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EDITORIAL

CORRELATION BETWEEN ABDOMINAL MUSCLE STRENGTH AND PULMONARY FUNCTION TEST PARAMETERS IN HEALTHY STUDENTS: AN OBSERVATIONAL STUDY

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ABSTRACT:

Background: Ventilation is the mechanical process by which air is inhaled and exhaled. During forced expiration, active muscle contractions are required which include four abdominal muscles rectus abdominis, external oblique, internal oblique, and Transverses Abdomonis. Pulmonary function tests are an important tool in the investigation and monitoring of patients with respiratory pathology. This study aimed to find a correlation between abdominal muscle strength and pulmonary function test parameters in healthy students. **Methodology:** It was an observational study with 6 months duration including 40 healthy students recruited by purposive sampling method. The outcome measure was ACSM Strength Test and Pulmonary Function Test. **Result:** Using Spearman Test, the correlation between Abdominal Muscle Strength and FVC performed, r = +0.3621, p = 0.0217 showed positive weak correlation that was statistically considered significant, the correlation between Abdominal Muscle Strength and FEV1 performed, r = + 0.3957, p = 0.0115 showed positive weak correlation that was statistically considered significant, the correlation between Abdominal Muscle Strength and FEV1/FVC performed, r = - 0.1257, p = 0.4396 showed negative very weak correlation that was statistically considered not significant., the correlation between Abdominal Muscle Strength and PEFR performed, r = - 0.1543, p =0.3419 showed negative weak correlation that was statistically considered not significant. **Conclusion-** From the present study, we found that there is a positive weak correlation between Abdominal Muscle Strength and FVC, between Abdominal Muscle Strength and FEV1, and a negative very weak correlation between Abdominal Muscle Strength and FEV1/FVC and Abdominal Muscle Strength and PEFR.

Keywords: Abdominal Muscle Strength, Pulmonary Function Test, FVC, FEV1, FEV1/FVC, PEFR.

INTRODUCTION:

Ventilation is the mechanical process by which air is inhaled and exhaled through the lungs and airways. [1] Breathing consists of two phases: inspiration (breathing in), during which air flows into the lungs, and expiration (breathing out), during which air is expelled from the lungs. The combined actions of inspiration and expiration constitute the respiratory cycle. When the diaphragm and external intercostal muscles contract, quiet inspiration begins. During expiration, the events are just the opposite of those in inspiration. The diaphragm and external intercostal muscles relax and return to their original position. [2]

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During low breathing effort (i.e., at rest) only the inspiratory muscles are active. During high breathing effort (i.e., exercise) the expiratory muscles become active as well.[3]

Quiet (tidal) expirations are a normally passive process by elastic recoil of the thorax, lung, and relaxing diaphragm which reduces the dimensions of the thorax. During forced expiration, active muscle contractions are required to rapidly reduce intrathoracic volume which includes four abdominal muscles rectus abdominis, external oblique, internal oblique, and Transverses Abdomonis (TA) that forms the ventrolateral wall of the abdomen.[4]

The Rectus abdominis is a long strap muscle that extends the entire length of the anterior abdominal wall lies close to the midline, it is an important postural and core muscle. With a fixed pelvis, contraction results in flexion of the lumbar spine. When the ribcage is fixed contraction results in a posterior pelvic tilt. It also plays an important role in forced expiration and increasing intra-abdominal pressure. External oblique muscle, the most superficial anterolateral abdominal muscle its fibers run anteromedially, unilateral action results in ipsilateral side flexion and contralateral rotation of the trunk bilateral action to flex the vertebral column by drawing the pubis towards the xiphoid process. [5]

Internal oblique directed superomedial perpendicular to the external oblique acts unilaterally for ipsilateral trunk rotation and side flexion and bilaterally to compress the abdominal viscera, pushing them up into the diaphragm, resulting in forced expiration. Transversus abdominis is the deepest of the abdominal muscles, it is an important core muscle and its primary function is to stabilize the lumbar spine and pelvis before movement of the lower and /or upper limbs occurs [6] They have a wide variety of functions, including participation in postural, ventilatory, and airway defensive reflexes. These muscles exhibit specific characteristic activity during different behaviors. For example, the rectus abdominis is considered to be primarily a postural muscle, whereas the Transversus abdominis has both postural and ventilatory functions.[7]

Pulmonary function tests (PFT) are an important tool in the investigation and monitoring of patients with respiratory pathology. They provide important information relating to the large and small airways, the pulmonary parenchyma, and the size and integrity of the pulmonary capillary bed[8] The parameters typically measured during spirometry are Forced Vital Capacity, Forced Expiratory Volume in 1 second, Ration of FEV_1 to FVC, Forced Expiratory Volume in 3 seconds, Forced Expiratory Volume in 6 seconds, Peak expiratory flow, Maximal mid expiratory flow. After the test results are valid, patients FVC, FEV_1, and FEV_1/FVC are compared to predicted reference ranges. If all three values fall within the reference ranges, the results are deemed normal. If FEV_1 is reduced and FEV_1/FVC ratio falls below LLN (below the 5th percentile of predicted) the patient is classified as having an obstructive ventilator impairment. If FVC is reduced, FEV_1 is normal or reduced and FEV_1/FVC is above LLN (normal or higher than normal) the patient is classified as having restrictive ventilators impairment.[9]

METHODS:

This was an observational study with study duration of 6 months. A total of 40 participants were recruited using the purposive sampling method from Dr. Vitthalrao Vikhe Patil College of Physiotherapy, Ahmednagar. The study materials included Computer with RMS Helios 401 Spirometer, a Chair, a Nose clip Pen &Pencil, Weighing Machine, Measuring Tape, Mat, Metronome.

The inclusion criteria included healthy students with age 18-25, both male and female, healthy students with normal Body Mass Index. (18.5 – 24.9), healthy students with normal Chest-Xray findings, healthy students with normal breath sound on auscultation. While the exclusion criteria included students with BMI > 24.9 and < 18.5, students with any past or present history of acute or chronic respiratory disorders, cardiovascular disorders, a neuromuscular or musculoskeletal condition affecting the respiratory system, students with symptoms/signs/investigations showing pulmonary disorder, students with recent URTI / LRTI, recent thorax or abdomen surgery.

PROCEDURE:

Institutional Ethical Committee approval was obtained before the commencement of the study. Healthy students were selected based on inclusion and exclusion criteria. Informed consent was obtained before involving them in the study in a language best understood by them. Basic demographic data like name, age, gender, weight, height, BMI, smoking history were documented on the data collection sheet. The subjects were explained about the procedure, benefits, and the need of the study in a language best understood by them. Their abdominal muscle strength was examined using ACSM Abdominal Strength Test. Students were then asked to perform PFT which was carried out for each of these students using the RMS Helios401 spirometer. The subjects were explained in detail about the procedure of spirometry and values of FVC, FEV_1, FEV_1/FVC & PEFR of the best-performed maneuver were noted. The parameters were assessed and interpretation of PFT was done.

The procedure of ACSM Abdominal Strength Test:

Place two pieces of tape about 10 cm apart on the mat. Lie on back with arms flat to the floor and palms facing down. The middle fingers of each hand should touch the first line of tape and knees bent with feet flat on the floor. Begin to curl the upper part of the body until fingertips touch the second strip of tape. Return to the original position. Each movement should be performed to the "click" of the metronome of 50 beats per minute. Keep count of the number of repetitions. If the subject completes 25 repetitions within the time limit, the rating for abdominal strength is excellent,17-24 repetitions rating is very good, 12-17 reps. rating is good, 6-12 repetitions rating is fair. If the score is ≤6, the rating is poor.

The procedure of Pulmonary Function Test:

The test was done in a sitting position. The student was asked to inhale deeply through the nose and close his lips around the mouthpiece. After that, the student was asked to exhale forcefully into the mouthpiece for six seconds and inhale forcefully through the mouthpiece. The student was asked to perform the maneuver three times and the best-obtained reading was considered. Values of FVC, FEV1, FEV1/FVC & PEFR of the best-performed maneuver were noted.

Fig 1: Starting position of ACSM

Fig 2: End position of ACSM

Fig 3: Pulmonary Function Test

RESULT:

The data were analyzed in an excel sheet. Instat version3 was used to calculate the mean, standard deviation, and p values. Spearman test was used to correlate abdominal muscle with FVC, FEV1, FEV1/FVC & PEFR.

Table 1: Mean and Standard Deviation of Age, Weight, Height, BMI.

	Mean ± SD
Age	22.35 ± 1.145
weight	55.3425 ± 6.789
Height	161.625 ± 6.720
BMI	21.06 ± 1.821

Table 2: Mean and Standard Deviation of Abdominal muscle strength, FVC, FEV1, FEV1/FVC ratio, and PEFR

	Mean ± SD
No. of reps of AMS	13.82 ± 1.89
FVC Pred	4.10 ± 0.48
FVC Pre	2.68 ± 0.50
FEV_1 Pred	3.39 ± 0.35
FEV_1 Pre	2.36 ± 0.37
FEV_1/FVC Pred	78.79 ± 17.54
FEV_1/FVC Pre	87.26 ± 14.66
PEFR Pred	7.14 ± 0.97
PEFR Pre	5.56 ± 1.36

Table 3: Correlation between Abdominal muscle strength, FVC, FEV1, FEV1/FVC ratio, and PEFR.

	Type	r value	p-value
Abdominal muscle strength and FVC Pre	Positive	0.3621	0.0217
Abdominal muscle strength and FEV_1 Pre	Positive	0.3957	0.0115
Abdominal muscle strength and FEV_1/FVC Pre	Negative	0.1257	0.4396
Abdominal muscle strength and PEFR Pre	Positive	0.1543	0.3419

Correlation between Abdominal Muscle Strength and FVC performed, r = +0.3621, p = 0.0217 showed a positive weak correlation that was statistically considered significant. (Table 3)

Correlation between Abdominal Muscle Strength and FEV1 performed, r = + 0.3957, p = 0.0115 showed a positive weak correlation that was statistically considered significant. (Table 3)

Correlation between Abdominal Muscle Strength and FEV1/FVC performed, r = - 0.1257, p = 0.4396 showed negative very weak correlation that was statistically considered not significant. (Table 3)

Correlation between Abdominal Muscle Strength and PEFR performed, r = - 0.1543, p =0.3419 showed a negative weak correlation that was statistically considered not significant. (Table 3)

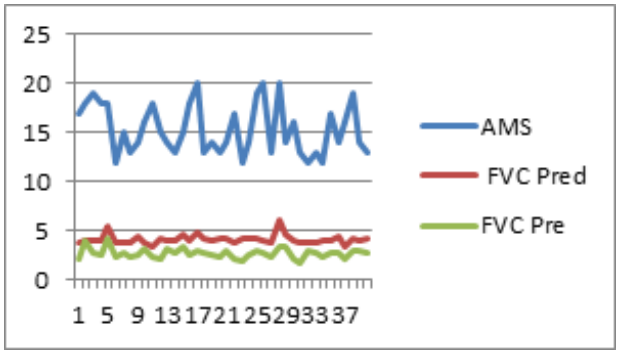

Fig 4: Line graph representing the correlation between abdominal muscle strength, FVC Predicted, FVC Performed

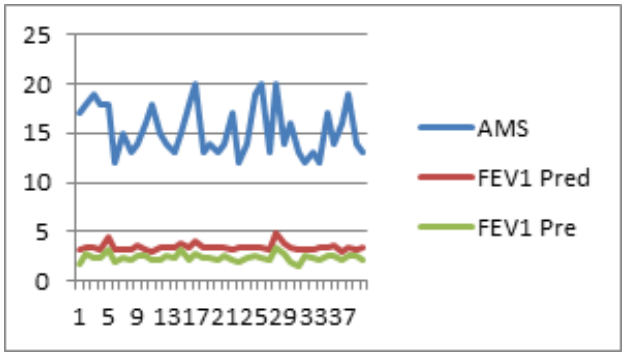

Fig 5: Line graph representing the correlation between abdominal muscle strength, FEV1 Predicted and FEV1 Performed.

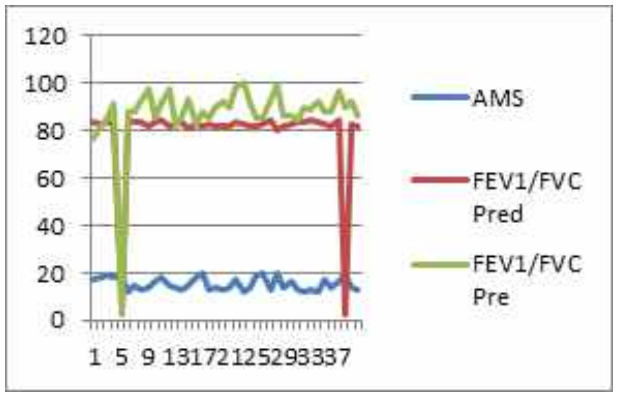

Fig 6: Line graph representing the correlation between abdominal muscle strength, FEV1/FVC Predicted, FEV1/FVC Performed.

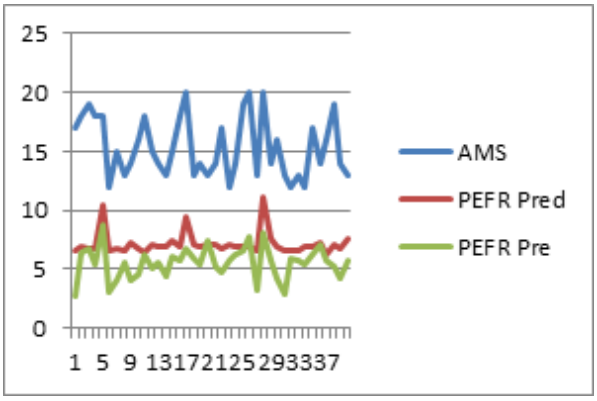

Fig 7: Line graph representing the correlation between abdominal muscle strength, PEFR Predicted, PEFR Performed.

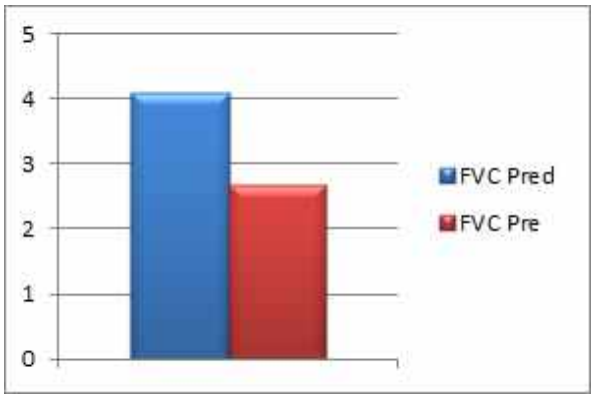

Fig 8: Bar Graph of FVC predicted & FVC performed.

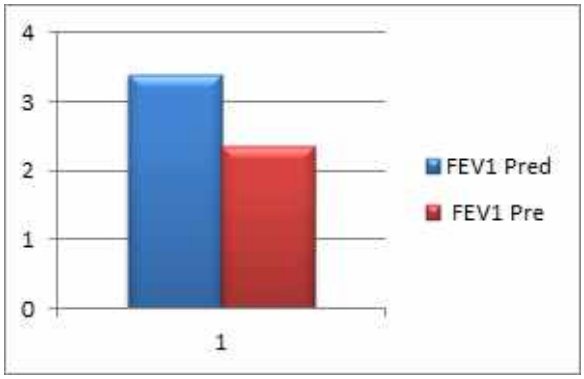

Fig 9: Bar Graph of FEV1 predicted & FEV1 performed.

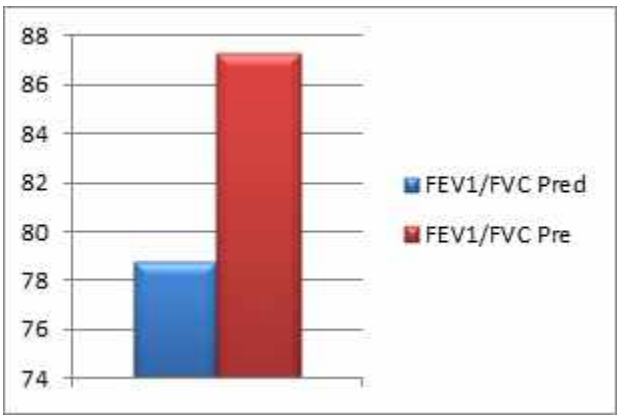

Fig 10: Bar Graph of FEV1/FVC predicted and FEV1/FVC performed.

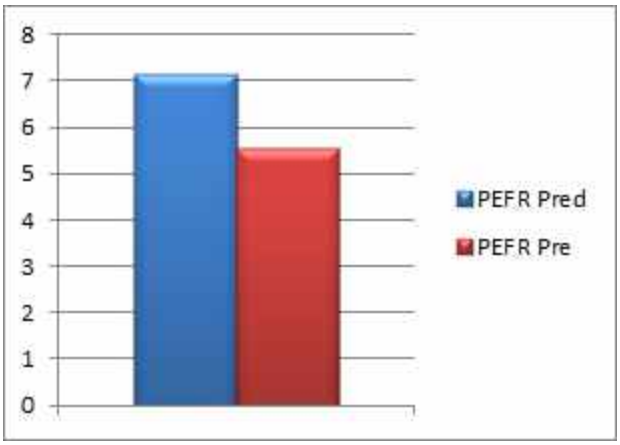

Fig 11: Bar Graph of PEFR predicted and PEFR performed.

Line graph representing the correlation between abdominal muscle strength, FVC Predicted, FVC Performed is as per Fig 4. Line graph representing the correlation between abdominal muscle strength, FEV1 Predicted and FEV1 Performed is as per Fig 5. Line graph representing the correlation between abdominal muscle strength, FEV1/FVC Predicted, FEV1/FVC Performed is as per Fig 6. Line graph representing the correlation between abdominal muscle strength, PEFR Predicted, PEFR Performed is as per Fig 7. Bar Graph of FVC predicted & FVC performed is as per Fig 8. Bar Graph of FEV1 predicted & FEV1 performed is as per Fig 9. Bar Graph of FEV1/FVC predicted and FEV1/FVC performed is as per Fig 10. Bar Graph of PEFR predicted and PEFR performed is as per Fig 11.

DISCUSSION:

The present study was conducted on the correlation between abdominal muscle strength and pulmonary function test parameters in healthy students. The abdominal muscle strength was measured by ACSM Abdominal strength test. A pulmonary function test was done to assess the pulmonary function test parameters like FVC, FEV1, FEV1/FVC, and PEFR.

From the current study it is stated that the Correlation between Abdominal Muscle Strength and FVC performed, r = +0.3621, p = 0.0217 showed a positive weak correlation that was statistically considered significant (Table No.3). Correlation between Abdominal Muscle Strength and FEV1 performed, r = + 0.3957, p = 0.0115 showed a positive weak correlation that was statistically considered significant (Table No.3). Correlation between Abdominal Muscle Strength and FEV1/FVC performed, r = - 0.1257, p = 0.4396 showed negative very weak correlation that was statistically considered not significant (Table No.3). Correlation between Abdominal Muscle Strength and PEFR performed, r = - 0.1543, p =0.3419 showed a negative weak correlation that was statistically considered not significant. (Table No. 3).

The study indicates that with an increase/decrease in abdominal muscle strength there is an increase/decrease in FVC, with an increase/decrease in abdominal muscle strength there is an increase/decrease in FEV1, with an increase/decrease in abdominal muscle strength there is decrease/increase in FEV1/FVC, with increase/decrease in abdominal muscle strength there is decrease/increase in PEFR.

Abdominal muscles (Transversus abdominis, internal oblique abdominis, external oblique abdominis, and rectus abdominis) are expiratory muscles.

Abdominal muscle fibers pull the ribs and costocartilage caudally, into a motion of exhalation. By increasing intra-abdominal pressure, the abdominal muscles can push the diaphragm upward into the thoracic cage, increasing both the volume and speed of exhalation[19].

When a person inhales more air, pressure is created within the abdomen, this pressure is supported by the abdominal and lower back muscles, and when the muscles are weak the support system cannot function properly leading to problems in breathing. [20]

The study conducted by Ruchi Patel et.al. 2016 found that there is a weak correlation between abdominal muscle strength and pulmonary function.[13]

A study conducted by Meenakshi Sable et.al. in the Indian adult population concluded that there is a positive correlation of BMI with lung function parameters like FVC, FEV1, and MVV. It also concluded that good pulmonary function can be maintained by good abdominal function and muscle strength. [21]

In a study conducted by Pranita Bhavsar et.al. 2018, it was concluded that there is a partial positive correlation between abdominal muscle strength and PEFR and there is no correlation between abdominal muscle strength and FEV1/FVC in individuals with low back pain. It also suggested that abdominal strengthening may help in good pulmonary function and may assist the ventilatory process along with maximum forceful exhalation with correct breathing techniques and posture. [22]

According to Sanya AO and Ramayide AO it is believed that the abdominal muscles could be strengthened to assist the ventilator process. [23]

Kim E, et.al. studied the effects of deep abdominal strengthening exercise on respiratory function and lumber stability, he concluded that the deep abdominal muscle strengthening exercises enhance the respiratory function and effective for lower back pain patients in need of lumbar stabilization.[20] The study conducted by Anitha Kumari Abbina et.al. reported that there is a high positive correlation between Abdominal Muscle Strength and FEV1 / FVC ratio. It also reported that there is a high positive correlation between Abdominal Muscle Strength and Chest Excursion. This study concluded that good pulmonary function can be maintained by good abdominal muscle strength[24]

CONCLUSION:

This study concludes that there is a positive weak correlation between Abdominal Muscle Strength and FVC, a positive weak correlation between Abdominal Muscle Strength and FEV1, a negative very weak correlation between Abdominal Muscle Strength and FEV1/FVC, and a negative very weak correlation Abdominal Muscle Strength and PEFR.

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