FITNESS, PERFORMANCE AND HEALTH JOURNAL
2024; 3(1): 82-88
Published online 05 28 2024 (https://todoxpublisher.com/index.php/fphj/index)
doi: https://doi.org/10.53797/fphj.v3i1.10.2024
e-ISSN 2821-3785

Correlation Analysis Between Locomotion Skills and Other Four Types of Motor skills in Children aged 3-6

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To Cite This Article: Jiang, W. M., You, M., Alhussin Alali, A., Ayubi, N., Baki, M. H. ., & Mohamad, N. I. (2024). Correlation Analysis Between Locomotion Skills and Other Four Types of Motor skills in Children aged 3-6. *Fitness, Performance and Health Journal*, *3*(1), 82–88. https://doi.org/10.53797/fphj.v3i1.10.2024

ABSTRACT The purpose of this study is to analyze the correlation between children's locomotion skills and four other types of motor skills (stationary performances, object manipulation, grasping and visual-motor integration). The study participants were 343 children aged 3-6 randomly recruited from the Children's Motor Ability Center in Chengdu, China. Peabody Developmental Motor Scale-2 (PDMS-2) was used to assess motor skills. Correlation of Inferential statistics was applied to analyze the correlation. Pearson correlation analysis ($p<0.001$) was used to show the correlation level. The results showed that children aged 3-6 years old had a strong correlation between locomotion skills and stationary performances, a moderate correlation with object control skills, and a moderate correlation with grasping skills. There was a strong correlation with visual-motor integration skills. The conclusion is that children aged 3-6 years old have a moderate or above correlation between locomotion skills and the other four types of motor skills. Future research should consider incorporating stationary performances, grasping, and visual-motor integration skills in the design of motor skill intervention programs to maximize the effectiveness of interventions for young children. Ultimately, focusing on a comprehensive approach to motor skill development will lead to better outcomes for children's motor performance and overall well-being.

Keywords: Motor Skills, Locomotion, Stationary Performances, Object Manipulation, Grasping, Visual-motor Integration.

1 INTRODUCTION

Children's motor skills include gross and fine motor skills (Valadi & Gabbard, 2020). Gross motor skills are categorized into stationary performances (SP) skills, locomotion (LM) skills, and Object Manipulation skills (OM) (Veldman, et al 2023), while fine motor skills are categorized into grasping (G) and visual-motor integration (VM) (hand-eye coordination) skills (Strooband, 2021), There are five categories in total. Children's motor skill development is most important between the ages of three and six (Bolger, et al 2021). Children's physical activity at this age is greatly influenced by their level of motor skill development, the more developed a child's motor skills, the more active the child will be (Palmer, et al 2019). Furthermore, the degree of motor skill development in children has a significant impact on their health, and the development of strong motor skills in this age group has a significant impact on the health of children in the course of their future growth (Barnett, et al 2022).

In particular, of the five categories of motor skills, locomotion skills develop rapidly in children aged 3-6 years and have been an important content for researchers' intervention

programs. Locomotion abilities were the focus of almost all of the earlier research on children's motor skill intervention programs (Jones, 2011; Bardid, 2017; Palmer, 2019; Brian, 2023), which were followed by object control skills. Nevertheless, intervention programs frequently exclude fine motor skills including postural control, grasping and visual-motor integration (hand-eye coordination). Therefore, how do locomotion skills connect to other types of motor abilities, and is it feasible that emphasizing locomotion skills in intervention programs can enhance children's total motor skills? The main purpose of this study was to analyse the correlations between locomotion skills and the other four types of motor skills (stationary performances, object manipulation, grasping, visual-motor integration) of children aged 3-6 years old. And to provide future researchers with new ideas for designing more effective and comprehensive motor skills intervention programs for children aged 3-6 years old. This will help children's parents and coaches to better understand the importance of developing young children's locomotion skills, as well as to further think about how to effectively and comprehensively promote children's motor skill development.

2 METHODOLOGY AND EQUIPMENT

Participants

All participants, aged 3-6 years, were from the Children Sports Ability Centre in Chengdu, Sichuan Province, China. Random selection was made at the centre through recruitment. All children at the centre underwent a standard physical examination as well as disease and injury history questioning before starting motor skills test. And disease and injury history enquiry and recording were done before starting data collection. Volunteers undergoing acute or chronic cardiovascular, pulmonary, or metabolic therapy were excluded. Volunteers with developmental delays, as well as dyspraxia, and a history of sports injury within the last 1 year were excluded. A total of 343 children aged 3-6 years were randomly recruited for this study (Table 1). The study was conducted at the centre. Written informed consent for the study was obtained from the parents or legal guardians of the volunteers. The study was approved by the Research Ethics Committee of the Centre.

Equipment

Body height and body weight assess equipment: All of the participants' body height and body weight were tested using the National Physical Fitness Monitoring All-in-One Machine from China.

Motor skills assessment: Motor skill development level of all the participants was assessed by Peabody Developmental Motor Scale-2 (PDMS-2). This assessment can conduct a comprehensive gross motor skills test as well as a fine motor skill test for children aged 0-72 months. This test has strict testing standards. For detailed evaluation, please refer to PDMS-2 Operation Manual (Folio & Fewell, 2000).

Data Analysis

In this study, the body height and body weight of 343 children aged 3-6 years old were analyzed using descriptive statistics for basic anthropometrics. Correlation of Inferential statistics was applied to analysis the correlation between locomotion (LM) and the other four types of motor skills stationary performances (SP), object manipulation (OM), grasping(G), visual-motor integration (VM), Pearson correlation analysis ($p<0.001$) was used to show the correlation level between locomotion (LM) and the other four types of motor skills.

3 RESULTS

Statistical Results of Anthropometric Data for Participants

The following is a description of the anthropometric data of the participation in this study Table 1. It includes Body Height (BH), Body Weight, and Months Age (MA).

Table 1: Statistical Results of Anthropometric Data

Parameter	N	Range	Minimum	Maximum	Mean	SD
BH (cm)	343	31.50	89.50	121.00	102.62	5.83
BW (kg)	343	17.40	10.60	28.00	16.64	2.40
MA (month)	343	37.00	38.00	72.00	47.83	7.77

Table 1 descriptive statistics of the participants' anthropometric data demonstrates the standard deviation of the height data is (5.83 cm), with an average of 102.62 cm. between (89.50 cm), the lowest value, to (121.00) cm, the greatest value. The average weight is 16.64 kg, while the standard deviation is 2.40 kg. ranging from (17.40 kg), the lowest weight, to (28 kg), the maximum weight. The average age in months is (47.83), with a standard deviation of (7.77). The range of ages is 38 months for the minimum and 72 months for the maximum.

Correlation of Locomotion Skills and Other Four Types of Motor Skills

The correlations between Locomotion (LM) and the other four types of motor skills (Stationary Performances (SP), Object Manipulation (OM), Grasping(G), Visual-motor integration (VM) is presented in Table 2.

Table 2: Correlation of LM and SP/OM/G/VM

Parameter-1	Parameter-2	Pearson Correlation	Sig.
LM 164.63±9.29	SP 53.07±5.26	0.73***	0.000
LM 164.63±9.29	OM 37.09±5.28	0.64**	0.000
LM 164.63±9.29	G 48.89±3.01	0.60**	0.000
LM 164.63±9.29	VM 134.50±8.85	0.72***	0.000

Pearson Correlation level: ***mean strong correlation (0.7-0.99), **mean moderate correlation (0.4-0.69), *mean weak correlation (0.00-0.39).

Correlation of Locomotion (LM)and Stationary Performances (SP)

The first column of Table 2 presents the results of the correlation analysis result between locomotion skills (LM) and stationary performances (SP) skills. The results show a Pearson's correlation coefficient of 0.73, there is a significant correlation. According to the Pearson

correlation level, it is indicating that there is a strong correlation between locomotion skills (LM) skills and stationary performances (SP) skills.

Correlation of Locomotion (LM)and Object Manipulation (OM)

The second column of Table 2 presents the results of the correlation analysis result between locomotion skills (LM) and Object Manipulation (OM) skills. The results show a Pearson's correlation coefficient of 0.64, there is a significant correlation. According to the Pearson correlation level, it indicates that there is a moderate correlation between locomotion skills (LM) skills and Object Manipulation (OM) skills.

Correlation of Locomotion (LM) and Grasping (G)

The findings of the correlation study between grasping (G) and locomotor (LM) skills are shown in Table 2 third column. The findings indicate a substantial association, with a Pearson's correlation value of 0.60. Grasping (G) and locomotor skills (LM) skills have a moderate association, according to Pearson correlation level.

Correlation of Locomotion (LM)and Visual-motor integration (VM)

Table 2 displays the correlation analysis results between locomotion skills (LM) and visual-motor integration (VM) skills in the fourth column. A substantial correlation can be seen from the data, which indicate a Pearson's correlation coefficient of 0.72. According to the Pearson correlation level, it indicating that there is a strong correlation between locomotion skills (LM) skills and Visual-Motor integration (VM).

4 DISCUSSIONS

The results showed a strong correlation between locomotion skills and stationary performance skills. In terms of the need for movement performance in both types of motor skills. Moving from one place to another requires children to have some postural stationary in order to perform well in locomotion skills (Franchak, 2018; Payne & Isaacs, 2020). The higher the level of development of stationary performances of postural, the higher the children's motor performance in locomotion skills and the more pronounced the associated breakthroughs in motor performance (Anderson, 2018; Schmidt, 2019). Additionally, good stationary performance is important for reducing the risk of injury when performing locomotion skills (Pojskic, 2019; Diekfuss, 2021). For example, if a child is unable to control his or her posture during running, and his or her body wobbles and limb control is not accurate during running, his or her running speed will be affected and it will be difficult for him or her to break through. Moreover, the risk of fall injury during running will increase substantially. In the process of motor skills intervention for children, many researchers have not included children's stationary performance skills in the content of the intervention program (Jones.,2011; Bardid, 2017; Palmer, 2019; Brian, 2023). This would be a direction of improvement for subsequent researchers in the content design of motor skills intervention programs for young children.

The results show that locomotion skills are moderately correlated with object manipulation skills (Salaj & Masnjak, 2022). This is not in line with the expected strong correlation. It is well known that the level of development of locomotion skills is the basis for excellent motor performance in almost all motor skills (Grillner, & El Manira, 2019). Especially object manipulation motor skills. Object manipulation skills require children to control external objects while controlling the body to move rapidly (Lages, & Bowman,2018). The correlation between them suggests that when designing the intervention content, the researcher should design as much as possible independent training content for

targeted intervention, which is more able to achieve the training effect for both locomotion skills and object manipulation skills.

The results showed that locomotion skills were moderately correlated with children's grasping motor skills (Cools et al, 2009). This is inconsistent with the expected weak correlation. Children's locomotion skills are gross motor skills, which involve mainly large muscles (Izzati,2019; Gonzalez, 2019). Children's grasping skills are fine motor skills that involve mainly small muscles (Gonzalez, 2019). The two types of motor skills do not correspond to the same neural control mechanisms. Fine motor skills such as grasping are mainly controlled by higher nerve centre in the brain (Valyear et al, 2019). Gross motor skills such as locomotion skills are controlled by both the central nervous system and the peripheral nervous system (Hordacre, & McCambridge, 2018). The moderate correlation between locomotion skills and grasping skills demonstrated that both gross and fine motor skills are equally important in children's motor skill interventions. However, in previous studies, researchers have often omitted grasping skills from the design of motor skill intervention programs (Jones.,2011; Bardid, 2017; Palmer, 2019; Brian, 2023).

The results showed a strong correlation between locomotion skills and visual-motor integration skills (hand-eye coordination), which is not in line with the expected weak correlation. Like grasping skills, visual-motor integration skills are fine motor skills that are controlled by the higher nervous system of the brain (Suggate, 2023). One of the reasons for the strong correlation between locomotion skills and visual-motor integration skills is that gross and fine motor skills tend to develop in tandem, and the better the development of gross motor skills, the higher the level of development of visual-motor integration skills (De Villiers, 2019). Another reason why visual-motor integration skills are also fine motor skills, but are more strongly correlated than grasping with locomotion skills, is that they require higher levels of visual system functioning (Oberer, Gashaj, & Roebers, 2018). Compared to simple grasping skills, locomotion skills and visual-motor integration skills require the visual system to quickly observe, analyse and make judgement about the object being viewed and the environment around, and to transmit effective information to the brain to allow the brain to make decisions and give commands quickly. This result has important implications for the design of intervention training methods for motor skills. Introducing visual-motor integration skills as a guiding principle in the design of training methods in traditional motor skills intervention programs may lead to faster and more effective improvement of children's locomotion skills.

5 CONCLUSIONS

In conclusion, the results of the study demonstrated the strong correlation between locomotion skills and stationary performance, object manipulation, grasping, and visual-motor integration skills in children aged 3-6 years old. The findings highlight the importance of including all these motor skills in intervention programs to enhance overall motor performance. The results also suggest that gross motor skills and fine motor skills develop in tandem, emphasizing the significance of addressing both types of motor skills in interventions. To optimize the efficacy of therapies for young children, future research should take grasping stationary performances, and visual-motor integration abilities into account when designing motor skill intervention programs. In the end, children's motor performance and overall well-being will benefit more from a comprehensive approach to motor skill development.

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