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Evaluation of Respiratory Parameters in Runners with and Without Iliopsoas Tightness

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ABSTRACT

Tightness in this muscle has been hypothesized to influence diaphragmatic movement and, consequently, respiratory function. This cross-sectional comparative study aimed to evaluate the potential relationship between iliopsoas muscle tightness and pulmonary function in runners. A total of 46 collegiate runners were recruited and stratified into two groups based on the presence or absence of iliopsoas tightness, as determined by the Modified Thomas Test. Pulmonary function was assessed using standardized spirometric parameters, including Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and the FEV1/FVC ratio. Statistical analysis using MANOVA revealed no significant differences ($p > 0.05$) between the two groups across all measured respiratory parameters. These findings suggest that while the iliopsoas and diaphragm may be anatomically and biomechanically interconnected but iliopsoas tightness does not significantly impair pulmonary functions in healthy, trained runner.

KEYWORDS: Iliopsoastightness, pulmonary functions, respiratory parameters, diaphragm, biomechanics, runners.

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INTRODUCTION

The effects of posture on diaphragm movement and function have been early scrutinised by physiologist and respirologists. Wade and Gilson have been the first to observe a close relationship between the change of posture (from standing to semi-sitting position) and the chest volumes [1]. Loading of diaphragm is reduced in individuals with LBP and activates the proprioceptive feedback, leading to increased diaphragm fatigue [2] . LBP predisposing factors is reduced flexibility, particularly of iliopsoas and hamstring muscles, leading to refl ex inhibition off stabilizing musculature of the spine[3]. Psoas major and diaphragm muscle share a common attachment proximal to T12 vertebra [4]. Previous study that was conducted they determined the effect of manipulating the thoracic spine, breathing exercise on respiratory parameters in the patients with nonspecific chronic low back pain [5]. Myofascial release is used to enhance function and decrease pain; it involves applying mild pressure stretch to myofascial complex [6].

The most common cause of reduced respiratory function in patients with chronic low back pain is a faulty posture demonstrated by stoop posture and thoracic kyphosis, leading to a decrease in the rib cage excursion because of altered muscle length tension relationship with posture [5]. The iliopsoas due to its retroperitoneal location often presents in an indolent manner with a wide variety of non-specific signs and symptoms [7].

When we refer to the anatomy of the diaphragm, we see that diaphragm originates form three different points, firstly from the posterior aspect of the xiphoid process, the costal pat originates from the sixth lower sixth rib. The medial Lumbocostal archis a tendinous arch in fascia covering psoas major. Medially, it attaches to the side of the body of vertebra L1. Laterally, it connects to the front of the transverse process of vertebra L1. The lateral Lumb costal arch is a tendinous arch in fascia covering the upper part of quadratus lumborum. Medially, attach to the front of the transverse process of vertebra L1. Laterally, it connects to the lower border of the 12th rib. The right crusarise from the anterolateral surface of the bodies of the upper three lumbar vertebrae and also the intervening intervertebral disc.The left crusarise from the corresponding parts of the upper 2 lumbar vertebrae [8]. Where as if we refer to the iliopsoas origin, The psoas major is a long muscle, originating from the transverse processes, vertebral bodies, and intervertebral disks of T5 to L5. The psoas major and iliacus converge to form the iliopsoas muscle at the L5 to S2 levels and inserts on the lesser trochanter of the femur as the iliopsoas tendon.

The most proximal attachment of the psoas major connects to the diaphragm via the medial arcuate ligament. The diaphragm becomes tendinous on either side of the aorta transitioning to the right and left crus, the attachment points on the spine at L1 Through L3, which merge to become the anterior longitudinal ligament moving caudally to the pelvic basin. The importance of the attachment point of the Psoas major and diaphragm at L2 on respiratory function is currently under investigation by[9] . Their study tested the efficacy of releasing tension in the psoas muscle to improve respiratory efficiency in patients with chronic low back pain;however, results have not yet been published. Because the direction of force production in the Psoas major is in the same plane but opposite direction as the posterior inferior fibres of the diaphragm, tension in the Psoas major can limit the pliability of the diaphragm during an inhalation[9,10]. The fascial continuity of the Psoas major, crus of the diaphragm, anterior longitudinal ligament and pelvic basin position thePsoas major to exert influence on the balance of the dynamics of respiratory function and the functional relationship between the diaphragm and pelvic floor.A strong fascia invests these muscles and forms a compartment, which communicates with the spine, thorax, femur and pelvis. This fascia blends superiorly with the fascia of the thorax, as the psoas major passes posterior to the arcuate ligament of the diaphragm[7]

To evaluate the parameters of respiration, pulmonary function tests is most reliable tool to assess it Pulmonary function tests (PFTs) allow physicians to evaluate the respiratory function.Spirometry is a physiological test that measures the ability to inhale and exhale air relative to time[15]. Spirometry is a diagnostic test of several common respiratory disperses such as asthmaand chronic obstructive pulmonary disease (COPD),it is also instrumental in monitoring the progression of various respiratory disorders. The main results of spirometry are forced vital capacity (FVC), forced expiratory volume exhaled in the first second (FEV1), and the FEV1/FVC ratio.

The relationship between deep hip flexors and the diaphragm primarily involves their functional connections within the body's kinetic chain and their role in posture and movement. The body is a complex system of interconnected muscles and joints[3], and the deep hip flexors and the diaphragm are part of this system. They work together to help maintain stability, balance, and efficient movement. The deep hip flexor muscles, such as the psoas major, iliopsoas, and rectus femoris, play a crucial role in maintaining proper postural alignment. When these muscles are tight or imbalanced, they can contribute to poor posture and alignment, potentially affecting the diaphragm's ability to function optimally.

I. MATERIALS AND METHODS

A. ***Study Design*****:** This correlational study was carried out in MYAS-GNDU Department of Sports Sciences and MedicineAmritsar with Purposive sampling method. The study was approved by institutional ethics committee.

B. ***Participants*****:** 46 collegiate athletes with and without Iliopsoas tightness were included in this study. Subjects were included on the following criteria, Running/Sprinting game athletes, 18-27 age, angle measured in modified Thomas test was 9.96°and athletes willing to participate were included in the study. The athletes were excluded on the basis of, if they had any kind of respiratory distress, any pathological tightness or injury which could lead to tightness in hip joint muscles.

C. Subject selection criteria

Only those subjects were included in study who were regularly and actively engaged in sprint training or running**,** having no history of pulmonary dysfunction, long-term respiratory conditions, or associated contraindications. Subjects with current respiratory illness ,history of hip, spine, or pelvic girdle injuries that may affect sports performance or gait biomechanics and with any physiological or medical condition that may limit the spirometric testing were excluded from the study

D. Assessment tools

1) Modified Thomas Tes**t**: Used to measure iliopsoas flexibility. Inclinometer-based readings quantified hip extension deficits, with angles >9.96° indicating tightness

2) Pulmonary Function Testing (PFT): Performed using a calibrated spirometer. Parameters measured are FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in 1 second) and FEV1/FVC Ratio.

Data was collected, documented and analysed using the SPSS version 24.0 (IBMCorporation, USA). The demographic data of this study population was described usingdescriptive statistics. Thestudy data was normally distributed and was assessed usingShapiro wilk. Correlation coefficients between 0.7 to 1.0 were considered strong, 0.4 to 0.6 were considered moderate and 0 to 0.3 were considered weak. A $p<0.5$ was considered statistically significant.

II. RESULTS

Prior to conducting the MANOVA, Assumption testing was performed for 3 primary assumptions for a one-way

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MANOVA, firstly Shapiro-wilk's test was performed to test multivariate normality (performed as separate univariate normality assessments) which reported the data to be distributed in a non-normal manner (P values .627, .629 & .01 FEV1, FVC, FEV/FVC ratio respectively). Additionally, the Box's M value of 25.99 was associated with a p value of .001, which is below to the significance level of .01. Accordingly, it can be seen that the covariance matrices between the groups were unequal, Levene's test of equality of error variances were equal for the dependent variables across groups. MANOVA was then conducted to test the effects of Iliopsoas tightness (>11 degrees) on pulmonary function test parameters (FEV1 (FEV1), FVC (FVC), FEV1/FVC (FEV/FVC ratio).

A statistically significant MANOVA effect was revealed for (N=26(15-9)-Pillai's trace method, Pillai's Trace=0.238, F (3,20) =2.078, p .135, Partial Eta Squared [ηp2] =0.238, observed power=.452) indicating a statistically insignificant difference among the sub-dimensions (FEV1 (Fev1P), FVC (FVC), FEV1/FVC (FEV/FVC ratio) of people with iliopsoas tightness and without.

Table 1. Shows Mean Age for Both the Group with and Without Iliopsoas Tightness.

Age	With Tightness	Without Tightness
Mean	23.2 + (1.48)	23.4 + (1.63)

Table 2. Shows Mean of Respiratory Parameters of with and Without Iliopsoas Tightness Groups.

Parameter	With Iliopsoas Tightness(Mean ± SD)	Without Iliopsoas Tightness (Mean ± SD)
FVC	81.35 ± 11.06	74.63 ± 6.86
FEV1	84.46 ± 11.38	83.11 ± 8.79
FEV1/FVC Ratio	106.91 ± 8.65	112 ± 5.01

Table 3. Shows Data of MANOVA Between With and Without Tightness of Iliopsoas Groups.

Variables	Value	F	P	Partial Eta Squared
FEV1	10.336	93	0.763	0.004
FVC	254.016	2.43	0.133	0.1
FEV1/FVC	167.008	2.94	0.1	0.118

Table 3 provides a statistical value, typically representing a p-value that further indicates weather there is significant difference between groups across multiple dependent variables, in the given data there is significant difference between the following groups.

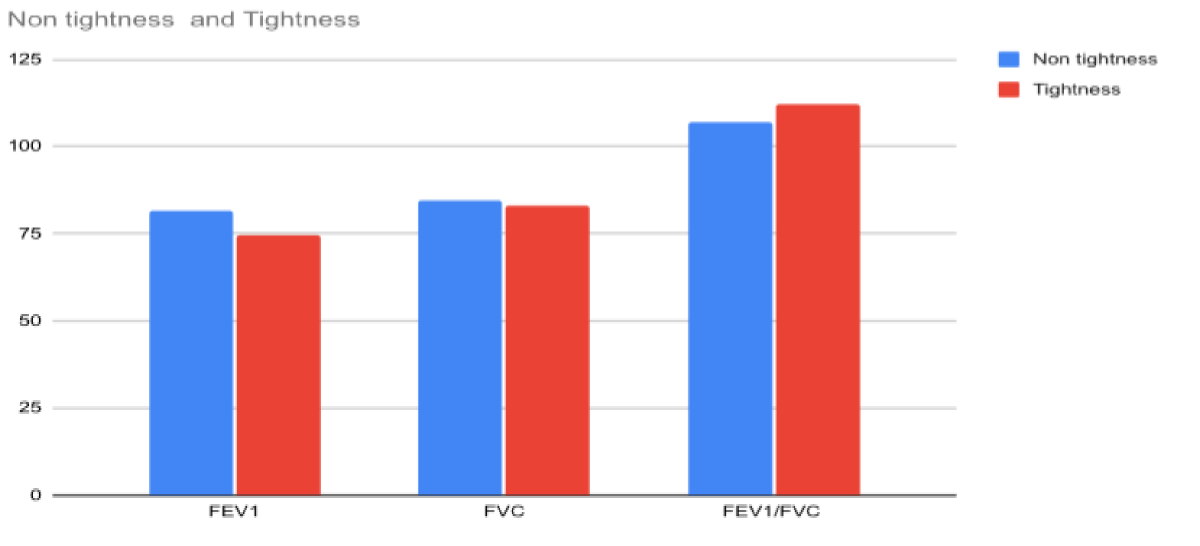

Figure 1. Shows Comparison of Respiratory Parameters of Both the Groups

III. DISCUSSION

The objective of the present study was to evaluate the respiratory parameters in runners with and without iliopsoas tightness. The findings of present study showed that athletes with iliopsoas tightness had no significant decrease in their respiratory parameters, which again suggests that muscle tightness has not substantially impacted on breathing mechanics or lung functions.

Previous studies have described that iliopsoas tightness related low back pain may lead to reduced diaphragm excursion leading to breathing difficulty thus various studies related to it provided an insight on effect of impaired function of iliopsoas on the respiratory efficiency in patients with chronic low back pain[9]. These observations showed relationship between the iliopsoas muscle group tightness and diaphragmatic excursion. But as per the explanation given by researchers, there was a decrease in the respiratory parameters like FEV1, which might be because of low back pain.

The hypothesis that iliopsoas tightness could influence respiratory function through its anatomical and fascial connections to the diaphragm has been an area of interest in research. Given the iliopsoas' attachments to the lumbar spine and the diaphragm's origins from the same region, it has been proposed that excessive tightness in the iliopsoas might alter diaphragm mobility, thereby affecting pulmonary function test (PFT) parameters. However, the results in study suggest that tightness in the iliopsoas does not significantly impact pulmonary function, including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), or its ratio (FVC/FEV1 ratio). This lack of association might be due to various factors.

If anatomical factorsand its dependency on respiratory functions are taken into consideration, it can be stated that while the iliopsoas and diaphragm share anatomical connections through the lumbar spine and fascia[12,13], the mechanical interplay between these structures may not be sufficient to significantly influence lung functions. The diaphragm remains the primary driver of respiration due to its direct neuromuscular control via the phrenic nerve, which originates from cervical spinal levels (C3–C5). So even if iliopsoas tightness is present, the diaphragm gains its capacity to generate effective respiratory excursions[14].

Compensatory mechanisms and postural adaptations could occur in athletes to overcome the respiratory requirements. This might be one possible explanation for the absence of significant changes in PFT parameters that postural adaptations or increased dependency on accessory respiratory muscles might help an individual to maintain normal lung **functions[15].** Previous studies have shown that individuals with altered postural mechanics due to musculoskeletal tightness often compensate through greater activation of accessory breathing muscles that involved the scalenes, sternocleidomastoid, and intercostals. This compensation may prevent observable changes in lung function parameters, despite been restricted by iliopsoas tightness. To an extent the compensatory mechanics would surpass the altered mechanics in order to carry out normal lung functions.

Again, if we consider core stability it has been identified as a factor influencing respiratory mechanics, as the diaphragm plays a dual role in both respiration and core stabilization [14]. However, studies investigating the link between core muscle function and lung volumes have yielded mixed results[16] found that certain core strengthening interventions could enhance diaphragmatic efficiency, but this effect was not necessarily correlated with changes in pulmonary function metrics such as FVC or FEV1. So, in case if the diaphragm is having adequate strength to carry out its regular function,iliopsoas tightness won't alter the function of the diaphragm to any extent. Again, increasing the strength of the diaphragm which can be altered with regular respiratory muscles training might cause no influence on diaphragm excursion and athletes undergo regular endurance training to increase their endurance capacity.

Although this study did not find a statistically significant impact of iliopsoas tightness on standard PFT parameters but there is possibility that subtle biomechanical effects could exist at a subclinical level. Advanced imaging studies or real-time diaphragmatic movement assessments via ultrasound may be required to detect minor changes in diaphragm excursion that are not reflected in spirometric testing. Future research using electromyography (EMG) to assess neuromuscular coordination between the iliopsoas and diaphragm could further clarify the nature of this relationship.

IV. CONCLUSION

This study concludes that iliopsoas tightness does not significantly affect pulmonary functions like FVC, FEV1, and FEV1/FVC ratio in runners. The anatomical and biomechanical connections between the diaphragm and iliopsoas do exist but they appear to exert negligible functional influence on respiratory parameters in healthy, trained and asymptomatic runners.

V. FUTURE DIRECTIONS

Future studies could incorporate dynamic imaging techniques (e.g. ultrasound, MRI) to directly observe diaphragmatic movement in response to hip flexor tightness. Investigating neuromuscular coordination using surface EMG may also offer insights into compensatory respiratory patterns.

VI. LIMITATIONS

Small sample size may reduce generalizability. Spirometry may not detect subclinical respiratory changes. Study limited to male and female runners aged between 18–27.

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