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The Effect of Early Exercise Interventions on Gross Motor Skills of Children with Preterm Birth Aged 3 to 6 Years

Musa Dehghan [1], Abdullah Ghasemi [1*], Ali kashi [2], Elahe Arabameri [3], Kayvan Molanorouzi [4]

1. Department of Motor Development, Science and Research Branch, Islamic Azad University, Tehran, Iran
2. Associate Professor of Motor Control and Learning Department, Sport Sciences Research Institude, Tehran, Iran
3. Associate Professor of Motor Behavior, Tehran University, Tehran, Iran
4. Department of sport Management, Islamshahr Branch, Islamic Azad University, Islamshahr, Iran

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Correspondence:

Abdullah Ghasemi,
Department of Motor Development, Science and Research Branch, Islamic Azad University, Tehran, Iran

Abghasemi@fullerton.edu

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Abstract

***Background and Objective*:** Human development is influenced by genetic, environmental, and social factors whose foundation is formed from infancy and childhood. Preterm birth and low birth weight are important issues that can affect the development and threaten the public health. The aim of this study was to investigate the effect of early exercise interventions on gross motor skills of children with preterm birth aged 3 to 6 years.

Material and Methods: In this Experimental study, 30 children with the average weight (2066 ±354g) were selected from the preterm infants (32 to 37 weeks less than 2500 g) admitted to NICU ward. They were divided into two groups (experimental group n=15 and control group n=15 children). To evaluate the gross motor skills of children, the second version of the Peabody developmental motor scale was used. The results were analyzed by SPSS using ANCOVA test ($p \leq 0.05$).

Results: The results of this study showed that early interventions can have a positive effect on the gross motor skills of these children and the participants in the experimental group were able to obtain higher scores than the control group after participating in the training program.

Conclusion: The results showed that training interventions have a significant effect on both stability and locomotion skills.

Keywords: Premature Birth [MeSH], Growth and Development [MeSH], Early Medical Intervention [MeSH], Locomotion [MeSH]

Highlights

- Early intervention is one of the most effective ways to compensate for the developmental delay of preterm infants.
- Eight weeks of training interventions had a positive and significant effect on the gross skills of premature children.
- The results showed that training interventions have a significant effect on both stability and locomotion skills.

Introduction

According to the studies done by the World Health Organization, about 25 million low birth weight babies are born each year worldwide; This means that one in six babies is underweight (1). Babies who are less than 37 weeks old at birth or weigh less than 2,500 grams are called "premature." Researchers divide premature infants into several categories based on birth weight and maternal gestational age. Children with low-birth-weight LBW (between 2500 and 1500 g), children with very low birth weight VLBW (between 1499 to 1000 g) and children with birth weight less than 1000 g ELBW. Based on gestational age, children are divided into three groups (between 32 to 37 weeks, 28 to 32 weeks of gestation and less than 28 weeks of gestation) (2).

Studies have shown that 55% of ELBW children or children of less than 28 weeks of pregnancy at the age of 8 suffer from neurobehavioral problems which vary from behavioral problems to severe disorders and cerebral palsy. It has also been shown that 15 to 20 percent of VLBW children have scored less than normal-born children from half to one standard deviation; this percentage is doubled in ELBW children (2, 3).

Growth and development are influenced by genetic, environmental and social factors and its most important and initial stage is formed from the embryonic and neonatal period. Premature birth and low birth weight are among the important issues that can affect the course of growth and development and threaten the health of society. Findings by Brown et al. (2013) (4), Anderson and Doyle (2003) (5), Joseph et al. (2016) (6) show that many low birth weight infants will experience motor, cognitive and sensory problems in the future. Undoubtedly, one of the world's problems is the existence of people with physical or brain injuries caused by premature birth or low birth weight; however, many of these disorders are not diagnosed in time, and it is in the condition that predicting late and long-term neonatal complications is an essential part in the continuous neonatal evaluation and care (7). Coparte, as a clinical psychologist, in his "Perceptual-motor theory" states that the development of perception and cognition have a common motor base; so that to reach full development of intelligence, the child must have reached the stage of generalized movement. Since the physical, intellectual and cognitive development of the child at the primary school age is the fastest, the children's adaptability is extraordinary and the child's motor experiences at this age are the basis of his later knowledge (1).

In addition to the above-mentioned points, it has been shown that premature infants have a higher rate of inattention and internalization of behaviors, and are weaker in adaptive skills than their natural peers (8). Various researchers in separate studies have shown that premature children have many problems such as disability, cerebral palsy, sensory disabilities, poor cognitive function, impaired organization of the brain topology, especially the communication capacity of brain networks, and experience simple movement problems (hitting coins on the wall, walking on the heel-toe, standing on the toe, and complex problems (coordination, balance, and manipulation skills) as well as poor performance in gross and fine motor skills (1, 9). It is noteworthy that the movement problems of these children continue until the school age and adulthood and affect school performance and their self-confidence (10).

Numerous interventions have been performed to support children with developmental delays. Some programs emphasize support of premature infants and their parents after hospital discharge (11). Another type of programmer is the mother-

child transition (12, 13). Sensory stimulation and gentle massage of the child by the mother or nurse (14- 16), atrial stimulation through the swing of water mattresses to stimulate the various senses (17) and also the use of play to compensate for the developmental delays in children (18, 19) are also some of the interventions done in this field.

Some studies in the field of motor development have pointed to the effectiveness of motor and behavioral interventions on accessibility skills (20), motor and behavioral performance, eye and hand coordination, and individual-social scales (9). It seems that the main issue regarding interventions is the critical age of nervous-motor system and motor skill development in early childhood (21).

Regarding the above points, and regarding the contradictory effects of activity-based interventions on children's motor development and the lack of sufficient studies on the effectiveness of exercise interventions on children with premature birth, the need is felt for early intervention in preschool and primary school ages. Therefore, this study was conducted to determine the effectiveness of exercise interventions on the gross skills of children with premature birth (between 3 and 6 years old).

Materials and Methods

The present study is a semi experimental one with a pre-test and a post-test along with a control group. The statistical population of the study consisted of premature 3 to 6-year-old children (<37 weeks gestation), with low birth weight (less than 2500 g) in Behbahan. It should be noted that all premature children were hospitalized in the NICU ward of the hospital for some time. Thirty children were randomly selected from the population (experimental group 15 and control group 15 children). The inclusion criteria for them were: 1- Medium to late premature infants (32 to 37 weeks) 2- Low birth weight of children (1000 to 2500 grams), 3- Lack of regular daily physical activity or special sports activities from birth to the time to research entrance. Exclusion criteria are: 1- Having special physical and mental problems or motor disability 2- Prematurity due to multiple births. It should be noted that The present study was conducted in 2020 and all subjects participated in the study with their informed consent and the written consent of their parents. After selecting the participants, the second version of the second version of the Peabody developmental motor scale was first performed as a pre-test.

- ***Peabody Developmental Motor Scale Second Edition***

The Second Edition of Peabody Developmental Scale (PDMS-2) (Folio and Fewell, 2000) (22) has been designed to assess the motor development of gross and fine skills in children and young children (from birth to 60 months). The fine motor characteristics that are measured include hand agility, eye coordination and hand and grip. Gross motor items include reflections, displacement motor skills, non-displacement motor skills, and balance. The total test time for each child is 45-60 minutes. In this version, a three-step scoring system is used to classify children's performance.

The validity of this test (correlation coefficient of the total material) in Iran and in the study of Rahmani-Rasa, Mortazavi, Rashedi and Gharib (2014) for gross motor scale was 0.94 and for fine motor scale was 0.93 (23). In order to assess the reliability, this study was tested twice by a tester in a time span of one week. It had an acceptable overall reliability. Tavassoli, Azimi and Montazeri (2014) (24) also measured the psychometric properties of this test on low birth weight infants with preterm birth in Tehran. They obtained the Cronbach's alpha of this test 0.92 and the reliability of the test-retest was excellent (0.98) (24). In general, they recommended the use of this tool to measure the motor development of low birth weight infants with preterm birth in Iran.

To select the participants, at first before starting the research, a letter was written by the director of research of Islamic Azad University to the Behbahan Medical Science College regarding the implementation of the project (doctoral dissertation) on preterm children. With the

consent of the dean of the mentioned college, a list of the parents of preterm children was prepared and by the order of the Dean, the staff of the health network contacted the families and invited the families who were willing to cooperate in the project to participate in the briefing session. At that meeting, the procedure was described at length for the families and they were asked to sign a consent form if they wish to cooperate. All children aged 3 to 6 years who had a preterm birth and were eligible for the study participated in the pre-test of Pb2 test, and finally 15 children were randomly placed in the experimental group and 15 other children placed in the control group. Then, the experimental group was exposed in group to the experimental variable of this study (training interventions) during 6 weeks and for 3 sessions in each week in the children's sports club.

The purpose of these sessions was to raise the level of children's gross motor skills. To achieve this goal and to prevent possible injuries, children warmed up for 10 minutes through games and activities in each session (Landy and Bridge 2000). Then, they spent 40 minutes on doing special exercises that were planned for them (Smith 2010, 2011). In the end, they did special exercises for cooling in 10 minutes. Table 1 is an example of some of the activities performed in a training session. The control group perform their usual activities during this period.

Table 1. An example of some activities performed in training sessions

Exercise consideration	Used tool	Skill execution time	Difficulty level	Type of exercise
children circled around the umbrella and performed rhythmic movements with the song	Rainbow umbrella	10 minutes	No level	1. warm up
During the exercise, he jumps over one of the obstacles with pair of legs and passes under the next obstacle by crawling	barrier with the length of 50 cm and height of 30 cm	10 minutes	Level 1	2. jumping and crawling
In this exercise, vertical stairs are made with wood and rope and the child climbs up the rope by taking the sticks	rock climbing land of wood and rope	15 minutes	level 2	3. climbing rope and rock climbing
This exercise uses some skills such as jumping, squatting, and rabbit movements	Mattress or roll	15 minutes	Level 3	4. Basic gymnastic skills
Morning stretch - Angels in snow	No tool	10 minutes	No level	5. Cool down

- ***Statistical Method***

Shapiro-Wilk test was used to evaluate the normality of data distribution. At the end of the training sessions, all participants in the experimental and control groups retake the post-test of the Peabody-2 Motor developmental Scale and the data were analyzed by ANCOVA inferential test. Finally, the obtained data were analyzed using SPSS software version 16.

Results

- ***Statistical description of the measured data***

The data in (Figure 1) show that the means of the experimental group are different in pre-test and post-test, but there is no significant difference in the control group.

The results of the Shapiro-wilk test are insignificant for all research variables (P> 0.05), meaning that all measured data of the research variables have a natural distribution (Table 3).

- ***Investigating the Homogeneity of the Variances of Measured Variables***

The results of Leven test are not significant for all variables (P> 0.05) which indicate that the variances are homogeneous (Table 4).

Table 2. Mean and standard deviation of the standard scores related to variables measured in research groups

Variable	Group	Intervention lbw	Control
		Mean ± SD	Mean ± SD
Stability Skills	Pretest	8.80±1.20	7.75±1.05
	Posttest	11.26±1.38	8±0.73
Locomotor Skills	Pretest	8.73±1.27	7.91±1.08
	Posttest	11.3±1.54	8.16±.93

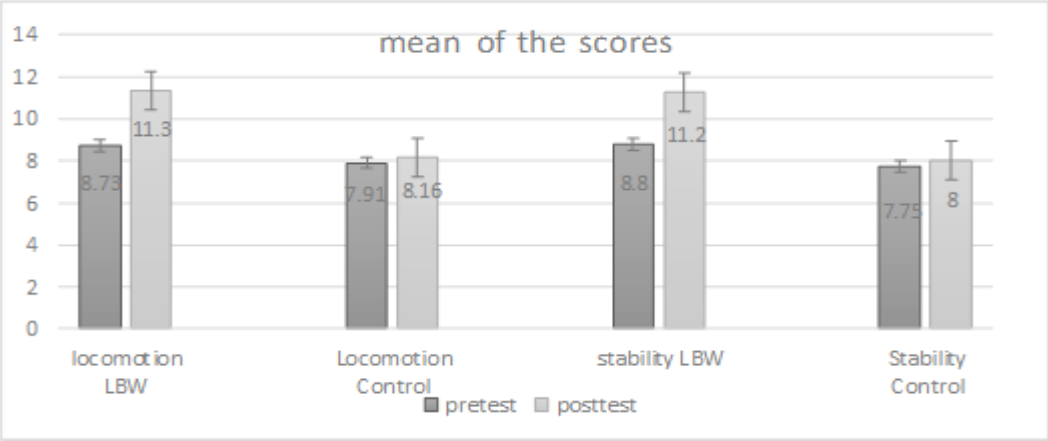

Figure 1. Mean scores of pre- and post-test of different research groups

Table 3. Summary of the results of the Shapiro-wilk test to investigate the normal distribution of research data

Variable		Control		Intervention		
		Statistics	significance	Statistics	significance	
Stability Skills	Pretest	0.91	0.22	0.92	0.19	
	Posttest	0.82	0.20	0.82	0.08	
Locomotion skills	Pretest	0.93	0.48	0.94	0.50	
	Posttest	0.80	0.11	0.92	0.23	

Table 4. Leven test results to investigate the homogeneity of the variances of research

Variable	df1	df2	F	P value
stability skills	2	37	2.70	0.08
Locomotion	2	37	2.43	0.102

Findings from the (Table5) show that there is a significant difference between the post-test stability scores of the sample group with control compared to the pre-test scores (F = 59.13; df = 2; P = <0.001; Eta = 0.76). These results show that 0.76 of the variability of the stability score in the post-test of the experimental group was due to the training intervention. Therefore, eight weeks of training intervention is effective on stable motor skills in children with preterm birth. Also there is a significant difference between the post-test locomotion scores of the sample group with control compared to the pre-test scores. (F = 29.52; P = <0.001; Eta = 0.62).

These findings show that 0.62 of the variability of the locomotion score in the post-test of the experimental group was due to the training intervention. Therefore, eight weeks of exercise intervention is effective on motor mobility skills of children with preterm birth.

Table 5. Results of the analysis of covariance to compare score stability and Locomotion of participants in groups

Source	Type3 sum of squares	Df	Mean of squares	P value	Partial Eta squared
Stability Pre-test	16.384	1	16.384	0.771	0.002
Stability Post-test	96.821	1	48.410	0.001<	0.76
Locomotion Pre-test	8.030	1	8.030	0.32	0.126
Locomotion Post-test	95.472	1	47.736	<0.001	0.62

Discussion

The aim of this study was to investigate the effect of early exercise interventions on gross motor skills of children with preterm birth. The results of this study showed that early interventions can have a positive effect on the gross motor skills of these children and the participants in the experimental group were able to obtain higher scores than the control group after participating in the training program.

Findings of this study were consistent with the results of similar studies done on children with developmental delays (children with ADHD, children with mental retardation, children with genetic disorders, etc.), Malekpour and Nesai Moghaddam (2014)(30), Amoozadeh et al. (2016)(29) , Hishcock et al. (2008),(19) Alsie et al.(2014)(17), Al-Saif and Al- senany(2015)(21), Ketcheson , Hauck and Ulrich (2017) (24).

To explain these findings, it can be pointed out that developmental skills interventions aimed at improving motor skills on children's learning and domination in the advanced stages of development. The basic strategy of this type of intervention to achieve the normal behavior and development of movement is to encourage children to participate and engage in games and sports exercises that pursue a specific goal. It is assumed that in the developmental skills approach children can achieve higher levels of motor development through reinforcement and guided exercise (27). On the other hand, he proposed the theory of sensory integration to express the potential relationship between the neural processes of sensory perception, modulation and integration of sensory inputs and their output consequences, which is the adaptive behavior itself. Considering that the focus of this theory is on adaptive behavior, this approach has been repeatedly used by occupational therapists as a part of the occupational therapy programs. The purpose of such interventions is to improve the ability to process and integrate sensory information as well as to provide a basis for improving children's routines and independent activities, games and homework. (28).

On the other hand, it was different from the findings of studies like Kaaresen et al. (2008) (26), Orton et al. (2009) (5), Abdullah et al. (2013) (14), and Edwards et al. (2017) (18). It seems that the most important issue regarding the paradox of interventions is the critical age of neuromotor system development and the development of motor skills in early childhood (20).

On the other hand, the type of the interventions applied in the previous studies (Abdullah et al. 2013) (14) as well as short duration of interventions (Edwards et al. 2017) (18) may have been ineffective on children's motor development.

The most important limitation of this study was the lack of control over children's activities outside of training sessions. Also, some children were absent in some training sessions for various reasons like illness.

Conclusion

Although eight weeks of training interventions have had a positive effect on the gross motor skills of preterm infants, there are some points in this regard. First, before designing the exercise, children's movement problems were identified and a suitable exercise program was planned according to the children's problems, and second,

these interventions were performed at preschool age which is the best age to compensate for developmental and motor retardation.

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