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Effectiveness of core stability exercise program on abdominal and back strength in school going children: A randomized controlled trial

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Abstract: Purpose: **-** To determine the effectiveness of core stability program on the abdominal and back strength in school going children for prevention of low back pain and reduce the risk of injury.
Methodology: This was a randomized controlled trial of 70 school participant, subjects were divided into two equal groups, experimental and control group. Experimental group were given core stability exercises for 12 weeks and control group received normal physical education classes held in school curriculum. Outcome measures were used One minute Sit up test and back leg chest dynamometer.
Results:- The results showed that the core stability program group had significant higher strength over back leg chest dynamometer(29.29±12.43) and abdominal strength (25.80 ± 3.66) as compared to normal physical classes Group Back strength(21.86± 9.16) and abdominal strength (21±12) held in school.7
Conclusions:- A well planned core stability exercise program can be helpful to improve the core strength and physical fitness among school going participant over a 12 weeks period of time as compared to normal physical classes held in school.

Key words: **-** Core Stability Program, abdominal strength and back strength.

INTRODUCTION

Core or the lumbo-pelvic hip complex has to be functionally effective to use the strength, power and endurance as individual develop (Venu Akuthota, 2004)[1]. It is the term used for lumbar stabilization required to maintain functional stability around lumbar spine. The "core" has been described as a box with the abdominals in the front, paraspinals and gluteals in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom. The core muscles are multifidus, rotators, transverse abdominis, internal oblique and quadratus lumborum (Venu Akuthota et al, 2008).[2] Core has been described as a "powerhouse" or "engine" of all limb movements. All limb movements are generated from core and translated to extremities (Venu Akuthota,2004).[1]

Core stability training is a form of training meant to increase core musculature strength, endurance and neuromuscular control. Through core stability training, intersegmental control of the spine, control of intra-abdominal pressure and global muscular control of trunk movement can be improved (Venu Akuthota et al, 2008).[2]

Recently, prospective data have suggested a correlation between trunk and torso control and lower extremity injury. It is known that if the core is not stable, then the weaker links within the kinetic chain are at risk for injury (Willson D et al, 2003).[3]

There is an increase in the frequency of injuries in the youth over the past few decades (Radelet MA et al, 2002, M. A. Jones et al, 2004, G T Jones et al, 2005, Inmaculada Calvo-Muñoz1 et al, 2013, Zito M. 1983).[4-8]

Risk factors for youth musculoskeletal injuries: Extrinsic factors, such as repetitive exposure to sports, the sporting environment, and the equipment that has to be worn, and intrinsic factors, such as the physical and psychological state of the youth. An intrinsic risk factor of improper body mechanics tends to be the leading cause of many injuries (Zito M. 1983).[8]

During the last few decades, an increasingly large number of surveys have demonstrated that non-specific LBP in participant is more frequent than previously thought (Radelet MA et al, 2002, M. A. Jones et al, 2004, G T Jones et al, 2005, Inmaculada Calvo-Muñoz1 et al, 2013).[4-7] In participant and adolescents, epidemiological evidence indicated lifetime prevalence for back pain varying from 13 to 51% and point prevalence ranging from 1 to 31%. Also the onset of LBP is between 12-14 years; it appears that the onset of LBP is related to the growth spurt in participant, when the rapidly growing spine is very sensitive to loads(Shanmugam C et al, 2008, Jordaan R et al, 2005). [9, 10]

Current recommendations suggest that school-aged youth should participate daily in 60 minutes or more of moderate to vigorous physical activity that is developmentally appropriate and enjoyable and involves a variety of activities. Nowadays, comprehensive school-based programs are specifically designed to enhance health-related components of physical fitness, which include muscular strength (Micheli L.J et al, 2000).[11]

Strength-training programs may be undertaken to try to improve sports performance and prevent injuries, rehabilitate injuries, and/or enhance long-term health. Not only is regular physical activity essential for normal growth and development, but also a physically active lifestyle during the pediatric years may help to reduce the risk of developing some chronic diseases later in life(Mylene Kosseim et al, 2008, AK Burton et al, 2004, Faigenbaum Avery D et al, 2009, Faigenbaum AD, 2000, Pediatrics. 2008, Zazulak B et al , 2008).[12-17] Nonspecific back pain of at least moderate intensity is a major problem among adults causing significant distress and disability(Shyamal Koley et al, 2010).[18]

While the epidemiology of back pain at young age has been described extensively, studies evaluating the effects of interventions to prevent LBP or the consequence of LBP in school are still sparse. It has been suggested that good quality RCT's are needed to determine the effectiveness of specific interventions aimed at specific risk/ target groups(Van Tulder M et al, 2000, Gina L Fanucchi et al, 2009, A Antoine Helewa et al, 1999).[19, 21]

As per Roux's law it can thus be hypothesized that, during the adolescent growth spurt, specific stabilizing exercises and stretches could place positive 'stresses' on the body, and so promote better development of the 'deep muscle' stabilizing mechanism and correct alignment of the spine. Furthermore, a well-functioning stabilizing system in participant could protect the body against the repetitive loads placed on it during normal physical activity, as well as activities of daily living (Gretchen D Oliver et al, 2010, Kibler WB et al, 2006).[22, 23]

Hence, numerous authors have proposed that prevention needs to target a younger population ideally before the first onset or at the first onset of low back pain(Gretchen D Oliver et al, 2010, Kibler WB et al, 2006). [22, 23]

There is insufficient evidence to recommend for or against muscle strengthening as a preventive action for sports injuries and LBP in school participant. Thus, it can be assumed that implementation of core stability program during the period of early adolescence will reduce the risk of injury as well as occurrence of back pain later in life.

METHODOLOGY

A total of 70 school participant were selected by a preliminary examination from the nearby schools. The students who fulfilled the inclusion criteria were randomly divided into two groups. Simple random sampling was used to randomly allocate 35 students in group A (experimental group) and 35 students in group B (control group). Experimental group were given a set of core stability exercises and control group received normal physical education classes held in school curriculum.

Inclusion Criteria:

The subjects who met the following inclusion criteria are as follow:

1. Age:12-16 years
2. Both genders.
3. 1 min full sit-up test range
   Females: 14-20
   Males : 18-24
4. Students who are not participating in any other strengthening program.

Exclusion Criteria:

The subjects with the following criteria were excluded from the study:

1. Participant having Low back pain
2. History of recent trauma to upper limb, lower limb and spine.
3. Participant with any spinal pathology.
4. Have neurological conditions which alter motor tone.
5. Have physical disabilities.
6. Any history of breathlessness during physical activity or other respiratory disorder.
7. Participant with developmental delays (delayed milestones).

Outcome Measures:

1. One minute sit up test: - One of the most frequently used test to measure mainly abdominal muscular strength and endurance. This sit up test measures the strength and endurance of the abdominals and hip-flexor muscles. The one minutes sit up test is having had good reliability and validity(Jabar Haji johari et al, 1993, Maria H. Diener et al, 1995) [24, 25].
2. Back Leg Chest Dynamometer: - The Back Leg-Chest- Dynamometer are used to test the strength of various muscle groups in the back, legs, and chest. It has been used in many studies in India and abroad. Hannibal et al did a study to test the reliability and Validity of Low Back Strength/Muscular Endurance Field Tests in Adolescents. They concluded that Intra class test-retest reliability coefficients (one-way ANOVA model for a single measure) ranged from .940 to .996. For single and multiple measure interclass reliability coefficient for female was 0.940 and .970 and for male 0.98 and 0.99 respectively(Norman S. Hannibal III et al, 2006, Shyamal koley et al, 2012) [26, 27].

PROCEDURE

Baseline measurement was taken at pre intervention level for both the groups using a One minute Sit up test and back leg chest dynamometer. Following this students in group A (intervention Group) were given a set of core stability exercises, 3 sessions of exercises per week with 1 set and 5 repetitions, for one hour on alternate days for 12 weeks. The students in group B (control group) received normal physical education classes held in school curriculum. After the period of 6 weeks again data collection was done, the post intervention measures were taken for both the groups at the end of 12 weeks.

Exercise Protocol:

Experimental Group (n =35)
The participant in experimental group received intervention in three phases.

Warm Up Phase:

Warm up phase started with Diaphragmatic Breathing, spot jogging and then general stretching of group muscles like

Cat- Camel exercises, side trunk muscles stretch, trapezius stretch, pectoral stretch, hamstring and lunge stretch.

Core Stabilization exercises phase:

The core stability program consists of 4 different isometric positions held for 30 second each.

Exercise modification- If students cannot hold the position for the required time, they were instructed to hold the exercise as long as possible and then drop down to the floor to rest for 1 to 2 seconds and then reposition back to the exercise and continue with holding and resting throughout the 30-second interval.

One additional modification that was done is the front plank. If the student cannot perform the front plank (i.e., hold their body weight), a modified plank exercise was given that include forearm and knee support instead of forearm and foot support.
The exercises given were side plank, front plank position, flying squirrel position, twist curl exercise, Supine bridging.
For the modified plank position, the body remains straight and the position is held for 30 seconds.

Cool Down Phase:

Diaphragmatic breathing in supine, hamstring stretch, cat and camel exercise into prayer position, Relaxation.
The experimental group received the intervention 3 times a week with 1 set and 5 repetitions for a total duration of 60 minutes. The total duration of the treatment was 12 weeks.
Control Group (n = 35)

The participants in control group were received normal physical education classes held in school curriculum during the course of the study.

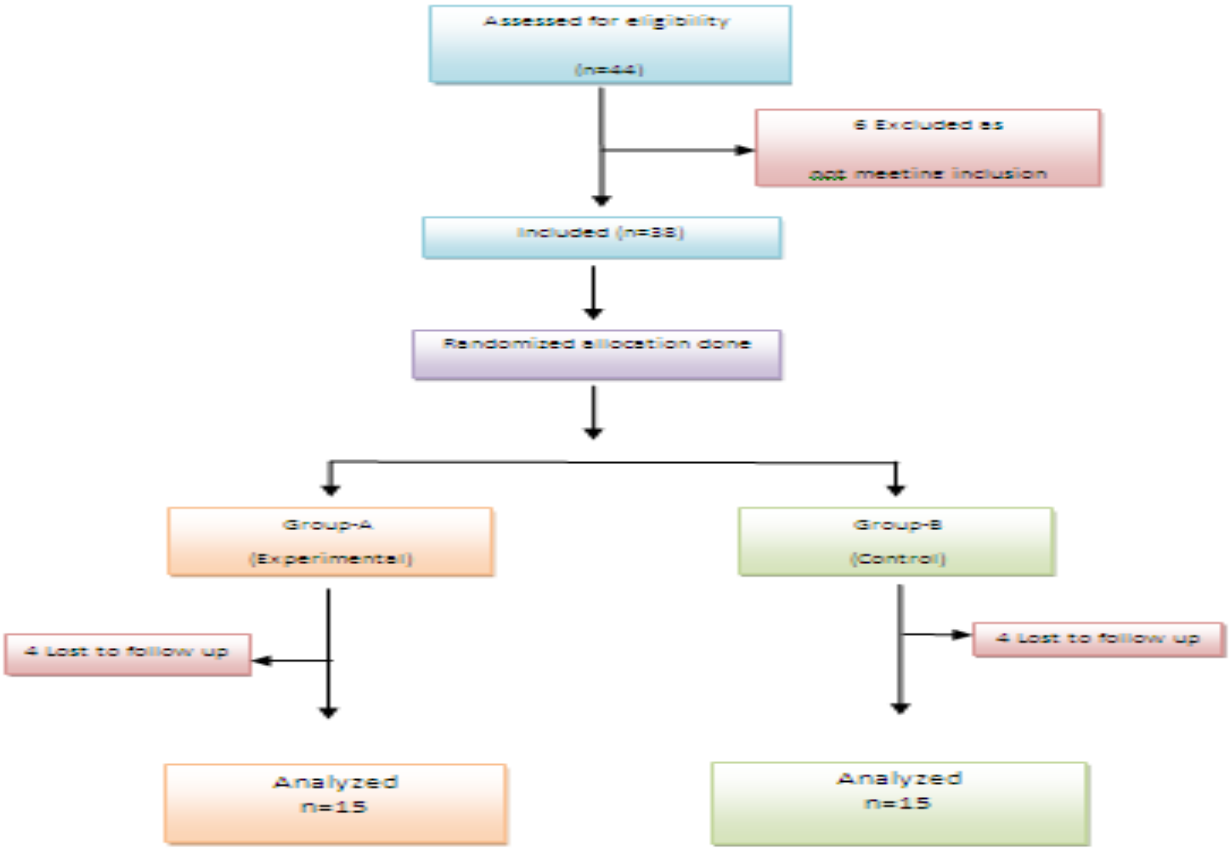
Ethical clearance for the study was obtained from the ethical clearance committee of, Maharishi Markandeshwer Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwer University, Mullana, Ambala, Haryana., INDIA.

DATA AND STATISTICAL ANALYSIS

For back strength within group analysis for group A and B was done using Z test. Within the group analysis of group A and B for abdominal strength was done by using paired t test and between the group A and B was done by using unpaired t test. The level of significance was set at $p<0.05$. SPSS version 17 was used for analysis.

RESULTS

Flow Chart (Selection criteria)



Total 126 subjects selected for study. 56 subjects unable to fulfill the inclusion criteria. (12 subject score below cut off criteria, 12 subjects reported low back pain, 8 had timing problem, 3 had medical concern and 9 reported history of trauma.) Total 70 subjects participated in study further divided into group A and group B.

Table 5.1 Demographic data for the two groups.

		Group A (Experimental) (n= 35)	Group B (Control) (n=35)	P - VALUE
Gender	Male	17	18	
	Female	18	17	
Height		146.14±9.38	145.57±8.48	.790 NS
Weight		38.85±6.92	38.83± 6.57	.992 NS
Age		14.23± 1.45	14.37 ±1.37	.672 NS

The above table shows that the two groups did not differ regarding age.

Table 5.2 Baseline measurements of the subjects for abdominal strength. No of (Sit-ups) and back strength.

	Group A	Group B	P value
Baseline values abdominal strength (Mean ± SD	19.34±2.91	19.25±2.51	.896 NS
Baseline values for back strength (Mean ± SD)	21.42±11.01	20.57±8.38	.715 NS

NS- NON SIGNIFICANT

The above table shows that both groups are matched for their baseline characters (abdominal strength & BACK STRENGTH).

Table 5.3:- Pre and post measurement of both the groups for abdominal strength (Within group analysis).

	Pre-values (mean ± sd)	Post-values (mean±sd)	p- value
Group A	19.34 ± 2.91	25.80 ± 3.66	0.00 S
Group B	19.25 ±2.51	21.17± 2.98	2.03 NS

The above table shows difference in the pre and post values of abdominal strength for group A & group B.

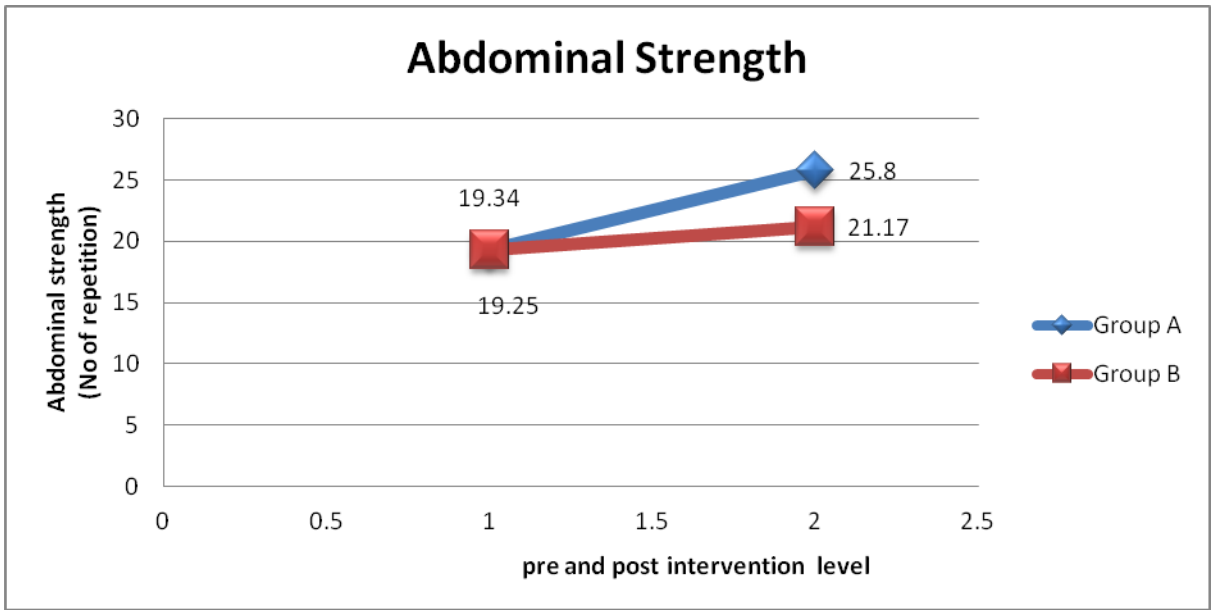


Figure 5.1 Comparison of pre and post values for abdominal strength within group A & group B.

The above graph shows difference in pre and post values for abdominal strength of group A & group B.

Table 5.4:- Pre and post measurement of group A & group B for back strength (Within group analysis).

	Pre-values (mean ± sd) (in Kgs)	Post-values (mean±sd) (in Kgs)	P- Value
Group A	21.42 ± 11.01	29.28 ± 12.43	.000 S
Group B	20.57 ± 8.38	21.85± 9.16	.0016 NS

Ns= non-significant, s- significant

The above table shows the difference in the pre and post values of back strength for group A.

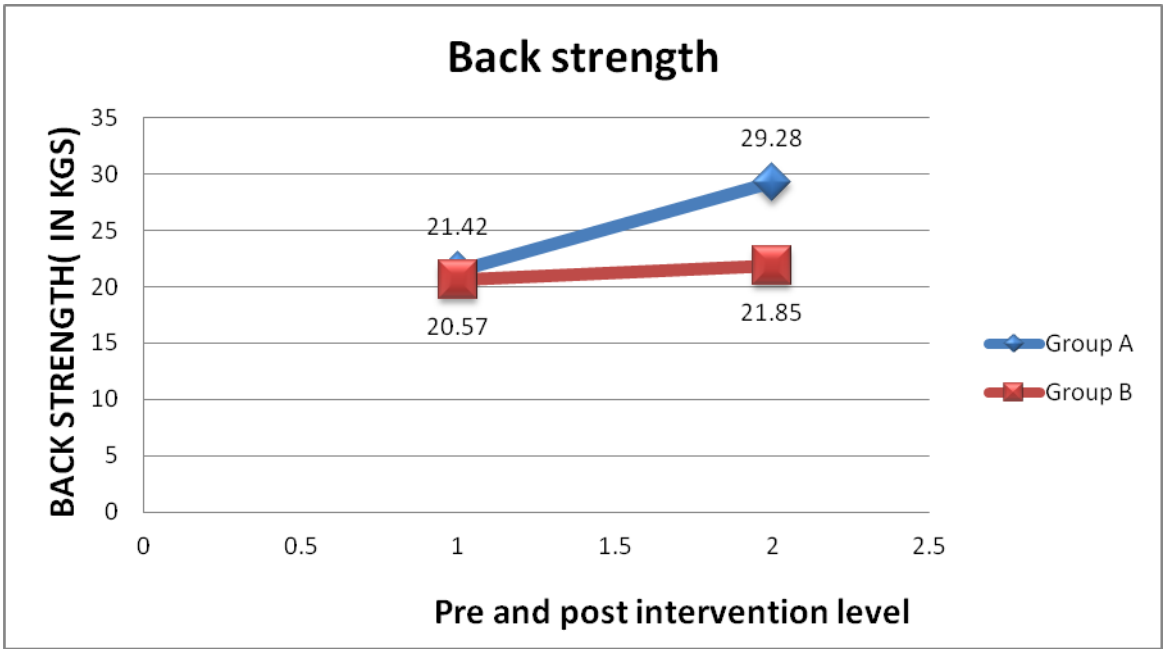


Figure 5.2:- Comparison of pre and post values for back strength within group A & group B.

The above graph shows difference in pre and post values for abdominal strength of group A & group B.

Table 5.5:- Post Intervention group analysis in both the groups for Abdominal and Back strength.

	Group A	Group B	U value	
Post Intervention values abdominal strength (Mean ± SD	25.80 ± 3.66	21.17± 2.98	207	S*
Post Intervention values for back strength (Mean ± SD)	29.28 ± 12.43	21.85± 9.16	7.42	S*

S*- significant

The above table shows the post intervention values of abdominal and back strength for group A and group B.

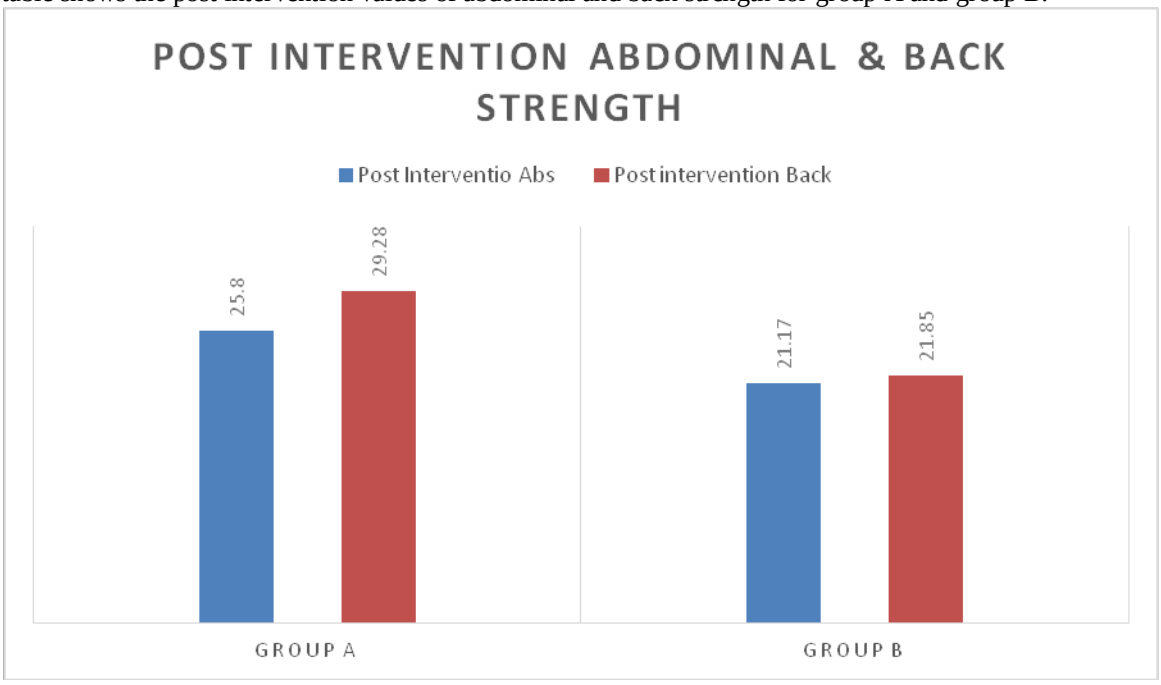


Figure 5.3: - Post Intervention Abdominal and Back strength for Group A & Group B.

The above graph shows post intervention values for abdominal and back strength of group A & group B.

DISCUSSION

Finding of this study suggest that 12 week core stability exercise program had a significant effect on abdominal and back strength among school going participant. The results suggest that a well-structured core stability program could be a better strategy to increase core strength as compared to normal physical classes held in school.

The results of this study shows that there is increase in the mean values of number of sit-ups to measure abdominal strength and back strength (KGs) after the intervention in

group A. Results obtained after the data analysis did not support null hypothesis and thus it was rejected and the alternate hypothesis was accepted.

The results of our study are consistent with the findings of study conducted by Oliver et al titled "implementation of core stability program for elementary school participant" and concluded that core stability intervention was effective in increasing core strength and endurance among elementary school participant(A Antoine Helewa et al, 1999).[22] However in contrast to the results of our study, Helewa et al investigated "the effects of abdominal muscle strengthening exercises on Low Back Pain risk reduction" and concluded that abdominal exercise and back education, compared to back education alone, does not appear to reduce the risk of LBP episodes over 24 months experimental period(Gina L Fanucchi et al, 2009).[21]

The results can further be based on the Roux's law that soft tissue responds to stress and that remodeling occurs over 6-8 weeks. As they grow, participants continue to experience weaknesses in the core strength due to lengthening of the musculature as it adapts to postural changes. A maintained level of improvement throughout the training regimen was expected because the exercises were anticipated to offset the weakness that would have developed from the lengthening of the skeletal and musculotendionuos units, as well as the fact that the participants were undergoing maturation(Gretchen D Oliver et al, 2010).[22]
In preadolescents, proper training can enhance strength without concomitant muscle hypertrophy. Such gains can be attributed to a neurologic mechanism whereby training increases the number of motor neurons that are "recruited" to fire with each muscle contraction. This mechanism accounts for the increase in strength among the population(Kibler WB, 2006).[23]

Involvement of subjects in specific exercise programs during childhood can promote optimal spinal alignment and tissue loading during growth spurt. If abnormal movement, musculoskeletal imbalance, and associated abnormal spinal loading are addressed during childhood, it may be possible to prevent the onset of chronic and recurrent LBP (Hoshikawa, Yoshihiro et al, 2010).[28]
The participant participated enthusiastically in the group exercise program which promoted the motivation and competition among participant to perform better. Therefore, it would appear that participant 12-16 years of age are an ideal, receptive target population for interventions consisting of exercise.

Limitation of study:

The sample size taken in the study was small. No follow up was taken to see if the effect of the intervention program was maintained for the longer period of time or not. Moreover maintenance program was not incorporated after the intervention program to maintain or improve the attained strength and endurance.

Future scope of study:

This study is done in normal and healthy school going participant population, the mentioned protocol can be implemented in school going population with low back pain. A more reliable and valid tool, that is pressure biofeedback can be used among participant population to measure the static strength of the abdomen and back musculature. Comparative study can be done with other protocol. This study can be done in athletic school population to enhance their performance and prevent the sports injuries. Lastly a long term follow up can be taken with the same study.

Clinical implication:

A weak core is a fundamental problem of inefficient movements that predisposes one to injury and disability. By implementing core stability exercises early in childhood, practitioners can attempt to address the core component of efficient movement. This protocol can be implemented in regular curriculum of the school so that participant can understand the importance of the strengthened core and thus incidence of low back pain and other injuries can be prevented among the school going participant and adolescents.

CONCLUSION

Finally it can be concluded that a well-planned core stability exercise program can help to improve the core strength and physical fitness among school going participant over a short period of time. . Thus, findings of the study can be used as a part of curriculum in the schools to improve the core strength, physical fitness which will further help in the prevention of low back pain and incidence of injuries among school going participant and later in their life.

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