLUSIONS

The intervention program based on fundamental motor skills is appropriate and can be used to improve the level of development of gross motor skills in children. Activities arranged according to the criteria required in each skill resulted in improvements to the skills and matched the chronological age of the children. The intervention program also provides small games to increase interest and enjoyment in a skill being taught. This aspect directly impacts to the development of the cognitive, psychomotor, and affective aspects of children.

The delay in urban gross motor development in this study was not surprising because the study groups were not exposed and experienced with gross motor skills before the intervention was implemented. As a result of the reports received by the researchers, the teachers said they were not given specific exposure to the children's gross motor skills. The study subjects stated that they had limited time to play outside of school hours due to several factors such as attending religious school and extra classes. On the other hand, according to Raudsepp and Päll (2006), children's participation in physical activities outside of school sessions is particularly important because there is a strong correlation between school physical activities and children's locomotor skills. Therefore, the ministry needs to provide specific exposure to children's motor skills to all physical education teachers. In addition, parents need to be exposed to the importance of gross motor skills so that the level of development of children is in line with their age and will indirectly attract their interest in sports.

The contribution of this intervention as a reference source for teachers to improve the development of children's gross motor skills. In addition, it can also be applied into lesson plans for the improvement of teaching and learning of Physical Education in improving children's gross motor skills. The results of this study can also provide new experiences to children on locomotor movement skills and object control movements. It can also improve the development of children's motor skills and attract interest to engaging in sports and active lifestyle.

REFERENCES

Aalizadeh, B., Mohamadzadeh, H., & Hosseini, F. S. (2014). Fundamental movement skills among Iranian primary school children. Journal of Family & Reproductive Health, 8(4), 155–159.

Abdullah, B., Amri, S., Yee, K. L., & Abu Samah, B. (2013). The impact of traditional games on the gross motor skill development of an early childhood. The Social Sciences, 8(6), 590–595.

Burns, R. D., Fu, Y., Fang, Y., Hannon, J. C., & Brusseau, T. A. (2017). Effect of a 12-week physical activity program on gross motor skills in children. Perceptual and Motor Skills, 124(6), 1121–1133.

Butler, J. I. (2006). Curriculum constructions of ability: Enhancing learning through Teaching Games for Understanding (TGfU) as a curriculum model. Sport, Education and Society, 11(3), 243–258.
Costello, K., & Warne, J. (2020). A four-week fundamental motor skill intervention improves motor skills in eight to 10-year-old Irish primary school children. Cogent Social Sciences, 6(1), 1724065.
Deli, E., Bakle, I., & Zachopoulou, E. (2006). Implementing intervention movement programs for kindergarten children. Journal of Early Childhood Research, 4(1), 5–18.
Department of Curriculum Development (2018). Ministry of Education.
Department of Statistics Malaysia. (2019). Population projections, Malaysia. Department of Statistics Malaysia.
Draper, C. E., Achmat, M., Forbes, J., & Lambert, E. V. (2012). Impact of a community-based programme for motor development on gross motor skills and cognitive function in preschool children from disadvantaged settings. Early Child Development and Care, 182(1), 137–152.
Goodway, J. D., Ozmun, J. C., & Gallahue, D. L. (2019). Understanding motor development: Infants, children, adolescents, adults (8th ed.). Jones & Bartlett Learning.
Logan, S. W., Ross, S. M., Chee, K., Stodden, D. F., & Robinson, L. E. (2018). Fundamental motor skills: A systematic review of terminology. Journal of Sports Sciences, 36(7), 781–796.
Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents. Sports Medicine, 40(12), 1019–1035.
Ministry of Education. (2013). Malaysia Education Blueprint 2013–2025. Ministry of Education. http://www.moe.gov.my/cms/upload_files/articlefile/2013/articlefile_file_003108.pdf.
Mohammadi, M., Ghadiri, F., Bahram, A., & Abadi, Z. M. S. (2018). Effect of Gallahue Model-based Developmental Exercises on Quantitative and Qualitative Development of Fundamental Kicking Skill. International Journal of Contemporary Applied Researches, 5(1), 106–115.
Raudsepp, L., & Päll, P. (2006). The relationship between fundamental motor skills and outside-school physical activity of elementary school children. Pediatric Exercise Science, 18(4), 426–435.
Singh, Y. K. M., & Lian, D. K. C. (2018). Gross motor development level amongst school children of Kuala Pilah, Negeri Sembilan. Malaysian Journal of Movement, Health & Exercise, 7(1), 129–143.
Slotte, S., Sääkslahti, A., Kukkonen-Harjula, K., & Rintala, P. (2017). Fundamental movement skills and weight status in children: A systematic review. Baltic Journal of Health and Physical Activity, 9(2), 115–127.
Sultoni, K., Suherman, A., & Wibowo, R. (2018). Increasing Gross Motor Skill Through Fundamental Skill Development Program. ACTIVE: Journal of Physical Education, Sport, Health and Recreation, 7(1), 39–43.
Ulrich, D. A. (2000). Test of Gross Motor Development 2nd ed. Examiner's Manual. Pro-Ed.
White, H., & Sabarwal, S. (2014). Quasi-experimental design and methods. Methodological Briefs: Impact Evaluation, 8, 1–16.