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Effect of Pilates on forward head posture correction and pulmonary functions in chronic neck pain individuals

Gauri Ramesh Gangane [1], Dr. T. Poovishnu Devi [2]

Krishna College of Physiotherapy, Maharashtra [1, 2]

ABSTRACT

Chronic Neck pain (CNP) is a common musculoskeletal problem in general population. According to Silva AG, Punt TD., it was found that people with neck pain had smaller Cranio-vertebral angle (CVA) than in other group with no neck pain, which indicates that individuals with neck pain have forward head posture (FHP)(7). The more the FHP the greater it affects the cervical range of motion particularly neck rotation and flexion. A number of studies have found that patients with neck pain have reduced respiratory capacity and function. Studies have been shown that chronic neck pain patients have significant reduction in maximum voluntary ventilation (MVV),maximal inspiratory pressure (Pimax) and maximal expiratory pressure (Pemax)(9). The aim of our study was to study the effectiveness of Pilates on posture correction and pulmonary functions in individuals with chronic neck pain. Method- To measure the severity of neck pain we used northwick's neck pain questionnaire and then we calculated the CVA by using the kinovea software after this the patient's pulmonary capacities like vital capacity (VC), Expiratory Reserve Volume(ERV),Forced Vital capacity (FVC) were measured using spirometry. The subjects were divided randomly into 2 groups, the people in 1st group were considered as experimental group (group A) and 2nd (Goup B) was the conventional group. Results- there was significant difference in the neck pain,CVA and pulmonary capacities in experimental and conventional group (p value <0.0001), but the ERV did not show significant changes in both the groups (p value 0.1504). Conclusion- Pilate's therapy when combined with conventional show better results when compared to only conventional, But the ERV in both groups did not show significant improvement.

Keyword: *forward head posture, pulmonary function, cranio-vertebral angle, spirometry*

1. INTRODUCATION

Chronic Neck pain (CNP) is a common musculoskeletal problem in general population. In a study conducted by Darivemula SB, et al., in the year 2016 shows that 43% of population had neck pain. Neck pain is known to have a periodic occurrence with varying recuperation between episodes, and it is said to be the most continuing musculoskeletal pain syndrome. Neck pain can be associated to conditions such as neurological conditions, infections, and fractures of the cervical spine, or it can be idiopathic.

In addition, the increasing use of latest technologies has led to a rise in time spent texting messages on cell phones or using laptops, which could have a huge impact on neck pain, definitely due to prolonged periods of neck flexion. In a study conducted by Chordiya S, Nikhade N et al., in the year 2019, it was found that 20% of industrial workers of Maharashtra had neck pain among other musculoskeletal problems. According to Cagnie B, Danneels L, et al., it was observed that 54.7% of females had neck pain whereas males having neck pain were 38.3% which is relatively significant.

In chronic neck pain patients it is observed that there is reduction in strength of muscles that produce flexion and extension of neck particularly deep muscles, deduction in range of motion of cervical spine than normal and hyperactivity and increased fatiguability of superficial neck flexors(9). A posture is considered ideal when the external auditory meatus is in line with the vertical posture line. A FHP exists when the head is in anterior position in relation to the theoretical plumb line, which is at 90 degrees to a horizontal line through the center of gravity of the body.

A FHP is perhaps the most typical abnormality associated with pain in the neck and is commonly considered as the prominence of the head in the sagittal plane so that the head is placed anterior to the torso (trunk). A common factor that leads to development of FHP is behavioural reasons, such as reading in a sitting position with books on a work surface putting neck in a flexion position. People may not have the knowledge of their bad posture

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and thus remain in this tensed posture for long periods (12).

Forward head posture can occur due to anterior shifting of the head, and it is considered to be related with a rise in upper-cervical extension. It is said that FHP leads to a rise within the compressive forces on the cervical apophyseal joints and posterior part of the vertebra and to changes in connective tissue length and strength (because of stretching of the anterior structures of the neck and shortening of the posterior muscles) resulting in pain (7). Neck flexion may promote FHP, which move head anterior to the shoulders. Severe FHP has been related with reduction in cervical motions, particularly neck rotation and flexion.

Increase in forward body posture is known to increase severity of thoracic kyphosis and cervical lordosis and this has a bad effect on function of diaphragm.

A stooped posture disrupts normal functioning of the muscle which puts great stress on the upper respiratory tract.

Normal respiration is a complex function comprising mechanical as well as non-mechanical components. It could be affected by various factors, including age, lifestyle, disease, and change in posture, that can interfere with its normal functioning (10). Various postures such as FHP and kyphosis have been proved to change breathing mechanism including mobility of diaphragm.

Alteration of cervicothoracic mobility impairs normal breathing mechanics by reducing diaphragm mobility and strength. FHP resulted in an immediate effect on respiratory function even when subjects assume FHP for a short duration of time. In a study conducted by Dimitriadis Z, Kapreli E et al., the individuals with chronic neck pain show marked reduction in vital capacity (VC), FVC, expiratory reserve volume (ERV), and maximum voluntary ventilation (MVV).

According to Ghanbari A, et al., it was observed that a distinct decrease in Vital Capacity (VC), FVC and ERV was seen with increasing Forward Shoulder Posture degree.

Severe FHP enhanced the actions of the sternocleidomastoid muscles and the anterior scalene muscles, and lessened the FVC (22).Although there is a lot of research done on the effect of sitting, lying, and standing postures on respiratory function, there are very few studies that examine the effect of altered head and neck posture on respiratory muscles strength in healthful young individuals with no previous deformity or disease (10). A number of studies have found that people with pain around neck have reduced respiratory capacity and function.

Studies have been shown that chronic neck pain patients have significant reduction in maximum voluntary ventilation (MVV),maximal inspiratory pressure (Pimax) and maximal expiratory pressure (Pemax)(9). Neck pain can be relieved by combining manual therapy with exercises; Exercise is mostly prescribed to control pain and help improve function of patients with neck pain (6), but pulmonary functions do not improve by these therapies and remain untreated.

Pilates training is often known to develop overall body flexibility and fitness by accentuating core strength, posture, and coordination of breathing with movement (13). It enhances posture by developing body awareness (14) and can be used as self-treatment, and can be simply modified for treatment of particular postural misalignments. In a study conducted by Sun-Myung Lee, MS et al., suggest that Pilate's physical activity results in over-all muscle retraining, which reinforces the deep neck muscles to enhance CVA and thus reduce neck pain (12).

The Pilates technique performs a role in the improvement of the trunk alignment, by strengthening and stretching exercises. It is supported six principles: Centralization, Control, Accuracy, Concentration, Breathing, and Flow.

As one is often observed, breathing is one among the principles, which for the creator of the tactic, it's important thanks to the higher synchronism between respiratory muscles and trunk stabilizers, leading to greater muscle control. The Pilates method is effective in increasing volumes and oxygenation in healthy individuals. Improves flexibility, strength, coordination, blood circulation, fitness, range of motion, and postural alignment. The technique works with low-impact muscle exercises that are supported isometric exercises of the abdominal muscles which generate force without action and alleviate the spine.

In the Pilates technique, the respiratory approach emphasizes costal breathing, where the ribs rise and fall during the respiratory flow, expanding laterally and to the posterior. The transverse muscle must work to stop abdominal distension, give greater support to the diaphragm to market the movement of the lower ribs, and supply greater diaphragmatic excursion. Pilates are often recommended as an efficient method of strengthening

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the abdominal muscles and to prevent development of asymmetries.

Thus, Pilate's method of exercise can be used to clinical populations that need to strengthen these particular muscles as well as increase abdominal activation on pulmonary functions.

The abdominal muscles—transverse abdominis, internal and external oblique, and rectus abdominis—are involved primarily in forced expiration in association to the expiratory muscles for ventilation. The abdominal muscles also have 2 inspiratory functions: (1) during forced expiration, the rise in intraabdominal pressure performs a passive stretch of the diaphragm's costal fibers, making it ready for the next inspiration; and (2) the increased pressure generated by the descent of the diaphragm within the inspiration must be countered by the strain of the abdominal muscles. Thus, without effective compliance of these muscles, the inner tendon of the diaphragm isn't effectively stabilized to perform the lateral expansion of the chest wall.

Therefore, during the increased work of breathing, a rise in abdominal activity follows in both stages of breathing. In the sense, increasing the abdominal muscle strength can lead to a strengthening of diaphragmatic function. The need of our study were, The effect on respiratory function in individuas with neck pain often goes unnoticed, which could further reduce the patient's lung volumes and capacities, forward neck posture increases neck pain.

Normally they take conservative treatment for pain and increasing Range of motion unaware about the progress it leads to changes in Posture and Pulmonary function. Chronic Neck pain could alter a patient's posture and has a negative impact on their respiratory function. Forward neck posture has been reported to reduce Expiratory Reserve Volume (ERV), Vital Capacity (VC), and Forced Vital Capacity (FVC). Advanced Exercise protocols is frequently prescribed to control pain, Range of Motion and improve strength of neck musculature in patients with neck pain.

Pilates minimizes neck pain by strengthening the postural muscles in order to encourage better spinal strength. The head, neck and shoulder position all have a key role in allowing the neck and shoulder stabilizing muscles to do their job correctly. Pilate's therapy is proven to reduce respiratory dysfunction and help improve posture of an individual. Strengthening the abdominal muscles can help in improving respiratory function, leading to improvements in lung volume and capacity. The aim of this study was to study the effectiveness of Pilates on posture correction and pulmonary functions in individuals with chronic neck pain. The objectives of this were, to reduce FHP in chronic neck pain patients, to improve pulmonary function in chronic neck pain patients and to find out effectiveness of Pilates in improving pulmonary function and forward head posture.

2. MATERIALS AND METHODOLOGY

The type of study was experimental and the study was randomized control trial. The study population was from Karad, Maharashtra and a total 35 individuals participated, study duration was of 3 months. Inclusion criteria for this was as follows, Patients having chronic neck pain with Cranio-vertebral angle less than 52˚, Patients with reduced pulmonary functions and Age between 18-35 years of both genders.

Also the exclusion criteria was Individuals who had any recent surgery of the thorax and abdomen, Individuals with recent fracture of cervical spine, Individuals with diagnosed obstructive and restrictive lung diseases and mentally unstable individuals.

Ethical committee approval was taken from Krishna institute of medical sciences deemed to be university, Karad. Consent was taken from patients. The patients who fulfilled inclusion criteria were chosen. The procedure of the study will be explained thoroughly. Total 35 participants were selected for the study who fulfil the inclusion criteria they were randomly split into two groups of 18(group A) and 17(group B) participants.

Group A was given advanced Pilates therapy and conventional management for total duration of 45 minutes per day. Total 10 females and 8 males were there in this group. The mean of their BMI was around 26.9 ± 1.53 which falls under the criteria for over-weight. Group B was offered with conventional physiotherapy treatment like combined exercise program consisted of stretching and strengthening protocol typically used to maintain posture. In this group total 9 females and 8 males were present. The mean of their BMI was about 24.5 ±1.03. This exercise also focused on managing the FHP related major muscle groups, although without co-activation of the core muscles. Thera-bands were also used to strengthen muscles. All the sessions will be supervised.

The treatment session will be of 45 minutes per day. They were given Northwick pain questionnaire for neck pain at the beginning and after the treatment session to assess

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the difference. The FHP was assessed by measuring craniovertebral angle (11) before and after completion of the treatment session. The craniovertebral angle is identified at the intersection of a parallel line passing via the C7 spinous process and a line connecting the midpoint of the tragus of the ear to the skin overlying the C7 spinous process (12), the kinovea software was used to measure the cranio-vertebral angle (15). Pulmonary functions were assessed using the spirometer that will help us find their VC, ERV and FVC. Patient's posture, neck pain and pulmonary functions were reassessed before and after completion of treatment session.

3. RESULTS

According to statistical analysis performed for group A (experimental group) where conventional management plus Pilates was included, total number of participants was 18, there was significant improvement in the CVA before treatment (39.944±3.84˚) and after treatment (52.22±1.7˚) with p value of <0.0001(table no 4). There is significant improvement in neck pain as well which is calculated by Northwick pain questionnaire (NPQ), the pre (79.66±12.52) and post (28.08±6.915) values show significant difference statistically with p value <0.0001. the spirometric values for VC before (3783.3±228.16) and after (4859±184.09) is extremely significant with p value <0.0001, for ERV measured before (487.22±58.39) and after (954±169.32) are extremely significant with p value <0.0001 and also same goes for FVC before (1190.6±214.1) and after (2016.7±120.05) treatment values are significant (p < 0.0001) as displayed in table no 6 and graphs 8,9,10 respectively.

According to statistical analysis performed for Group B with 17 participants, the difference in CVA pre (39.765± 3.882˚) and post (mean 46.47±2.348˚) treatment was significant with p value <0.0001 as displayed in table 1. And the same analysis performed for Northwick pain questionnaire also showed significant difference with p value of <0.0001(table 2). Statistical analysis for VC and FVC assessed prior and post treatment is significant with p value <0.0001 but ERV values measured before (mean 486.47±60.098) and after (929.41±1184.4) treatment is not significant statistically with p value 0.1504

According to statistical analysis done between the group A and group B post treatment, it shows that there is significant difference in the mean of CVA(p<0.0001) as shown in table no 7, the group A (52.22±1.335˚) participants has improved CVA then those in group B(48.05±3.05˚).

When neck pain was compared between group a (28.11±7.13) and group B (41.05±16.532) after treatment it was observed that there was no major variation among them with p value of 0.0062.

According to statistical analysis for spirometric measurements, there is significant improvement in the group A when compared with group B, the mean of VC of group A is 4811±199.67 and group B is 4188±289.14, difference is extremely significant(p<0.0001). ERV values of group A (954.17±169.32) and group B (911.11±115.1) is significant with p value <0.0001.

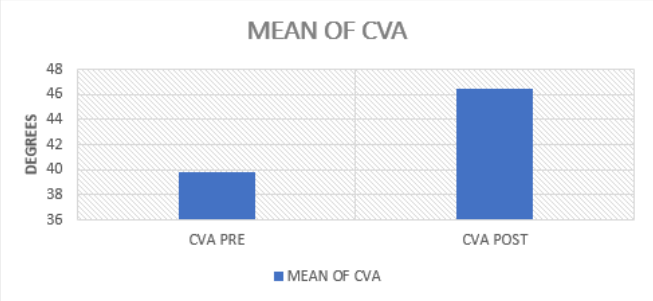
FVC values of group A (2016.7±140.96) and group B (1600±270) are found to be extremely significant with p value of <0.0001.

3.1 CONVENTIONAL MANAGEMENT

Table # 1

	MEAN	SD	P value	t value
CVA (PRE)	39.765	3.882	< 0.0001	6.092
CVA (POST)	46.47	2.348		

Graph # 1

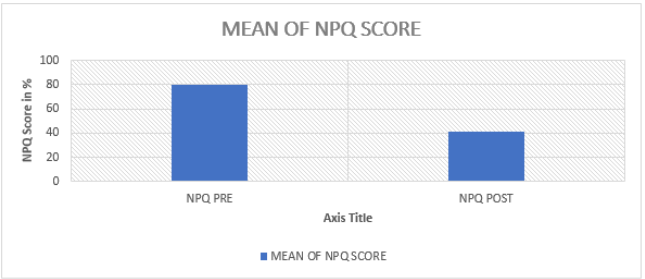


3.2 NORTHWICK PAIN QUESTIONNAIRE (NPQ)

Table # 2

	Mean	SD	P VALUE	t value
NPQ (PRE)	79.706	12.90	<0.0001	8.237
NPQ(POST)	41.05	16.532		

Graph # 2



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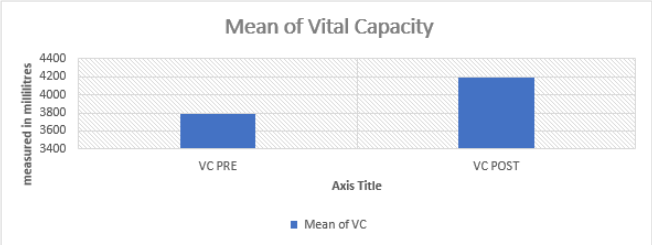
3.3 SPIROMETRY

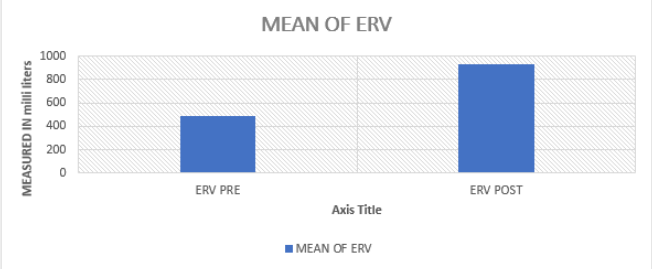
Table no 3

	Mean	SD	P value	t value
VC (PRE)	3783.3	228.16	<0.0001	14.811
VC (POST)	4188.9	280.52		
ERV (PRE)	486.47	60.098	0.1504	1.511
ERV (POST)	929.41	1184.4		
FVC (PRE)	1190.6	50.465	< 0.0001	9.452
FVC (POST)	1488.9	56.527		

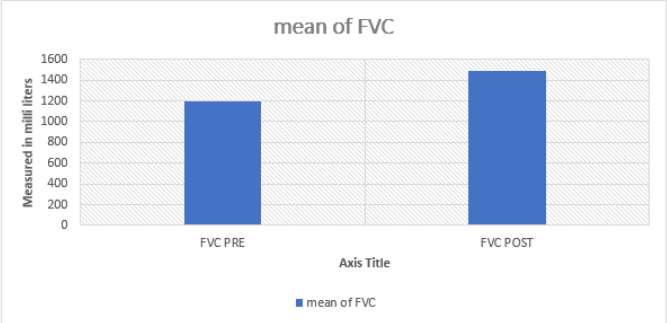
Graph # 4



Graph # 5



Graph # 6

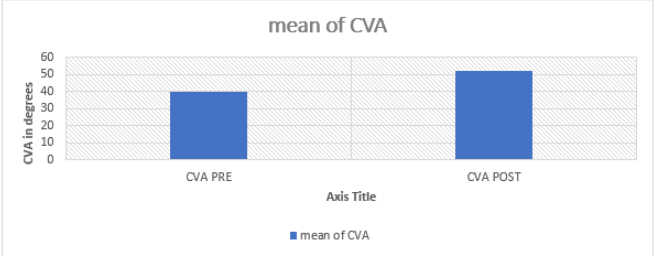


3.4 PILATES MIX

Table # 4

	Mean	SD	p value	t value
CVA (PRE)	39.944	3.84	< 0.0001	11.29
CVA (POST)	52.22	1.7		

Graph # 6

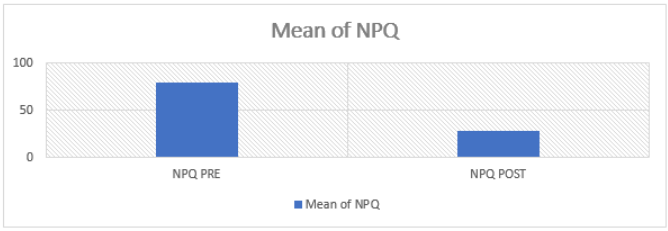


3.5 NORTHWICK PAIN QUESTIONARRE

Table # 5

	Mean	SD	p value	t value
NPQ (PRE)	79.667	12.523	< 0.0001	15.343
NPQ(POST)	28.086	6.915		

Graph # 7

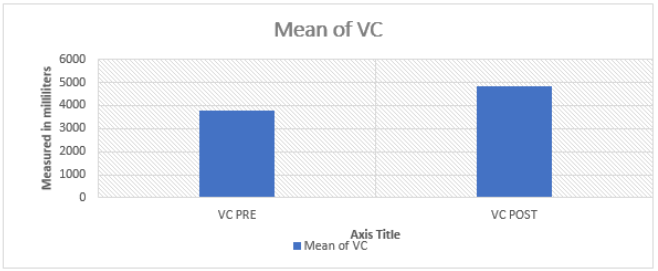


3.6 SPIROMETRY

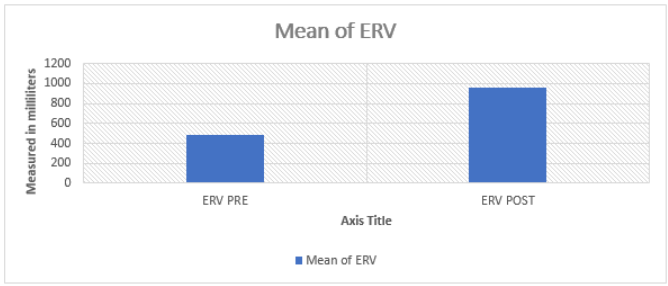
Table # 6

	Mean	SD	p value	t value
VC (PRE)	3783.3	228.16	< 0.0001	17.631
VC (POST)	4850	184.09		
ERV (PRE)	487.22	58.391	< 0.0001	10.261
ERV (POST)	954.16	169.32		
FVC (PRE)	1190.6	214.10	< 0.0001	14.964
FVC (POST)	2016.7	120.05		

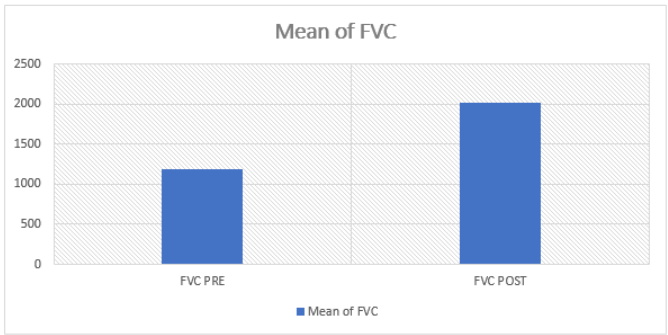
Graph # 8



Graph # 9



Graph # 10



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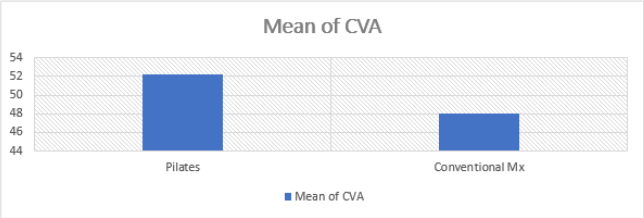
4. COMPARISON

4.1 CRANIO-VERTEBRAL ANGLE

Table # 7

	Mean	SD	p value	t value
CVA (pilates)	52.22	1.335	< 0.0001	5.495
CVA (conventional mx)	48.05	3.05		

Graph # 11

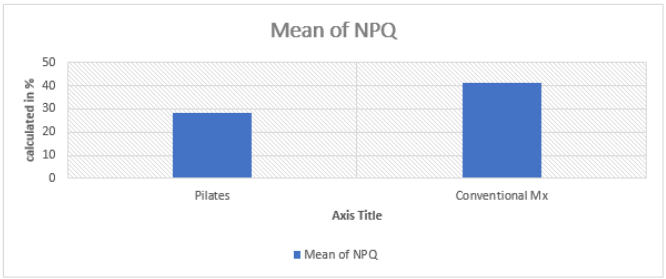


4.2 NORTHWICK PAIN QUESTIONNAIRE

Table # 8

	Mean	SD	p value	t value
NPQ (pilates)	28.11	7.13	0.0062	2.921
NPQ (conventional Mx)	41.05	16.532		

Graph # 12

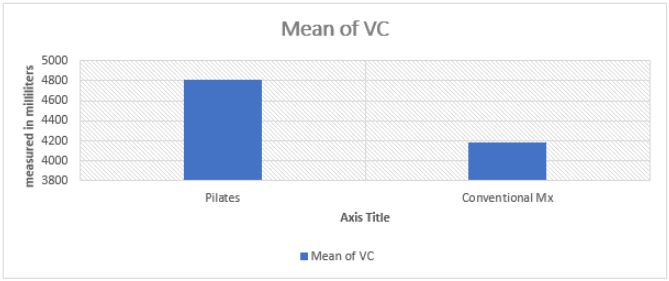


4.3 SPIROMETRY

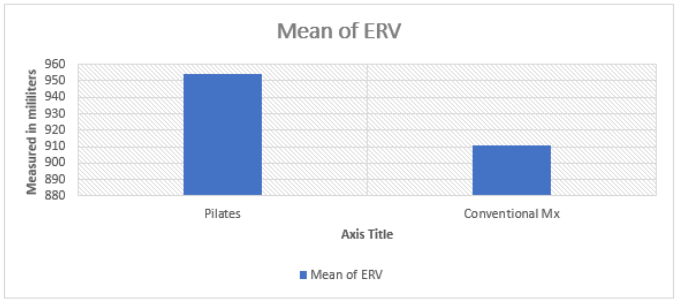
Table # 9

	Mean	SD	p value	t value
VC (PILATES)	4811	199.67	< 0.0001	7.452
VC (conventional Mx)	4188	289.14		
ERV (Pilates)	954.17	169.32	0.9306	0.8762
ERV (conventional Mx)	911.11	1151		
FVC (pilates)	2016.7	140.96	< 0.0001	5.416
FVC (Conventional Mx)	1600	270		

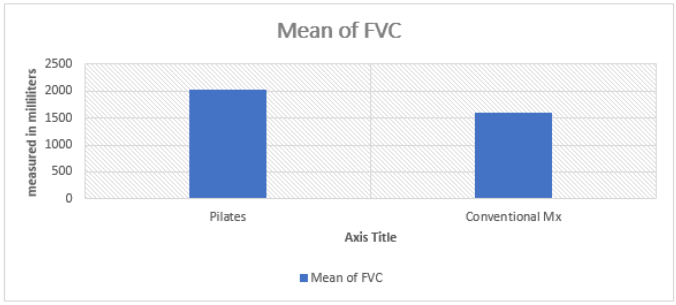
Graph # 13



Graph # 14



Graph # 15



5. DISCUSSION

In this study our aim was to find out effective treatment for neck pain, FHP and pulmonary function. The results show that group A individuals to whom Pilates treatment with conventional therapy was given had better results when compared to group B with only conventional treatment, individuals in group A(experimental group) had significant improvement in all the three aspects i.e., neck pain, CVA and pulmonary functions (VC, ERV, FVC) except results were not significant for ERV. According to a research conducted by G J Gibson in the United Kingdom it was found that FRC was reduced due to the impact of the abdominal contents on the diaphragm, this results in reduction in ERV which is so much that it FRC approaches residual volume (RV)(23).

According to Holley et al. found that in obese individual ventilation was preferentially distributed to the upper zones of the lungs, leaving the lower dependent zones relatively under ventilated with marked reductions in ERV to 21% of the predicted value (24).

Also in a study conducted by Eishaan K. Bhargava and Farah Khaliq, they did a study on effect of active and passive smoking on pulmonary function (in people who smoked for over a year or more and other whose parents smoked for over a year), the results exposed that both groups had significantly lower VC and ERV when compared to non-smoker group (25). And it turns out that many of our subjects had parents who smoked for a long time and could be the reason why some of our

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participants ERV did not increase significantly before and after treatment.

In group B (conventional group) neck pain and CVA prior and post treatment had improvement but there was less significant improvement in pulmonary functions. Similarly, in a study conducted by Lee SM, Lee CH, et al., it showed that, the Pilates therapy program seemed to considerably improve head posture in individuals with FHP (12) when compared to the combined exercise group. Increasing FHP in adults with neck pain could also be related to lower endurance of the deep neck flexors and extensors and with a better activity of superficial muscles compared with those without neck pain (1)

In a research performed by Kang JI, Jeong DK, and Choi H about co-relation between CVA and pulmonary functions, a positive co-relation was established between CVA and FVC (21)

It is observed that in people with neck pain there is reduced CVA that indicates high prevalence of FHP (7) due to muscle imbalance and fatigue. According to a study conducted by Han J, Park S, et al., The FHP group showed statistically significantly lower FVC and FEV1 levels than the normal group (22).

Severe FHP places a great load on the actions of the sternocleidomastoid muscles and the anterior scalene muscles, and reduced the FVC (22). The scalene muscle and the sternocleidomastoid muscle help in flexion of the neck and help in the posture control of the neck. They also work as the accessory inspiratory muscles that raise the chest wall to help with breathing (21).

In a study conducted by Szczygieł E, Węglarz KA, et al., the findings show that, altering the position of the head causes disruptions in the three-dimensional shape of the chest and its respirational movements(3).

Here, we observed that the Pilates treatment when combined with conventional management turns out to be efficient and safe for management of chronic neck pain with FHP and improving pulmonary functions.

6. CONCLUSION

Pilates therapy when combined with conventional showed better results than only using conventional therapy as conventional management only focuses on improving ROM and pain but does not focus on one's pulmonary functions and Pilates treatment covers all the three aspects.

Inspite of this ERV did not show any significant change in both groups, the reasons for that being obesity and smoking either passive or active.

The further research can be done about how to improve ERV and factors that affect it.

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