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A Study to Find the Efficacy of Core Stabilization Exercise on Respiratory Functions

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Abstract: Core stabilization exercise has become a well-known trend in fitness. The diaphragm, which is a component of core stability, plays a role in respiration and stabilizing the trunk by controlling intra-abdominal pressure. Abdominal exercises, such as sit-ups and leg lifts, are used to enhance the strength of the core muscles. Correct breathing (especially as it involves the respiratory muscles) is vital to abdominal training because respiratory muscles are directly involved during common core stability exercises. This is an experimental study where pre and post design is used. This study was done on a healthy population; a total number of 30 subjects were taken according to the inclusion criteria. 15 subjects in Group-A received five core stabilization exercises combined with diaphragmatic breathing with pre and post-test analysis and 15 subjects in Group-B received resting breathing and diaphragmatic breathing with pre and post-test analysis. 6-Minute Walk Test (6MWT), Forced Expiratory Volume in 1 second (FEV_1), Forced Vital Capacity (FVC) and Peak Expiratory Flow (PEF) were measured. Based on the inter-group analysis, Group-A (Experimental Group) showed greater improvement $p < 0.05$ than Group-B (Control Group) in post-test on 6MWT as well as FEV1, FVC, PEF. All the interventions have brought about some improvement ($p<0.05$) in each group post-treatment based on the mean score but its significance varies. The significance of this study is that it showed the relationship between the core muscles and respiratory functions. So, this study can be concluded that the exercise protocol of core stability exercise with diaphragmatic breathing could improve respiratory functions significantly as compared to resting breathing and diaphragmatic breathing exercise alone.

Keywords: Core stabilization exercise, Diaphragmatic breathing, resting breathing, 6MWT, FEV_1, FVC, PEF.

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1. INTRODUCTION

The diaphragm is the primary muscle of inspiration. During movements involving the core (thoracic and abdominal) musculature, diaphragm activity is increased both to overcome pressures opposing inspiration and for postural support.[1] Stability is imparted on the lumbar spine by contraction of the diaphragm and increasing intra-abdominal pressure.[2] Core training has become a universal mark for any exercise that covers some aspect of "lumbo-pelvic" stability. Lumbo-pelvic stability includes various functional components - deep muscles that stabilize the lumbar spine, abdominal muscles, lower back, middle back muscles, and hip muscles that help maintain and stabilize the pelvis. In addition, the diaphragm, which is a component of core stability, plays a role in respiration and stabilizing the trunk by controlling intra-abdominal pressure.[3] The "core" is comprised of several groups of muscles including the transversusabdominus, multifidus, diaphragm, and pelvic floor muscles and the diaphragm serves as the roof of the core.[4] From a functional point of view, there are three groups of the respiratory muscles-the diaphragm, the rib cage muscles, and the abdominal muscles. Each group acts on the chest wall and its compartments, i.e., the lung-opposed rib cage, the diaphragm-opposed rib cage, and the abdomen. Contraction of the diaphragm expands the abdomen and the lower part of the rib cage (abdominal rib cage). The rib cage muscles, including the intercostals, the parasternal, the scalene, and the neck muscles, mostly act on the upper part of the rib cage (pulmonary rib cage) and are both inspiratory and expiratory. The abdominal muscles act on the abdomen and the abdominal rib cage, and they are expiratory.[5, 7]The core stabilization has been defined as the stabilization of the body center against the dynamic movements of limbs and the absorption of the pressures on the core of the body.[6] Core stability exercises include a range of exercise programs with different approaches, having the common goal of improving lumbo-pelvic and abdominal control. These exercises are designed to enhance the ability of the neuromuscular and motor control systems to prevent spinal injury.[8] In addition the well-trained core is essential for optimal performance and injury prevention in different activities.[6] Breathing exercises in respiratory physiotherapy are effective in improving lung expansion and include breathing control, deep breathing, and diaphragmatic breathing. Among the deep breathing techniques, diaphragmatic breathing has been shown to reduce the work of breathing and improve ventilation efficiency. The abdomen in diaphragmatic breathing rises during inspiration and returns during expiration, while the upper chest remains relatively motion-free. [9- 11] The purpose of this study was to find how effective core stability exercise is in respiratory functions.

2. MATERIALS AND METHODS

2.1 Study Design

An experimental study was carried out with 30 healthy subjects in both the control and experimental group. Each participant was explained about the study and after receiving Informed Consent from each participant with Ethical approval received from Ethical Committee from Assam down town University with Approval number ADTU/Ethics/stdnt-lett/2021/MPT/006.

2.2 Time and Duration of the Study

The whole study was carried out in 10 months and 30 subjects from both Group-A (n=15) and Group-B(n=15) have received individual treatment. The two training protocols were administered twice per week for 6 weeks in both groups.

2.3 Participants

This study was done on a healthy population; a total number of 30 subjects both male and female were selected according to the inclusion criteria. There was a randomized control distribution among Group A and Group B containing 15 numbers of subjects in each group. This study was carried out in Guwahati, Assam. The volunteers were selected based on inclusion criteria with consent from the participants.

2.4 Inclusion Criteria

i. Age 18-25 years,
ii. Non-smoker,
iii. BMI normal i.e., 18.5-24.9 kg/m^{2,} and
iv. Who did not participate in any regular activities in the past 6 months.

2.5 Exclusion Criteria

i. Any history of low back pain,
ii. Pulmonary or heart diseases,
iii. Surgical history and
iv. Physical disability.

2.6 Procedure

30 subjects were assigned into two groups – Group A and Group B. Group-A (core stabilization exercises combined with diaphragmatic breathing) and Group-B (resting breathing followed by diaphragmatic breathing) by random sampling, consisting of 15 subjects in each group. For each subject, demographic data were collected and a Pre-test and Post-test were carried out for both Group A and Group B by 6MWT for functional capacity and FEV1, FVC, PEF to test lung functions using Spirometer CONTEC SP 80B.

2.7 Intervention

Group-A received five core stabilization exercises[3] combined with diaphragmatic breathing for 45-60 minutes, twice a week for 6 weeks. The day before the first exercise training, the subjects attended a familiarization session to ensure they are comfortable with the exercise procedures. During this session, participants practiced neutralizing the spine and working the transverse abdominis and multifidus, correct postural control, the importance of breathing, and stability ball balance. At the start and end of each training session, participants completed a thorough 10-minute standardized warm-up and cool-down program, consisting of stretching and posture exercises for the large muscle groups to prepare the neuromuscular system for the training loads and to avoid injury. Group-A (Experimental Group): The core stabilization exercises performed were side bridge (Fig.1), curl-up (Fig.2), trunk extension (Fig.3), bird-dog exercises (Fig.4), double leg lifts (Fig.5), which support respiratory functions. The intensity of the training was gradually provided in the form of increased duration and frequency (sets, repetitions, and contraction time), increasing the complexity of the exercises (adding opposite limb movements), and increasing the lever arm of the exercises. The rest between sets is similar 60 seconds, and an additional 2 to 3 minutes rest is provided between exercises.

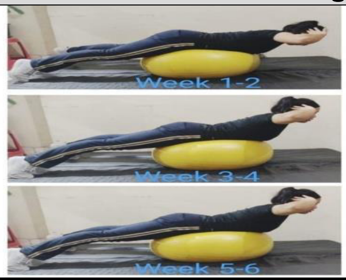
Fig. 1 Side Bridge

Weeks	Sets x Repetitions	Contraction Time
1	3x10	10 Seconds
2	3x10	10 Seconds
3	3x15	15 Seconds
4	3x15	15 Seconds
5	3x20	15 Seconds
6	3x20	15 Seconds

Fig.2 Curl up

Weeks	Sets x Repetitions	Contraction Time
1	3x10	10 Seconds
2	3x10	10 Seconds
3	3x15	15 Seconds
4	3x15	15 Seconds
5	3x20	15 Seconds
6	3x20	15 Seconds

Fig3. Trunk Extension



Weeks	Sets x Repetitions	Contraction Time
1	3x10	10 Seconds
2	3x10	10 Seconds
3	3x15	15 Seconds
4	3x15	15 Seconds
5	3x20	15 Seconds
6	3x20	15 Seconds

Fig.4 Bird-Dog Exercise

Weeks	Sets x Repetitions	Contraction Time
1	3x10	10 Seconds
2	3x10	10 Seconds
3	3x15	15 Seconds
4	3x15	15 Seconds
5	3x20	15 Seconds
6	3x20	15 Seconds

Fig.5 Double Leg Lifts

Weeks	Sets x Repetitions	Contraction Time
1	3x10	10 Seconds
2	3x10	10 Seconds
3	3x15	15 Seconds
4	3x15	15 Seconds
5	3x20	15 Seconds
6	3x20	15 Seconds

Group-B (Control Group) received, resting breathing (Fig.6) for 15 minutes and diaphragmatic breathing (Fig.7) for 15 minutes in each session, twice a week for 6 weeks. The rate of average breathing is 17 times/min in resting breathing. The average respiratory rate is 4 times/min in the diaphragmatic breathing exercise.

Fig.6 Resting BreathingFig.7 Diaphragmatic Breathing

3. STATISTICAL ANALYSIS

A paired t test and independent t test were used to analyze the variables pre-intervention and post-intervention in SPSS software (Version 22). The level of significance with p value was set at 0.05, less than this is considered as statistically significant.

4. RESULTS

Table 1: Intra-group analysis of Group-A and Group-B on improvement on 6-minute walk test

Group	6MWT	Mean	N	Std. Dev	t	df	p	Remarks
Group -A	Before Treatment	549.13	15	55.11	-19.150	14	0.000	S
	After Treatment	636.66	15	54.83				
Group -B	Before Treatment	528.26	15	44.47	-10.130	14	0.000	S
	After Treatment	574.46	15	54.057				

S= Significant

In Table 1, p value of Group-A, pre-treatment is p = 0.000 & post-treatment is p = 0.000 and p value of Group-B, pre-treatment is p = 0.000 & post-treatment is p = 0.000. N value for both Group-A and Group-B is 15. The above table is constructed to see whether core stabilization can improve lung capacity on a 6-minute walk test. Paired t-test was performed to see the significant difference in the 6-minute walk test before and after treatment. We can say that there has been remarkable increase in walking speed.

Table 2: Intra-group analysis of Group-A and Group-B on improvement on FEV_1

Group	FEV_1	Mean	N	Std. Dev	t	df	p	Remarks
Group- A	Before Treatment	87.60	15	4.136	-9.947	14	0.000	S
	After Treatment	97.20	15	2.541				
Group-B	Before Treatment	90.06	15	3.36	-8.336	14	0.000	S
	After Treatment	93.60	15	2.79				

S= Significant

In Table 2, p value of Group-A, pre-treatment is p = 0.000 & post-treatment is p = 0.000 and p value of Group-B, pre treatment is p = 0.000 & post-treatment is p = 0.000. N value for both Group-A and Group-B is 15. The above table is constructed to see whether core stabilization can improve lung capacity on FEV_1. Paired t-test was performed to see the significant difference in FEV_1before and after treatment.

Table 3: Intra-group analysis of Group-A and Group-B on improvement on FVC

Group	FVC	Mean	N	Std. Dev	t	df	p	Remarks
Group-A	Before Treatment	94.86	15	4.838	-17.795	14	0.000	S
	After Treatment	114.26	15	5.339				
Group-B	Before Treatment	94.13	15	3.81	-11.595	14	0.000	S
	After Treatment	109.26	15	6.36				

S= Significant

In Table 3,p value of Group-A, pre-treatment is p = 0.000 & post-treatment is p = 0.000 and p value of Group-B, pre-reatment is p = 0.000 & post-treatment is p = 0.000. N to see the significant difference in FVC before and after treatment. value for both Group-A and Group-B is 15. The above table is constructed to see whether core stabilization can improve lung capacity on FVC. Paired t-test was performed

Table 4: Intra-group analysis of Group-A and Group-B on improvement on PEF

Group	PEF	Mean	N	Std. Dev	t	df	p	Remarks
Group- A	Before Treatment	84.66	15	3.84	-11.251	14	0.000	S
	After Treatment	96.06	15	3.61				
Group-B	Before Treatment	85.53	15	4.30	-8.563	14	0.000	S
	After Treatment	91.66	15	2.84				

****S= Significant***

In Table 4, p value of Group-A, pre-treatment is p =0.000 & post-treatment is p =0.000 and p value of Group-B, pre-treatment is p = 0.000 & post-treatment is p =0.000. N value for both Group-A and Group-B is 15.The above table is constructed to see whether core stabilization can improve lung capacity on PEF. Paired t-test was performed to see the significant difference in PEF before and after treatment.

Table 5: Inter-group analysis between Group-A and Group-B to compare between Core Stabilization with diaphragmatic and resting breathing followed by diaphragmatic breathing. PRE-TEST

		N	Mean	Std. Dev.	t	df	p	Remarks
6MWT	Experimental Group	15	549.13	55.11	1.141	28	.263	NS
	Control Group	15	528.26	44.47				
FEV_1	Experimental Group	15	87.60	4.13	-1.791	28	.084	NS
	Control Group	15	90.06	3.36				
FVC	Experimental Group	15	94.86	4.83	0.461	28	.648	NS
	Control Group	15	94.13	3.81				
PEF	Experimental Group	15	84.66	3.84	-.581	28	.566	NS
	Control Group	15	85.53	4.30				

****NS= Non Significant***

In Table 5, 6-minute walk test between the two groups of subjects before treatment, p=0.263 which is statistically not significant. FEV_1 between the two groups of subjects before treatment p=0.084 which is statistically not significant. FVC test between the two groups of subjects before treatment. p = 0.648 which is statistically not significant. PEF test between the two groups of subjects before treatment. p = 0.566 which is statistically not significant. For 6MWT, FEV_1 FVC, and PEF N= 15.

Table 6: Inter-group analysis between Group-A and Group-Bto compare Core Stabilization with diaphragmatic and resting breathing followed by diaphragmatic breathing. POST TEST

		N	Mean	Std. Dev.	t	df	p	Remarks
6MWT	Experimental Group	15	636.66	54.83	3.128	28	0.004	S
	Control Group	15	574.46	54.05				
FEV_1	Experimental Group	15	97.20	2.54	3.689	28	0.001	S
	Control Group	15	93.60	2.79				
FVC	Experimental Group	15	114.26	5.33	2.331	28	0.027	S
	Control Group	15	109.26	6.36				
PEF	Experimental Group	15	96.06	3.61	3.704	28	0.001	S
	Control Group	15	91.66	2.84				

S= Significant.

In Table 6, an Independent t-test was performed to compare between the experimental group (core stabilization with diaphragmatic breathing) and the control group (resting breathing and diaphragmatic breathing) Concerning the 6-minute walk test p= 0.004. Concerning the FEV1 test, p=0.001 is statistically significant. Concerning the FVC test, p= 0.027 which is statistically significant. Concerning the PEF test p= 0.001which is statistically significant. For 6MWT, FEV_1 FVC, and PEF N= 15

4.1 6-Minute Walk Test (6mwt)

According to Table 5, there was no significant difference in walking speed in the two groups before treatment According to Table 6 it has been inferred that walking speed increased significantly among subjects in the experimental group as compared to that among subjects in the control group.

4.2 Forced Expiratory Volume In 1 Second (FEV_1)

According to Table 5, it has been inferred that there was no significant difference in FEV_1in the two groups before treatment. According to Table 6, there is an increase significantly among subjects in the experimental group as compared to that among subjects in the control group.

4.3 Forced Vital Capacity (FVC)

According to Table 5, there was no significant difference in FVC in the two groups before treatment. According to Table 6, FVC increased significantly among subjects in the experimental group as compared to that among subjects in the control group.

4.4 Peak Expiratory Flow (PEF)

According to Table 5, there was no significant difference in PEF in the two groups before treatment. According to Table 6, PEF increased significantly among subjects in the experimental group as compared to that among subjects in the control group.

5. DISCUSSION

The main finding of this study was that core exercises performed with diaphragmatic breathing has greater improvement in lung function was observed in the Experimental Group. As compared to a study[1], both studies showed that proper diaphragmatic breathing is directly linked to better functional movement and can produce a greater effect on such functional parameters. Regarding the biomechanical aspects of breathing, the expiration phase promotes active recruitment of the abdominal muscles, contrasting the natural elevation of the rib cage and putting the diaphragm in an oblique position that inhibits its proper function. Using a correct diaphragmatic breathing pattern promotes co-contraction of the abdominal muscles in the so-called bracing technique, which provides trunk stiffness and stability and improves lung functions. In other study[5] the influence of eight-week core strength training on respiratory muscle strength in young soccer players was studied and there were significant improvements in FVC, MIP, and MEP between pre-test and post-test in the experimental group There were statistically differences in FEV1 and SVC between the experimental group and control group in the post-test. The difference was found in MEP between the experimental group and the control group in post-test. [10]The pulmonary function and respiratory muscle strength are associated with the endurance of the trunk muscles, which ensure core stability. Trunk muscle endurance exercises may have a positive influence on respiratory function. [12] Another study, also found that the aerobic and forced vital capacities of the sedentary women showed a parallel increase as a result of the applied 12-week aerobic and core strength exercises and stated that the RHR, VO2max, FEV, and FEV1 respiratory parameters also improved positively. [13] In another study, it was concluded that adding core stabilization exercises to basic deep breathing exercise may be more effective due to the improvements in thoracic mobility. [14] It was suggested that abdominal bracing exercises can be presented as effective exercises to improve respiratory function. [15] Another study compared core stabilization exercise and a chest mobilization exercise on stroke patients and suggested that both exercises were effective in some aspects of pulmonary function while core stabilization can help increase peak expiratory flow and chest mobilization can assist with chest expansion. [16] In another study, the effects of deep abdominal muscle strengthening exercises on respiratory function and lumbar stability were examined, and found that deep abdominal muscle training was effective at enhancing respiratory function and lumbar stabilization. [17]The effects of deep abdominal muscle strengthening exercises on pulmonary function and the ability to balance in stroke patients were conducted to propose an exercise program for improving cardiovascular function and found that the experimental group showed a more effective significant difference than the control group. [18] The effects of diaphragm breathing exercise and feedback breathing exercise on respiratory function could also affect respiratory function. [19] Other studies also concluded that in male trainers that predominately engage in endurance compared to strength-related exercise, and appears to be unique differences in respiratory system characteristics. The endurance-trained group exhibited superior respiratory endurance as well as a trend towards greater lung function performance for various indices compared to the strength-trained group. [20]The effects of an intervention program to enhance the pulmonary function and muscle activity of elderly smokers and find an improved the pulmonary functions of elderly smokers, demonstrating the potential benefits of the development of various training methods using balloons, and group programs, including recreational factors, for increasing respiratory muscles strength. [21] The effects of core stability exercise on the strength, activation of the trunk muscle, and pulmonary function in a Guillain-Barre syndrome (GBS) patient and the results suggested that core stability exercise improves strength, activation of the trunk muscle, and pulmonary function in subjects with GBS. [22] The effectiveness of core stabilization exercises combined with the Asthma Education Program (AEP) and breathing exercises in patients with asthma was concluded that greater improvements in inspiratory muscle strength, physical activity level, functional exercise capacity, and dynamic balance when core stabilization exercises are included in the pulmonary rehabilitation program for the management of asthma. [23]The effects of core stabilization exercises on pulmonary function, functional capacity, and peripheral muscle strength in children with adolescent idiopathic scoliosis concluded that core stabilization exercises further improve MIP and MEP value compared to the traditional scoliosis exercises in children with AIS. [24] Other study compared the effects of two 6-week high-intensity interval training interventions. Sixteen recreational runners were allocated to either ICT or CON groups. The findings suggest that the addition of inspiratory-loaded core conditioning into a high-intensity interval training program augments the influence of the interval program on endurance running performance and that this may be underpinned by an improvement in running economy.

6. CONCLUSION

All the interventions have brought about some improvement in each group post-treatment based on the mean score but the significance varies. The significance of this study is that this study showed the relationship between the core muscles and respiratory functions and further study is recommended in subjects with some respiratory diseases. So, this study can be concluded that the exercise protocol of core stabilization with diaphragmatic breathing could improve significantly on respiratory functions after as compared to diaphragmatic breathing exercise alone.

7. AUTHORS CONTRIBUTION STATEMENT

Lalnunmawii MPT Scholar carried out the research work in data collection, review of literature, and prepared the thesis as a part of the curriculum of Masters in Physiotherapy under the supervision of Dr. Abhijit Dutta, Associate Professor, Assam down town University guided the whole study with methodology, result analysis and discussion of the study. Dr. Trishna Saikia Baruah and Dr.Abhijit Kalita helped in the review of literature, data collection, and carrying out the study.

8. LIMITATION

The present study has several limitations

- The sample size was small.
- Gender wise protocol could be implemented
- The subjects only belong to a healthy population.
- Experimental Group exercises are limited and more exercises could be done to get better results.
- By increasing the duration of the exercise there could be more improved results.

9. ACKNOWLEDGEMENT

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10. CONFLICT OF INTEREST

Conflict of interest declared none.

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