Quantitative Assessment of Core Strength in School Children.

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Abstract— Core muscular strength is an essential requirement in youth/ children who engage in physical exercise, as they run the risk of suffering a musculoskeletal injury it's been demonstrated that strong core muscles can help lower your risk of injury. The objective of the study is to determine a quantitative measure of core strength in school children. This a is descriptive cross-sectional study conducted on 367 school going children of age 6 to 16. The study was carried out with Modified sphygmomanometer to assess the strength of core muscle. The results reveal Core muscle strength increased with the increasing age; strength of multifidus was greater than rectus abdominis. Significant difference in strength of multifidus was seen in boys when compared with girls. A marked rise of strength in adolescent age and difference of strength of boys and girls is seen which can be associated with pre-pubertal and pubertal change.

***Index Terms*— Core strength, school children's, rectus abdominis, multifidus, modified sphygmomanometer.**

INTRODUCTION

Core stability and core strength have been subject to research since the early 1980s. Core strength is defined as to the ability of the musculature to produce force through contractile force and intra-abdominal pressure [1]. To produce, transfer and control force and motion to the terminal segment during integrated activities, one must be able to regulate the position and motion of the trunk over the pelvis. This is referred to as "core stability" [2].

The core can be visualized as a muscular box with the pelvic floor and hip girdle muscles at the bottom and the diaphragm at the top, with the abdominal muscles in the front, paraspinals and glutes in the back. In the absence of these muscles, the spine would become mechanically unstable. These muscles are in charge of maintaining the integrity of the spine and pelvis [3].

To define core, the combination of global and local system has been used. The global system refers to the larger, superficial muscle around the abdominal and lumbar region, such as rectus abdominus, paraspinal and external obliques. Local refer to the deep, intrinsic muscles of abdominal wall, such as transverses abdominus and multifidus [4]. The literature largely agrees that the low back's ability to withstand physical stress during dynamic physical activity and spinal stability are influenced by the axial (spinal) stabilizers, which are made up of the core muscles [5].

The core serves as the center of the functional kinetic chain; it is a type of muscular corset that functions as a unit to stabilize the body and the spinal column whether or not limb movements are present [6]. The core has been referred to as the "powerhouse" in the zone of complementary medicine, the basis or source of all limb movements [7].

This functional, stable core serves as the foundation for coordinated movement of the child's arms and legs [8]. As kids transition from childhood into adulthood, increasing muscular endurance in the school-going population may improve sports performance as well as lower the prevalence of low back pain [9].

For many sports, as well as daily tasks like sitting, standing, and walking straight ahead, core muscular strength is an essential requirement. Advantages of a strong core are an increase in peripheral mobility, posture, and balance. Better agility, strength, and stamina [10]. Youth/ children who engage in physical exercise run the risk of suffering a musculoskeletal injury. It's been demonstrated that using your core muscles can help lower your risk of injury [11]. Many injuries are primarily caused by an intrinsic risk factor of poor body mechanics and weak core. Also, a growing number of studies conducted over the past few decades have shown that non-specific LBP in students in school due to week core musculature [12,13].

Methods for testing and training activation of the core musculature have been developed, pressure biofeedback unit has been shown to have clinical usage in training activation and control of the core musculature of the trunk and neck, it also measures movement of the spine in relation to an air-filled reservoir [14,15]. The PBU is typically utilized in rehabilitation to assess the activation of the neck and abdominal muscles as well as to give patients receiving motor control exercise therapies biofeedback [16].

The Modified Sphygmomanometer Test (MST) is an intriguing alternative given the need for an objective evaluation of muscular strength in clinical settings and the shortcomings of frequently used methods to measure this outcome, such as the manual muscle testing (MMT) and the portable dynamometry [17]. The hand-held dynamo-meter (HHD) and the manual muscle test (MMT), both have certain drawbacks. The MMT is limited in its ability to identify significant changes in strength. The portable dynamometer is difficult to employ due to its relatively expensive cost [17,18].

There is decreased availability of standardized values for measurement of core strength or a set interval of figures regarding the baseline quantitative data about core strength in school going children. Measurement of core strength is essential to guide clinical decision-making regarding rehabilitation program. Thus, this study is needed to quantify the core strength in school going

children and identify a regulated and uniform group of values for advances in future research. The aim of the study is to determine a Quantitative measure of core strength in school children. Objective is to determine the core strengths of school going children with the help of Modified Sphygmomanometer. The secondary objectives off the study is to determine and classify the core strength in school going children according to age with Modified Sphygmomanometer. And to determine the core strength in school going children according to gender with Modified Sphygmomanometer.

METHODOLOGY

Study design

This study was a Descriptive type of Cross-Sectional Study, the study was conducted at Dr. APJ Abdul Kalam Collage of physiotherapy, Loni for a period of two years from. The study was approved by the Institutional ethical committee, Pravar Instituted of medical Sciences. Registration No. COPT/MPT/2023/24.

Participants

Participants were the school going children who were recruited from schools in and around Loni via Simple Random Sampling. A brief information regarding the data collection procedure was explained to children and informed consent sought from all participants parents/ guardian prior data collection.

School going children aged between 6 to 16, Children who are able to follow simple verbal commands, children with no significant postural deformity and who were willing to give written inform consent from parents/guardian were included. Children with visual and auditory impairments, Children with cardiorespiratory and muscular disorder. And history of any recent surgery was excluded. The sample size was determined to be 367 which was calculated with Rao software.

Outcome Measure-

1. Modified sphygmomanometer

The Modified Sphygmomanometer Test (MST) is an alternative method for the clinical measurement of muscle strength. This test uses the aneroid sphygmomanometer, a commonly acquired equipment by healthcare professionals for the assessment of blood pressure. This instrument is portable, has a low-cost and provides an objective measurement. There are different ways to adapt the sphygmomanometer to evaluate muscle strength; however, the bag method is the most commonly used. Test-retest and inter-rater reliabilities ($0.80 \leq ICC \leq 0.99$; $p < 0.001$) and validity ($0.80, \leq r \leq 0.91$; $p < 0.001$) [19].

Data collection-

Total 396 children were screened out of which 367 children were included and had undergone the assessment of core strength measurement with the help of Modified sphygmomanometer.

the strength of Multifidus and Rectus Abdominis was evaluated. For evaluation of Multifidus muscle, the participant was positioned in supine position with the inflatable cuff placed under the back. The cuff was inflated to 20 mmHg and then the participant was instructed to exert force on the inflated cuff. And the readings were recorded. For evaluation of Rectus Abdominis muscle the subject was in the prone position and the inflating cuff was placed beneath the abdomen. Then the cuff was inflated to 70mmHg and the participant was instructed to perform drawing the abdomen in and up towards the spine. And the readings were recorded.

Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts. True Type 1 or Open Type fonts are required. Please embed all fonts, in particular symbol fonts, as well, for math, etc.

STATISTICAL ANALYSIS

All statistical analyses were conducted using Graph Pad Instat Trial Version 13.3. Descriptive statistics for all outcome measures were expressed as mean, standard deviation and test of significance. Paired t-test was used for within group analysis. The confidence interval was set at 95% and data was considered statistically significant with $p<0.001$.

RESULTS

Between date to date 396 children aged 6 to 16 were assessed for eligibility where 29 children were ineligible as they were not able to follow verbal commands, and few were not willing to give consent.

The study included 156 girls and 211 boys in it. Out Of these, Age 6 (n=26), 3 Age 7(n=30), Age 8(n=36), Age 9(n=38), Age 10(n=28), Age 11(n=37), Age 12(n=41), Age 13(n=33), Age 14(n=35), Age 15(n=33) and in Age 16(n=30).

The muscle strength of Multifidus and Rectus Abdominis for each age group (Girls Boys combined) according to the muscle was calculated, Mean score of Multifidus and Rectus Abdominis muscle for each age group is given in table- 01. the results showed that multifidus was stronger than the rectus abdominis. Additionally, it was observed that muscle strength continued to increase as the age progressed. Graph 01

The mean score for girls and boys differently for same age group of each muscle was calculated. The mean score for strength of multifidus in boys and girls is presented in table-02. The mean score for strength of Rectus Abdominis in boys and girls is presented in table-03 and the results showed significant difference in the strength of multifidus muscle when compared between girls and boys, indicating boys having greater multifidus strength than girls. when compared the strength of rectus abdominis muscle between boys and girls, there was no significant difference observed instead it was seen that girls had slight greater strength than boys.

PAIRED T-TEST ANALYSIS-

Paired t- test was applied for the mean of difference between the boys and girls for multifidus muscle. There is significant difference in strength of multifidus between boys and Girls. p value is < 0.006.

Paired t- test was applied for the mean of difference between the boys and girls for rectus abdomins muscle. There is no significant difference in strength of rectus abdominis muscle between boys and Girls. p value is < 0.006.

DISCUSSION

Evaluation of the strength of multifidus and rectus abdominis, and results showed that multifidus was stronger than the rectus abdominis. Additionally, it was observed that muscle strength continued to increase as the age progressed. however, the strength of the core muscle was greater in boys than in girls.

This study showed significant difference in the strength of multifidus muscle when compared between girls and boys, indicating boys having greater multifidus strength than girls.

On the other hand, when compared the strength of rectus abdominis muscle between boys and girls, there was no significant difference observed instead it was seen that girls had slight greater strength than boys.

The results of current study, which compared the strength of the rectus abdominis and multifidus, indicated that the multifidus was stronger compared to rectus abdominis. these findings are similar to the study conducted by Mehrsheed Sinaki et, where the results of their study showed that in comparison to the back flexors, the back extensors were stronger [20]. In few other studies the authors suggested postural adjustments can reflect the trunk's gravitational effect on data. The results of these tests indicate that flexor muscles were weaker than extensor muscles, with ratios of flexor to extensor forces during evaluation in the standing position of approximately 3:4 [20].

In this present study it was also observed that the muscle strength continued to increase with the progressing age however, the strength of the core muscle was greater in boys than in girls.

These findings are in correlation with the study conducted by I Holm and et al. The study stated that Muscular strength increases with age during the period between childhood and adolescence, although the rate of gain depends on a number of factors, including gender, physical characteristics, growth, maturity, and, to some extent, motor skill and amount of physical exercise. Task-to-task variations may also exist in the improvement [21]. A similar study conducted by F Balague et al, They demonstrated that children's isokinetic trunk strength significantly increased with age, not only as a consequence of growth factors but also as a result of age-influenced factors including biochemical alteration and neuromuscular maturation [22].

In this study it was seen that the strength of the core muscle was greater in boys than in girls these findings were similar to the study conducted by B. FALK et al. Where they stated that There were noticeable variations in the physical fitness of girls and boys. Boys' greater levels of activity could be the cause of the differences [23].

In another study conducted by Rohan M. Telford et al showed similar results, they claimed that A gender-based difference in youth physical activity (PA), involving girls being less active than males, although research findings vary regarding the extent of the difference in physical activity levels between males and females, a comprehensive analysis of European youth aged 4-18 years suggests that females engage in around 17% less total daily physical activity on average than boys. The less physical activity in girls is due to impact of poor Socioecological factors at the person, family, school, and environmental levels. Less parental support, fewer school-related impacts on PA, and lesser involvement in community sports may all contribute to girls' lower PA than that of boys [24].

These findings of physical activity influence the muscle strength is supported by the study conducted by Allie Leblanc on Relationships between physical activity and muscular strength among healthy adults across the lifespan. Where they mentioned that Frequent physical activity encourages bone density, muscular function, and a healthy weight. Loss of muscle mass is largely determined by factors such as physical inactivity age, gender, and body mass index [25].

On the other hand, in our study when compared the strength of rectus abdominis muscle between boys and girls, there was no significant difference observed instead it was seen that girls had slight greater strength than boys. These findings are similar to the findings in the study conducted by Mehrsheed Sinaki et al on Correlation of Trunk Muscle Strength with Age in Children 5 to 18 Years Old. Which states that abdominal muscles are slightly stronger in boys than in girls, and the ratio of back extensor strength to back flexor strength is higher in girls than in boys [20].

In the present study it was observed that there was a sudden increase in muscle strength in girls at around the age of 10 to11 and at the age of 14 to 15 in boys in both group of muscles, these findings can be explained through the study conducted by E Ramos. A significant increase in muscle strength with age was observed during adolescence in both genders, it has been demonstrated that increases in height, weight, and muscle mass with aging are correlated with increases in muscle strength throughout adolescence. Increases in strength with age during adolescence can be caused by a variety of variables, including changes in body size and composition. The observed increases in strength during adolescence may be explained by neurological maturation that enhances motor unit recruitment and firing rate, by modifications in the size or type composition of muscle fibers, or by a combination of these [26].

Another study conducted by Alan D Rogol at el, on Growth and pubertal development in children and adolescents: effects of diet and physical activity. This study explains changes related to puberty that leads to increased muscle strength in this age group. study Stated that the adolescent's growth spurt is one of the main characteristics of puberty. Puberty is a significant time of weight gain and increasing height velocity. During pubertal maturation, there are noticeable changes in body composition that lead to characteristic differences between males and females. These changes include changes in the relative proportions of fat, muscle, water, and bone. Increases in bone mineral content and muscle mass are brought on by growth hormone (GH) and gonadal steroid hormone [27].

Limitations-Daily physical activity hours were not considered, BMI correlation was not done, in future, correlation with MMT Gradings and readings with modified sphygmomanometer can be done.

CONCLUSION

Present study assessed the core muscles' strength in school going children with the modified sphygmomanometer, and study concluded that strength of the muscles increases with age. A marked rise of strength in adolescent age is seen which can be associated with pre-pubertal and pubertal change. However, the core muscles of boys are stronger than those of girls. The strength of multifidus was found greater in boys when compared with girls. Whereas girls showed greater strength of rectus abdominis than boys.

Abbreviations and Acronyms

MMT- Manual muscle testing
HHD- Hand Heald dynamometer
PBU- Pressure biofeedback unit
MST-Modified sphygmomanometer test

Figures and Tables

Table 01- Strength of Multifidus and Rectus Abdominis for each age group.

Age (years)	Multifidus (MEAN± SD)	Rectus Abdominis (MEAN±SD)
6 (n=26)	20.56±8.33 mmHg	9.21±2.19 mmHg
7 (n=30)	34.26±10.83 mmHg	11.06±2.96 mmHg
8 (n=36)	34.55±10.09 mmHg	12.38±4.14mmHg
9 (n=38)	is 0.48±12.65 mmHg	14.98±6.63 mmHg
10 (n=28)	55.83±16.75 mmHg	16.99±8.21 mmHg
11 (n=37)	54.44±16.82 mmHg	15.86±5.45mmHg
12 (n=41)	61.27±15.81 mmHg	17.14±7.14 mmHg
13 (n=33)	64.32±16.57 mmHg	17.18±5.53mmHg
14 (n=35)	66.47±11.54 mmHg	18.59±5.52 mmHg
15 (n=33)	84.48±16.85 mmHg	24.51±7.66 mmHg
16 (n=30)	95.58±17.86 mmHg	26.40±8.01 mmHg

Table 02- strength of Multifidus in Boys and Girls.

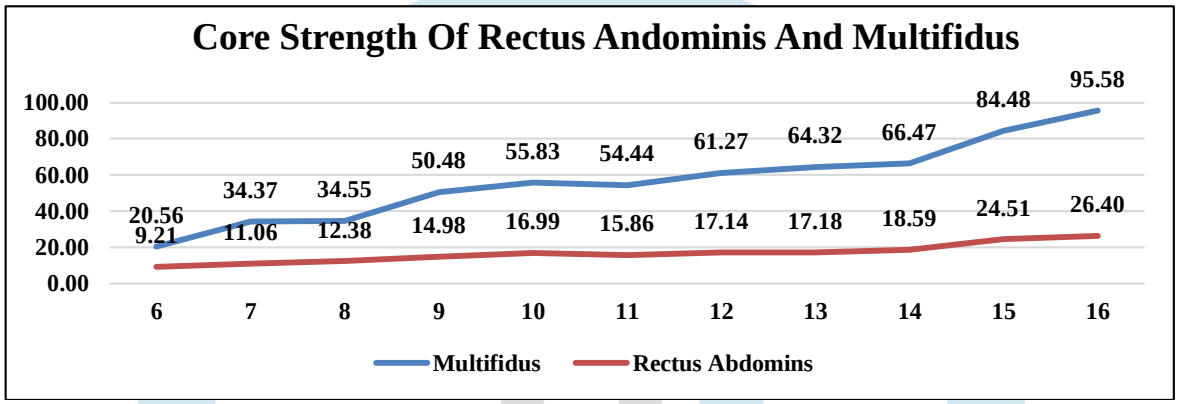
Girls		Boys	
Age (years)	Multifidus (MEAN±SD)	Age (YEARS)	Multifidus (MEAN±SD)
6 (n=10)	9.54±7.34 mmHg	6 (n=16)	24.5±5.86mmHg
7 (n=11)	34.54±6.64 mmHg	7 (n=19)	34.26±12.83 mmHg
8 (n=13)	33.48±8.28 mmHg	8 (n=23)	35.14±11.11mmHg
9 (n=16)	45.1±11.79 mmHg	9 (n=22)	54.39±12.02mmHg
10 (n=10)	43.93±9.74 mmHg	10 (n=18)	62.44±16.30 mmHg
11 (n=16)	52.41±18.13mmHg	11 (n=21)	55.98±16.03mmHg
12 (n=20)	59.28±16.76 mmHg	12 (n=21)	63.15±15.02 mmHg
13 (n=15)	59.28±16.34mmHg	13 (n=18)	68.25±16.16mmHg
14 (n=20)	60.76±11.04 mmHg	14 (n=15)	74.06±16.01 mmHg
15 (n=11)	74.18±15.34mmHg	15 (n=22)	89.63 ±15.86 mmHg
16 (n=13)	92.71±15.98mmHg	16 (n=17)	97.79±19.36mmHg

Table 03- Strength of Rectus Abdominis in Boys and Girls.

Girls		Boys	
Age(YEARS)	Rectus Abdominis (MEAN±SD)	Age (YEARS)	Rectus Abdominis (MEAN±SD)
6 (n=10)	8.66±2.08 mmHg	6 (n=16)	9.54±2.26mmHg
7 (n=11)	10.45±01.78 mmHg	7 (n=19)	10.82 ±3.49mmHg
8 (n=13)	10.75±2.81 mmHg	8 (n=23)	13.28±4.54 mmHg
9 (n=16)	11.02±3.54 mmHg	9 (n=22)	17.86 ±6.96mmHg
10 (n=10)	13.33±3.87 mmHg	10 (n=18)	18.01±9.33mmHg
11 (n=16)	15.62±4.44 mmHg	11 (n=21)	16.03±6.26mmHg

12 (n=20)	18.00±7.61 mmHg	12 (n=21)	16.31± 6.74 mmHg
13 (n=15)	17.91±4.83 mmHg	13 (n=18)	16.57±6.12mmHg
14 (n=20)	20.08±5.68 mmHg	14 (n=15)	21.04±4.89 mmHg
15 (n=11)	24.20±5.39 mmHg	15 (n=22)	25.21±8.08 mmHg
16 (n=13)	26.54±8.33mmHg	16 (n=17)	29.09±8.01mmHg

Graph 01- Core strength of Multifidus and Rectus Abdominis for each age group



COMPARISON OF MEAN SCORE BETWEEN BOYS AND GIRLS FOR MULTIFIDUS MUSCLE

Table 04- Comparison Of Multifidus Strength Between Boys and Girls

Strength of multifidus	Boys (n=156)	Girls (n=211)	P value	Results
MEAN± SD	59.96±22.12	51.41± 22.12	< 0.006	Significant

COMPARISON OF MEAN SCORE BETWEEN BOYS AND GIRLS FOR RECTUS ABDOMINS MUSCLE

Table 05- Comparison Of Rectus Abdominis Strength Between Boys and Girls

Strength of multifidus	Boys(n=156)	Girls(n=211)	P value	Results
MEAN± SD	17.35±5.29	16.31± 6.46	> 0.136	Not Significant

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