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Relationship between Dynamic Balance and Fine Motor Performance with Core Endurance in School Children

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ABSTRACT

Introduction: The core is the center of the functional kinetic chain providing the proximal stability for the distal mobility and function of the limbs. The core muscles transfer force and act as a bridge between the upper and lower extremities.
Objective: To determine if there is a relationship between dynamic balance and fine motor performance with core endurance in school children.
Methodology: The study was conducted among 20 subjects who met with both inclusion and exclusion criteria and who are willing to participate in the study. Demographic data of the subjects, that is, height, weight and age will be taken initially. Subjects were asked to perform plank test, forward reach test and Nine-hole Peg Test in which the therapist will demonstrate the position of the test and procedure first and they were asked to perform 3 trials. The mean value of the trials will be taken.
Results: The mean age of the population was 9.39 years. Karl Pearson correlation was calculated between the parameters. There exists a highly significant correlation between the parameters i.e. core endurance and dynamic balance (r=.956) ($p<0.01$). Also the result shows a significant negative correlation between the parameters core endurance and dominant hand fine motor performance (r= -.967) ($p<0.01$), core endurance and non-dominant hand fine motor performance (r=-.925) ($p<0.01$).
Conclusion: There is a significant relationship found between dynamic balance and fine motor performance with core endurance.

Keywords: core endurance, dynamic balance, fine motor performance, trunk stability, nine-hole peg board, motor skills.

INTRODUCTION

The core has been described as a box with the abdominals in the front, paraspinals and gluteus in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom[1]. It serves as a muscular corset that works as a unit to stabilize the body and spine, with and without limb movement. In short, the core serves as the centre of functional kinetic chain. In the alternative medicine world, the core has been referred to as the "powerhouse," the foundation or engine of all limb movement[2]. Spinal stability is essential for the production of movement and relies on the core muscles to acquire sufficient strength, power and endurance[3]. Contraction of core muscles provides a basis for the naturally unstable spine, and allows forces between body parts to transfer during dynamic movements[4, 5].

Core stability has been defined as the ability to control trunk position and motion for the purpose of optimal production, transfer, and control of forces to and from the terminal segments during functional activities[6]. The concept of stability encompasses both static and dynamic control. This includes the ability of the neuromuscular system to keep the trunk in an upright position (static) and control trunk movements (dynamic). This is predominantly accomplished via quick postural responses by the neuromuscular system to both internal and external perturbations. This also includes perturbations caused by forces generated from or traveling through the extremities. Both feed-forward and feed-back mechanisms are integrated within the neuromuscular system to respond to these forces[7]. Core stability involves many components like core strength, endurance, power, balance and coordination of spine, abdominal and hip muscles[8, 9]. Core activity doesn't involve only in spinal stability and force generation but also it is involved in most of activities of upper limb and lower limb[10].

Individuals with high levels of core muscular endurance were more likely to have good overall core stability and be less prone to musculoskeletal disorder[11]. Not only can a simple program be initiated to strengthen core musculature, but that it is also effective in maintaining the improvement in core endurance over a 10-month period. This is significant because muscular imbalances and segmental maturations will occur as youth develop. Growth does not take place uniformly across the skeleton and neuromuscular complex, and the inconsistency in segmental growth can lead to imbalances in the skeleton[12]. In theory, the individual risk of injury can be lowered through the implementation of core stability by improving the strength, endurance and balance in the musculoskeletal complex[13, 14].

Balance can be defined as the ability to maintain body's centre of gravity over its base of support with minimal sway or maximal steadiness[15]. Balance ability can be divided into static and dynamic. Static balance is defined as the ability to maintain a posture such as balancing in standing or sitting and dynamic balance is defined as the ability to maintain postural control during movement such as reaching for an object or walking on various surfaces[16, 17].

The ability to maintain postural stability is an essential pre-requisite to competently perform most activities of daily living, and important for proficient performance of fundamental movement skills[18]. For children, proficiency in postural control develops not only as they increase in age but also from interacting with their environment and through fine tuning of muscular torques during growth and development[19]

The upper extremity functions require dynamic stability of the shoulder girdle on a stable trunk. Fallang et al. showed that hand reaching performance rose due to increasing postural stability[20].Rehabilitation practitioners often assume that trunk control and alignment affects functioning of the extremities as well as the performance of functional activities[21].

It is believed that improving trunk stability produces distal stability and improved controlled movement of the upper extremities. Trunk stability ensured the movement of the shoulders, and shoulder stability improved the movement of the elbow, wrist and fingers. Upper extremity function such as reaching, grasping, manipulating objects require dynamic stability of shoulder girdle on a stable trunk[22].

Motor development in children typically occurs according to a sequence pattern and timing[23]. It has been suggested that distal ability may be influenced by postural control of the head and neck and the core[24]. The ability of people to use their hands in order to accomplish everyday activities depends on the anatomical integrity, sensation, coordination, strength, and dexterity of the hands. The assumption that trunk stability and control are necessary for the maturation of manual dexterity has influenced the development of therapeutic treatment methods[25]. Therapeutic treatment methods have been based on the assumption that trunk control and postural stability and balance are needed for the maturation of fine motor skills and therapists are often taught in school that working on trunk control and posture are key interventions for pediatric patients. In practice, this may indicate that a physical therapist could work on core strength and muscular endurance activities, which may lead to improving specific fine motor skills, such as copying shapes[26]. Hence the aim of the study is to find the relationship between dynamic balance and fine motor performance with core endurance in school children.

MATERIALS AND METHODS

This cross sectional study was conducted on 20 subjects who met with both inclusion and exclusion criteria and who are willing to participate in the study from several schools in and around Mangaluru. The subjects will be given a brief explanation about the test procedure. The test procedure was demonstrated to avoid compensatory activities. Demographic data of the subjects, that is, height, weight and age will be taken initially. Subjects were asked to perform plank test, forward reach test and Nine-hole Peg Test in which the therapist will demonstrate the position of the test and procedure first and they were asked to perform 3 trials. The mean value of the trials will be taken. The collected data was tabulated and subjected to statistical analysis. Ethical clearance was obtained from the ethics committee of A J Institute of Medical Sciences, Mangalore. The subjects participating in the study were given patient information sheet containing the study details and also the Inform consent was obtained from the subjects prior to the study.

Outcome Measures

- To assess core endurance: Plank Test
- To assess dynamic balance: Functional Reach Test
- To assess fine motor performance: Nine-hole peg Test

PROCEDURE

Subjects fulfilling the inclusion criteria were enrolled for the study. A brief introduction about the procedure was explained to all the participants. The subjects will be given a brief explanation about the test procedure. The test procedure was demonstrated to avoid compensatory activities. Demographic data of the subjects, that is, height, weight and age will be taken initially. Subjects were asked to perform plank test, forward reach test and Nine-hole Peg Test in which the therapist will demonstrate the position of the test and procedure first and they were asked to perform 3 trials. The mean value of the trials will be taken.

Plank Test: The plank protocol required participants to maintain a static prone position with only forearms and toes touching the ground. Proper form required feet together with toes curled under the feet, elbows forearm distance apart, and hands clasped together against the floor mat. Participants maintained eye contact with their hands, a neutral spine, and a straight line from head to ankles. The child was given one 5-s practice trial, and the examiner instructed the child into the proper position, followed by a brief period of rest. The test began when the participant demonstrated the correct position. Participants were allowed to deviate from the correct position once and could continue the test if they immediately resumed the correct starting position. The test was terminated on the second deviation from the correct position or if the participant did not return to the correct position after the first warning. Throughout the development of the plank protocol, different maximum time limits were evaluated across three distinct cycles of testing. A stopwatch is used to record the time.

Nine-hole peg Test: The test measures fine motor dexterity in terms of the number of seconds (i.e., completion time) a subject takes to place nine pegs in a pegboard and then remove them. Children were tested at a desk and chair of appropriate height with their feet supported on the floor. The pegboard was centered in front of the subject with the container side on the same side as the hand being tested. The dominant hand was tested first. Subjects completed one practice trial followed by the actual timed test for each hand. For the non-dominant hand, the pegboard was turned so that the container was on the same side as the non-dominant hand. The stopwatch was started by the examiner as soon as the subject touched the first peg and stopped when the last peg hit the container.

Functional Reach Test: The participant is instructed to next to, but not touching, a wall and position the arm that is closer to the wall at 90 degrees of shoulder flexion with a closed fist. The assessor records the starting position at the third metacarpal head on yard stick. Instruct the participant to reach as far as they can forward without taking any step. The location of third metacarpal is recorded. Scores are determined by assessing the difference between start position and end position is the reach distance, usually measured in inches. Three trials are done and the average of the last two is noted.

RESULT

Table 1: shows descriptive statistics of age, height, weight, BMI, dynamic balance, core endurance, dominant hand fine motor performance and non- dominant hand fine motor performance.
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	20	8.00	10.00	9.150	.8127
Height	20	110.00	146.00	129.950	11.445
Weight	20	20.00	42.00	29.000	6.859
BMI	20	14.00	19.70	16.920	1.523
DB	20	19.00	30.00	24.650	3.116
CE	20	1.13	1.40	1.242	.080
FMDH	20	16.00	25.00	20.600	3.1017
FMNDH	20	17.00	25.00	21.900	2.863

Table 2: shows Pearson correlation of core endurance and dynamic balance. Correlations

		CE	DB
CE	Pearson correlation	1	.956
	Sig.(2 tailed)		.000
	N	20	
DB	Pearson correlation	.956	1
	Sig.(2 tailed)	.000	
	N	20	20

Table 3: shows Pearson correlation of core endurance and dominant hand fine motor performance.

		CE	FMDH
CE	Pearson correlation	1	-.967
	Sig.(2 tailed)		.000
	N	20	20
FMDH	Pearson correlation	-.967	1
	Sig.(2 tailed)	.000	
	N	20	20

Table 4: shows Pearson correlation of core endurance and non- dominant hand fine motor performance.

		CE	FMNDH
CE	Pearson correlation	1	-.925
	Sig. (2 tailed)		.000
	N	20	20
FMNDH	Pearson correlation	-.925	`1
	Sig.(2 tailed)	.000	
	N	20	20

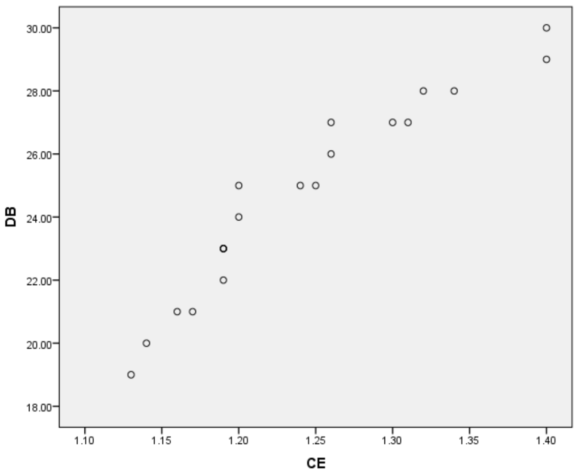

Figure 1: The scatter diagram shows core endurance and dynamic balance.

Karl Pearson correlation was calculated between the population. It shows a highly significant correlation between the parameters. i.e.: core endurance and dynamic balance (r=.956) (p<0.01). There is also a significant negative correlation between the parameters core endurance and dominant hand fine motor performance (r= -.967) (p<0.01), core endurance and non-dominant hand fine motor performance (r=-.925) (p<0.01).

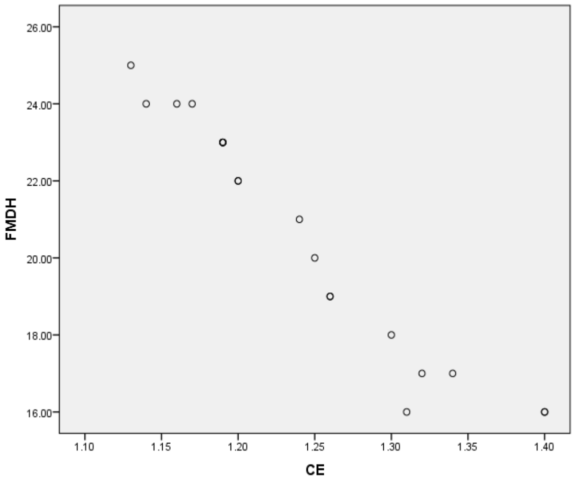

Figure 2: shows scatter diagram of core endurance and dominant hand fine motor performance.

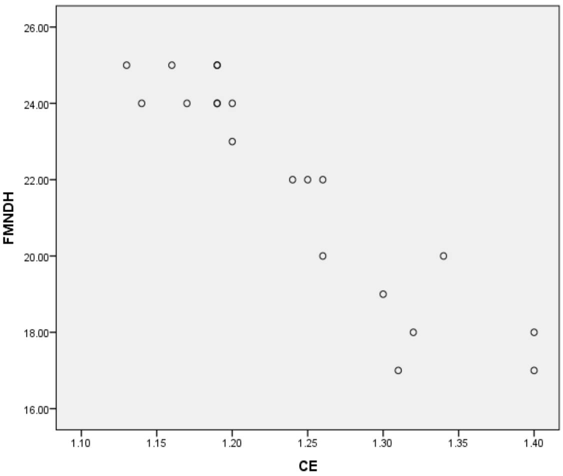

Figure 3: shows scatter diagram of core endurance and non-dominant hand fine motor performance.

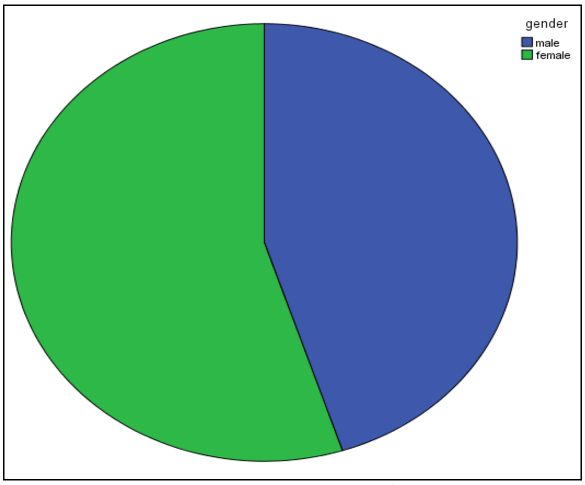

Figure 4: shows gender distribution of the population

DISCUSSION

The core plays an important role in the connection of movements and the transfer of load between the upper and lower extremities[27]. Individuals with high levels of core muscular endurance were more likely to have good overall core stability and be less prone to musculoskeletal disorder[13]. The core muscles transfer force and act as a bridge between the upper and lower extremities. Children spend between 30% and 60% of their school day performing fine motor tasks. Those activities involving manipulation of writing implements, such as pencils, are perhaps the most important skill regarding academic achievement; with paper and pencil based activities making up as much as 85% of the time spent engaged in fine motor tasks[28].

In this study we have included 20 students aged 8-10 years who met the inclusion criteria. The students who were recruited belonged to various schools from Mangaluru. The subjects who met inclusion criteria was assessed for three testing conditions -plank test, nine hole peg test, and functional reach test. The demographical data including age, height, weight and BMI were recorded.

The mean age of the studied population is 9.15 with a standard deviation of .8127. The mean height, weight, BMI of the studied population is 129.9±11.44, 29.00±6.85, 16.92±1.52 respectively. Karl Pearson correlation value between core endurance and dynamic balance was r= .956 ($p<0.01$). There is a strong correlation between core endurance and dynamic balance and the result is statistically significant. The findings of the study support our hypothesis that core endurance would correlate with dynamic balance in school children.

Correlation value between dominant hand fine motor performance and non-dominant hand fine motor performance with core endurance was (r=-.967) ($p<0.01$) and (r=-.967) ($p<0.01$) respectively. There is a negative correlation between core endurance and fine motor performance and the result is statistically significant.

Case-Smith et al[29] studied the relationship between proximal and distal motor control with a sample of 60 normal infants ranging in age from two to six months. The fine motor section of the assessment measures the developmental level of a wider range of hand function components than those measured in the current study: Reach, grasp, and manipulation of objects. The study reported that fine motor control was not strongly associated with postural control.

Michelle A et al[30] conducted a study to determine the effects of a 6-week core-stabilization training program for high school track and field athletes on dynamic balance and core endurance. The study suggested that after the 6-wk core-stabilization-training program, measures of the SEBT, AFT, BET, and SBT improved, thus advocating the use of this core-stabilization-training program for track and field athletes.

Limitation

This study was a cross-sectional design which prevents us from casual inferences about the relationship between the studied variable. The sample size was small. So we cannot generalize the result of the study. Thus further confirmation of these results must be done in larger population. Recruiting a sample from specific area reduced the generalizability of these findings. We did not analyse whether the age and gender will influence this relationship.

CONCLUSION

This study aimed to investigate the relationship between dynamic balance and fine motor performance with core endurance in school children. The study found that there is a significant relationship between dynamic balance and fine motor performance with core endurance in school children. Future studies are recommended in the area of core endurance and dynamic balance in children with a larger population.

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