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Original Research Article

Effectiveness of Abdominal Muscle Exercises on Peak Expiratory Flow Rate in Normal Healthy Female Individuals

Gutha Rathnam Naidu Rajeswariri [1], Govindaraj Revathi [2], Elukuru Asha Jyothi [3], Karunanithi. Sathiya seelan *[4].

[1] B.PT, Intern, PES college of Physiotherapy, Kuppam, Chittoor district, Andhra Pradesh, India.

[2] Assistant Professor, PES college of Physiotherapy, Kuppam, chittoor district, Andhra Pradesh, India.

[3] Assistant Professor, PES college of Physiotherapy, Kuppam, chittoor district, Andhra Pradesh, India.

[*4] Vice Principal and Professor of Physiotherapy, PES College of Physiotherapy, Kuppam, Chittoor District, Andhra Pradesh, India.

ABSTRACT

Background: The major expiratory muscles are the abdominal muscles and play an important role in ventilation. The lungs and respiratory system allow us to breathe. They bring oxygen into our bodies (called inspiration, or inhalation) and send carbon dioxide out (called expiration, or exhalation) Expiration is a passive process and it achieved through the elastic recoil of the lung. During forceful expiration, the abdominal muscles are used. They may get weak due to nerve involvement, disuse atrophy, stretch weakness due to parity, diastasis recti etc. In females, Pregnancy and post- natal muscle weakness, successive pregnancies are factors that compromise abdominal muscle strength and endurance.

Objective: To find the effectiveness of abdominal strengthening exercises for improving peak expiratory flow rate abdominal muscle endurance.

Methods: In this study, 30 subjects (Age 18- 25 years) were selected based on inclusion criteria by simple random sampling method and by having fair abdominal muscle endurance (ACSM abdominal curl up test) were taken. After obtaining the consent of subjects, they were allotted in single group and were given the intervention for 4 weeks. Peak expiratory flow rate and abdominal muscle endurance was measured before and after the exercise program. Peak flow meter was the tool used to evaluate peak expiratory flow rate.

Result: t test was used for data analysis. The mean difference and standard deviation of Peak expiratory flow rate for the group A was 241.173± 42.643 for pre-test and 254.887 ± 41.856 for post-test. The mean difference and standard deviation of Abdominal curl up test for the group B was 9.63 ±03.12 for pre-test and 13.90 ±3.07 for post-test The intragroup analysis of the group showed that Abdominal muscle exercise was extremely statistically significant difference with pd”0.05 (p=0.0001).

Conclusion: In this study it showed that there is statistically improvement in peak expiratory flow rate and abdominal muscle endurance after 4 weeks of abdominal muscle exercises in healthy females. There is significant difference in pretest and post-test measurement.

Key words: Peak Expiratory Flow Rate, Abdominal Muscle Endurance, Abdominal Muscle Exercise.

Address for correspondence: Dr. Karunanithi Sathiya Seelan, Vice Principal and Professor in Physiotherapy, PES college of physiotherapy, Kuppam, Chittoor District, Andhra Pradesh 517425, India.
E-Mail: seelank.phsio@gmail.com

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INTRODUCTION

The muscles of respiration are also called the 'breathing pump muscles', they form a complex arrangement in the form of semi-rigid bellows around the lungs. All muscles that are attached to the human rib cage have the inherent potential to cause a breathing action. Muscles that are helpful in expanding the thoracic cavity are called inspiratory muscles because they help in inhalation. Those that compress the thoracic cavity are called expiratory muscles and they induce exhalation. These muscles possess the same basic structure as all other skeletal muscles, and they work in concert to expand or compress the thoracic cavity [1]. The specialty of these muscles are that they are composed of fatigue resistant muscle fibers, they are controlled by both voluntary and involuntary mechanisms [2]. The primary inspiratory muscles are the diaphragm and external intercostals. Relaxed normal expiration is a passive process, happening because of the elastic recoil of the lungs and surface tension. However, there are a few muscles that help in forceful expiration and include the internal intercostals, intercostalis intimi, subcostals and the abdominal muscles [3].

The muscles of inspiration elevate the ribs and sternum, and the muscles of expiration depress the diaphragm the posterior aspect of the diaphragm is considered to be part of the posterior abdominal wall. The diaphragm is a double domed musculotendinous sheet, located at the inferior-most aspect of the rib cage. Undergoes contraction and relaxation, altering the volume of the thoracic cavity and the lungs, producing inspiration and expiration [4]. Innermost intercostal muscles are an incomplete muscle layer and cross more than one intercostal space. These muscles assist in the function of external and internal intercostal muscles [5]. The accessory inspiratory muscles are sternocleidomastoid, the scalenus anterior, medius and posterior, the pectoralis major and minor, the inferior fibers of serratus anterior and latissimus dorsi, the serratus posterior superior may help in inspiration also the iliocostalis cervicis. Technically any muscle attached to the upper limb and the thoracic cage can act as an accessory muscle of inspiration through reverse muscle action (muscle work from distal to proximal) [2].

The major expiratory muscles are the abdominal muscles and play an important role in ventilation. The lungs and respiratory system allow us to breathe. They bring oxygen into our bodies (called inspiration, or inhalation) and send carbon dioxide out (called expiration, or exhalation). The respiratory system is crucial for life as it allows the exchange of gases between an organism and the environment. This exchange of oxygen and carbon dioxide is called respiration. Expiration is a passive process, and it is achieved through the elastic recoil of the lung. During forceful expiration, the abdominal muscles are used. They may get weak due to nerve involvement, disuse atrophy, stretch weakness due to parity, diastasis recti etc. In females, Pregnancy and post-natal muscle weakness, successive pregnancies are factors that compromise abdominal muscle strength and endurance. It has been evaluated that person with partial or complete weakness of abdominal muscles is unable to cough and produce forced expiration effectively which affects in clearing secretions from the lungs [6].

Peak expiratory flow rate is one of the important parameters in pulmonary function testing that evaluate cough strength. Abdominal muscle strengthening exercise is safe and beneficial for any normal individual. Which can improve peak expiratory flow rate which improves quality of life [7]. The purpose of the present study is to examine the effects of abdominal muscle exercises may improve the abdominal endurance and pulmonary function performance (peak expiratory flow rate) in females.

MATERIALS AND METHODS

Research Design, Setting, and Sampling Method: The current study used a quasi-experimental research approach to assess the expected outcomes in a controlled academic setting. The study lasted one month and took place on the campus of the PES Institute of Medical Sciences and Research (PESIMSR) in

Kuppam. The study included physiotherapy students from PESIMSR. A purposive sample strategy was used to identify participants who met the inclusion criteria and were most relevant to the study's aims. The study sample of the study consisted of 30 people, guaranteeing enough representation for relevant data interpretation and analysis.

Criteria for Selecting Samples: The study comprised healthy female adult individuals aged 18-25 years with a normal Body Mass Index (BMI) of 18.5 to 22.9 kg/m². Participants had to have at least "fair" abdominal muscle endurance (6-12 repetitions) according to the American College of Sports Medicine's (ACSM) Abdominal Curl-Up Test. Only those who wished to freely engage in the study were chosen. Subjects were excluded if they participated in another exercise program during the study period. Individuals with a history of recent thoracic or abdominal surgery, rib fractures, recent abdominal muscle strain, back injury, or smoking status were excluded. Participants with cardiorespiratory disorders such as asthma, COPD, TB, angina, a recent heart attack, respiratory infection, or pneumothorax were also excluded. In addition, people with neurological diseases such as multiple sclerosis, peripheral nerve injury, spinal cord injury, or hernia were excluded. Participants who had diastasis recti or were pregnant were also excluded from the trial.

METHODOLOGY

Approval from the ethical committee was obtained and then recruitment of subjects was conducted among the PESIMSR students. Throughout the period of study, ethical issues were followed with almost care and due request towards the subject health. All the participants were asked for their information consent before entering trail. Each subject was explained about both beneficial and potential harmful effects (if any) of the treatment which participants will be supposed to receive. The participant explained the purpose of the trail. Demographic data was obtained from all the subjects at the beginning of the study. Samples who met the inclusion criteria were selected. Then, they were taken into single groups and consent letter was signed. Measurements of peak expiratory flow rate were taken as baseline on the 1st day and post-test on the 14th day. Assessment was done approximately at the same time. The values were recorded on day 1 and day 14 and peak expiratory flow was measured with Mini Wright's peak flow meter as pre and post-test.

Pre-Test: Every participant was instructed to stand. The peak expiratory flow rate was checked in sitting position.22 The peak flow meter was taken, and the cursor was set to Zero (0). Then, the mouthpiece was attached to end and firmly held by lips (no air leakage) by the subject. Then, the peak flow meter was placed in the mouth, in front of eyes and in horizontal position. Every Subject was instructed to inhale as deeply as possible and exhale with maximal force into peak flow meter using the mouthpiece. Same procedure was performed three times and best trial was noted. Before and after exercise protocol same procedure was done. The metronome was set for 50 beats per minute. Individuals lay on back with arms flat to the floor and palms facing down. The middle fingers of each hand touched the first line of tape. Heads were facing the ceiling and Knees were bent with feet flat on the floor.

Test: When the individual was ready, the stopwatch was set for 60 seconds. Then, they began to curl the upper part of body until their fingertips touched the second strip of tape and returned to original position with shoulder blades touching the floor or mat. Each movement was performed to the "click" or beat of the metronome. The number of repetitions was counted during the 60 seconds.

Termination: If the subject could complete 25 repetitions within the minute or when the minute is over. If the subject is no longer able to keep the beat of the metronome. If individuals begin to roll their neck forward at any time, they need to stop the test.

Grading: Excellent: 25 repetitions, very good: 17 to 24 repetitions, Good: 12 to 17 repetitions, Fair: 6 to 12 repetitions, Needs improvement: 6 or less than that.

After the end of the procedure abdominal endurance was derived. Before and after exercise protocol same procedure was done.

EXERCISE PROTOCOL:

Abdominal muscle exercises: For 1st And 2nd Week (6 Sessions) - Abdominal muscle strengthening exercises were taught to the participants. Initially warmup exercises were taught to the participants.

CRUNCH EXERCISE: The Starting position was in Crook lying. The subject had to lift their head off the mat. This caused a stabilizing contraction of abdominal muscles. They lifted their shoulders until the spine of scapula and thorax cleared the mat keeping the arms horizontal. The patient did not come to a full sit-up because once the thorax cleared the mat, the rest of motion is performed by hip flexors.

LEG LOWERING EXERCISE: The participants were in supine lying position and forearms and elbows were resting on the mat for support. The participant's hips were at 90 º and knees were extended; then they lowered the leg as far as possible while maintaining stability in lumbar spine (should not increase the lordosis), followed by raising their legs back to 90º.

SIDE PLANK: Participants assumed the side bridge position with their elbow under shoulder and upper arm perpendicular to the ground, while their body was resting one lower arm/elbow and foot on same side. Finally cool down exercises were taught to the participants. Exercises were done for 3 days /week. Repetitions: 5-10 times. Frequency: 3 sessions per week on alternative day. In the 1 session 2 sets of exercise were done.18 Total duration: 30 Minutes. After first 2 weeks of exercise protocol there was progression in exercise protocol in 3rd and 4th week by increasing the number of repetitions and types of exercises.

For 3rd and 4th week (6 sessions) - Initially warm up exercises were taught to the participants.

BICYCLE CRUNCH: Participants were instructed to lie on their back on the mat, with their arms straight up, knees bent and feet flat. They kept their back flat on the floor slowly extending left arm and right leg with the flexion of opposite extremities. Maintaining a strong core and keeping low back on the floor was tough. Then they returned to the starting position and repeated the movement on the other side to complete 1 repetition.

SCISSORS: Participants lay on them down on back with their hands placed on either at sides or underneath glutes for added back support. Then they extended their legs out straight, twisting them in and out above each other, or straight up and down— either way. They did not let their legs drop to the mat. They ensured that their core was engaged and that their lower back was pressed onto mat throughout. Move with slow and controlled movements.

HEEL TAPS: To perform heel touches, the starting position was lying position, face-up on an exercise mat. They kept their backs flat and bent their knees to a 90-degree angle with their feet firmly planted on the floor. Then engaged their core as they bend their spine to reach right hand toward their right ankle. Participants were instructed to repeat this movement on left side, alternating sides between each repetition. Finally cool down exercises were taught to the participants. Exercises were done for 3 days /week. Repetitions: 10-15 times. Frequency: 3 sessions per week on alternative day. In the 1 session 2 sets of exercise will be done.22 Total Duration: 40 Minutes.

Post - Test: Post-test was done as same as pre-test.

Statistical analysis: GraphPad software was used for the statistical analysis to analyze and interpret the data. The paired T-test was used for intragroup analysis.

RESULTS

Participant Characteristics: A total of 30 participants were recruited for the study. All participants were female (100%), as illustrated in Figure 1. The mean age of participants in Group A was 20.53 years, as shown in TFigure 2.

Intragroup Analysis of Group A

Peak Expiratory Flow Rate (Test 1):

A paired-sample t-test was conducted to compare the pre-test and post-test values of

Table 1: Comparison of Pre- and Post-Test Peak Expiratory Flow Rate in Group A (n = 30).

Group A Test 1 Peak expiratory flow rate	Paired Differences				T	N	DF	Sig. (2-tailed)
	Mean	Standard Deviation	95% Confidence Interval of the Difference					
			Lower	Upper				
Pre-Test	241.173	42.643	-13.294	-8.619	9.5855	30	29	0.0001
Post-Test	252.13	40.453						

Table 2: Comparison of Pre- and Post-Test Abdominal Curl-Up Scores in Group A (n = 30).

Group A Test 2 Abdominal curl up test	Paired Differences				T	N	DF	Sig. (2- tailed)
	Mean	Standard Deviation	95% Confidence Interval of the Difference					
			Lower	Upper				
Pre-Test	9.63	3.12	-4.67	-3.86	21.623	30	29	0.0001
Post-Test	13.9	3.07						

peak expiratory flow rate in Group A. Results indicated a statistically significant improvement following the intervention ($t(29) = 9.59$, $p = .0001$). The mean pre-test value was 241.17 ± 42.64 L/min, while the post-test mean was 252.13 ± 40.45 L/min, representing a mean difference of -10.96 ± 2.19 L/min. These findings suggest a significant enhancement in respiratory function post-intervention (see Table 1 and Figure 3).

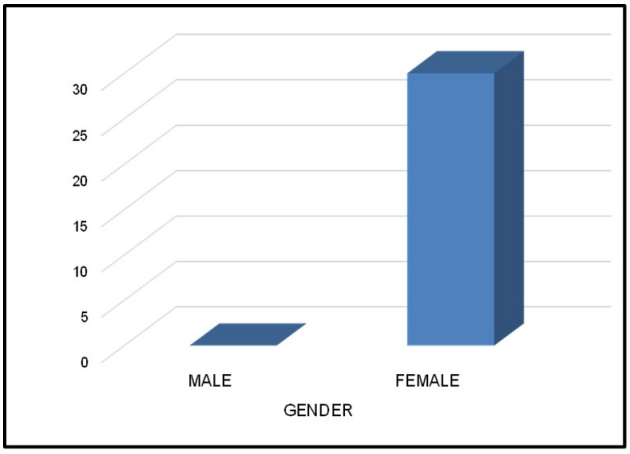

Fig. 1: Gender distribution of participants.

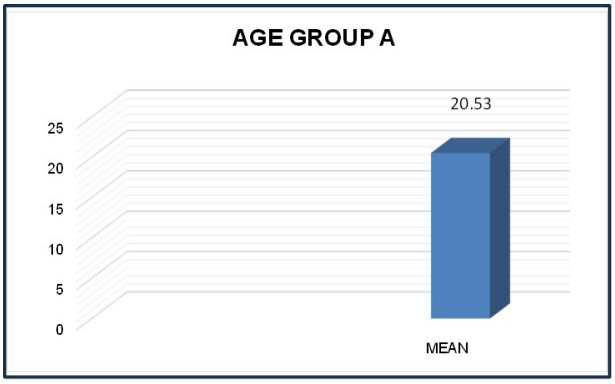

Fig. 2: Mean age of participants in Group A.

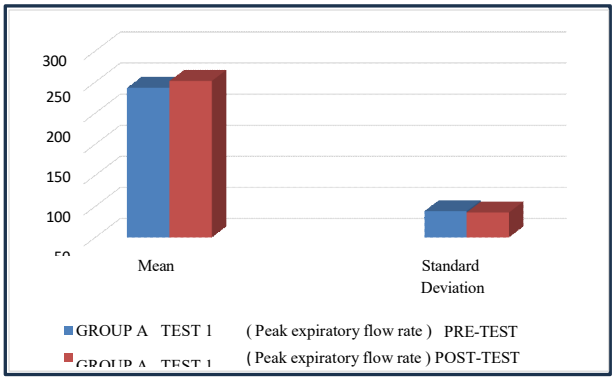

Fig. 3: Comparison of pre- and post-test mean peak expiratory flow rate in Group A.

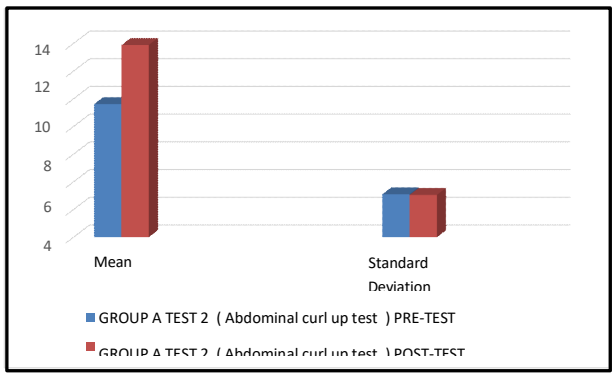

Fig. 4: Comparison of pre- and post-test mean abdominal curl-up scores in Group A.

RESULTS

All study participants were female, with an average age of 20.53 years. Intragroup comparisons demonstrated significant improvements in peak expiratory flow rate and abdominal curl-up performance after the intervention. These data show that the exercise intervention was helpful in improving participants' respiratory function and abdominal muscular endurance.

DISCUSSION

The current study sought to assess the effect of abdominal muscle exercises on peak expiratory flow rate (PEFR) in healthy people. The results showed that the intervention resulted in a considerable improvement in both peak expiratory flow rate and abdominal muscular endurance. These findings imply that strengthening abdominal muscles improves respiratory efficiency in healthy people.

The improvement in PEFR found in this study is most likely due to the abdominal muscles' facilitatory role in respiration. Expiration is primarily a passive process during silent breathing, resulting from elastic recoil of the lungs, chest wall, and abdominal muscles which push the abdominal contents upward against the diaphragm, thereby increasing intra-abdominal and intrathoracic pressures. This action compresses the lungs and enhances air expulsion. Strengthening these muscles through targeted exercises improves their capacity to assist the diaphragm in generating expiratory pressure, resulting in an increased PEFR [8].

The current study's findings are consistent with earlier research showing that abdominal muscle exercises improve respiratory parameters. Bajpai et al. (2024) found that graded abdominal exercises significantly increased respiratory muscle strength and lung capacities, including functional residual capacity and expiratory reserve volume, in obese female college students [8]. Similarly, Shah and Mishra (2021) discovered that a 6-week sit-up training program improved abdominal strength, endurance, and pulmonary function in female participants [9]. Modi and Shah (2021) discovered that abdominal curls improved PEFR in middle-aged females, while Shao et al. (2018) found similar benefits in healthy males performing sit-up exercises, including increased abdominal endurance, expiratory muscle strength, and maximal voluntary ventilation [4,10]. Furthermore, Wadhwa et al. (2016) showed that three weeks of abdominal muscle training significantly improved PEFR in normal individuals, emphasizing the role of these muscles in forced expiration [11].

Furthermore, another study found that abdominal muscle strengthening improved pulmonary ventilation (MVV and FVC) and reduced inter-recti distance in postnatal women with diastasis recti, emphasizing the significance of abdominal muscle conditioning in maintaining optimal respiratory function [12].

Implications and Future Directions: The findings suggest that abdominal muscle strengthening activities should be included in respiratory training programs, even in healthy people. Improved expiratory flow rates may help to improve breathing efficiency, athletic performance, and clinical outcomes in people with limited respiratory capacity. Future research should look into the optimal intensity, duration, and kind of abdominal exercises for maximum respiratory effects, as well as larger sample sizes and control groups to strengthen the evidence basis.

CONCLUSION

The current study found that abdominal muscle exercises significantly enhance peak expiratory flow rate and abdominal muscular endurance in healthy people. The improvement is linked to improved expiratory function of the abdominal muscles, improved diaphragmatic mechanics, and adaptive muscular changes caused by regular exercise. These findings are consistent with prior research and highlight the role of belly strengthening activities in improving respiratory performance.

Conflicts of interest: **None**

REFERENCES

[1]. Pasad B, Palkar A, Kumar A. Effect of abdominal muscle exercises on peak expiratory flow rate in obese individuals. International Journal of Physiotherapy and Research. 2020;8(4):3521-3525. https://doi.org/10.16965/ijpr.2020.138

[2]. Deshpande SS, Nataraj M. Effects of abdominal muscle exercises on the respiratory muscle strength & peak expiratory flow rate in females with BMI more than twenty-five. International Journal of Health Sciences and Research. 2018;8:167-170.

[3]. Rodríguez-Núñez I, Navarro X, Gatica D, Manterola C. Effect of abdominal muscle training on respiratory muscle strength and forced expiratory flows in sedentary, healthy adolescents. Arch Argent Pediatr. 2016 Oct 1;114(5):434-440. https://doi.org/10.5546/aap.2016.eng.434

[4]. Shao YJ, Chan ML, Chen YH. Effects of abdominal exercise on respiratory muscles and pulmonary function in healthy males. International Journal of Physiotherapy and Research. 2018;6(1):2606-2612. https://doi.org/10.16965/ijpr.2017.262

[5]. Singh K. Effectiveness of abdominal muscle exercise in improving peak expiratory flow rate in normal individuals. A Journal of Medical Science and Technology. 2013;2:1-4.

[6]. Rodríguez-Núñez I, Navarro X, Gatica D, Manterola C. Effect of abdominal muscle training on respiratory muscle strength and forced expiratory flows in sedentary, healthy adolescents. Arch Argent Pediatr. 2016 Oct 1;114(5):434-440. https://doi.org/10.5546/aap.2016.eng.434

[7]. Sutton PP, Parker RA, Webber BA, Newman SP, Garland N, Lopez-Vidriero MT, Pavia D, Clarke SW. Assessment of the forced expiration technique, postural drainage and directed coughing in chest physiotherapy. European Journal of Respiratory Diseases. 1983 Jan 1;64(1):62-68.

[8]. Bajpai S, Mishra R, Jain A, Jain M, Bhargava A. Effects of abdominal muscle exercises on peak expiratory flow rate in college going obese females. Journal of Cardiovascular Disease Research. 2024;15:316-322.

[9]. Shah K, Mishra A. Effect of sit up exercise for 6 weeks on pulmonary functions in females: An experimental study. Journal of Emerging Technologies and Innovative Research (JETIR). 2021;8:1518-1525.

[10]. Modi S, Shah S. Effect of abdominal curls on peak expiratory flow rate (PEFR) in middle age females. International Journal of Health Sciences and Research. 2021;11:62-66. https://doi.org/10.52403/ijhsr.20210509

[11]. Wadhwa D, Chhajed B, Hande D. Is there any effect of abdominal muscle exercises on peak expiratory flow in normal individuals? Int J Health Sci Res. 2016;6(6):192-198.

[12]. Francis NM, Mathew P. Effect of abdominal muscle exercise on peak expiratory flow rate in overweight/obese post menopausal women. International Journal of Health Sciences and Research. 2023;13:18-31. https://doi.org/10.52403/ijhsr.20230304

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