https://doi.org/10.7251/SSH2301031M
UDC: 796.071.2:612.17
Original scientific paper
Originalni naučni rad

Impact of Lumbopelvic Hip Complex Exercises on Upper Extremity Range of Motion, Strength and Functonal Performance Among Collegiate Overhead Athlete

Muhammad Muneer PP, Nagaraj Sibbala
Padmashree Institute of Physiotherapy, Affiliated to Rajiv Gandhi University of Health Sciences
Bangalore, Algeria

Correspondence:
Muhammed Muneer, Padmashree Institute of Physiotherapy, Affiliated to Rajiv Gandhi University of Health Sciences, Bangalore, Algeria
nagarajsibbala@gamil.com

Abstract: *An overhead athlete is a sportsperson who engages in activities that necessitate the use of the upper body in a forward and upward action, such as pitching a baseball, throwing a softball, spiking a volleyball, serving a tennis ball, swinging a golf club, passing a football, or launching a javelin. The arm needs to move to different locations and speed up along very specific trajectories for each of these tasks. To determine the impact of lumbopelvic hip complex exercises on upper extremity range of motion, strength and functional performance among collegiate overhead athletes. Based on the selection criteria, 46 people were recruited, however, only 40 of them did the lumbopelvic hip complex exercise. Six people were drop outs as they didn't meet the loads of the exercise. The subjects who took part did two sets of ten repetitions five days a week for twelve weeks. The order of the exercises was chosen by each person. All of the people on the intervention team were given a moderate level of resistance, which they used for the whole study. College overhead athletes showed statistically significant improvement in functional performance when CKCUEST was employed to describe performance (19.32±1.55-21.37±1.71) (t=18.458). The results of a paired t-test reveal a statistically significant (i.e., p<0.001) difference when the means are compared. Twelve weeks of lumbopelvic hip complex training has a significant influence on the range of motion, strength, and functional performance of the overhead throwing players in collegiate athletes.*
Keywords: *Lumbopelvic hip complex, Range of motion, strength, functional, performance, collegiate overhead athletes.*

Introduction

An overhead athlete is a sportsperson who engages in activities that necessitate the use of the upper body in a forward and upward action, such as pitching a baseball, throwing a softball, spiking a volleyball, serving a tennis ball, swinging a golf club, passing a football, or launching a javelin. The arm needs to move to different locations and speed up along very specific trajectories for each of these tasks. It's not only the arm that has to move in unison; the body's entire kinetic chain, from the toes to the trunk to the pelvis to the hand, has to work in harmony as well. Athletes that perform intricate yet explosive movements risk serious harm when doing them in the air.

A skilled and sophisticated maneuver, the overhead throw places significant strain on the shoulder joint. Extreme stress is placed on this complex by the overhead thrower. When a person throws a ball, they produce huge pressures that put extreme strain on the shoulder joint. The throwing shoulder needs to be flexible enough to allow for excessive external rotation, but sturdy enough to prevent symptomatic humeral head subluxations (Wilk, Meister & Andrews, 2002).

The motion of throwing the ball above is a high-speed, high-stress sporting exercise. The glenohumeral joint is the most mobile of any articulation in the body, which, along with the repetitive nature of the activity, can lead to looseness and instability (Wilk, Yenchak, Arrigo, & Andrews, 2011). The capsuloligamentous structures of the shoulder and the combined neuromuscular control of the entire upper extremity work in constant interaction and coordinated equilibrium to provide glenohumeral stability. Overhead throwers need challenging, dynamic, and particular rehabilitation therapies because of the repetitive stresses and loads exerted on the glenohumeral complex and the excessive motion required for throwing (Wilk, Meister & Andrews, 2002).

For motions such as the tennis serve, overhead throw, and volleyball spike, the high rotational forces experienced by the shoulder during the acceleration and deceleration phases of the movements place the soft tissue structures at risk for microtrauma and an ensuing injury, the repetitive overhead motions and subsequent periscapular and RTC fatigue place the shoulder in similarly vulnerable positions to that of the more ballistic athletic movement. Injuries like subacromial impingement and rotator cuff tendinitis are common in overhead athletes (Laudner & Sipes, 2009).

The musculoskeletal backbone consists of the spine, hips, pelvis, upper legs, and midsection. Muscles in the abdomen, low back, and pelvis play an important role in generating and transferring energy from large to small body parts, and in keeping the spine and pelvis stable, in a variety of sports (Putnam, 1993). Integrating proximal and distal segments in producing and directing forces to maximize athletic function benefits greatly from the core's (lumbopelvic hip complex) stability.

When the body is in motion, the huge, bulky muscles in the central core form a hard cylinder and a large moment of inertia to counteract the disturbance, while yet providing a solid foundation for distal movement. The core function is most commonly provided via the kinetic chain, the coordinated, sequenced activation of body segments that sets the distal segment in the optimum position at the optimum velocity with the optimum timing to produce the desired athletic task (Laudner, Wong & Meister, 2019). In addition, as the core is important to practically all kinetic chains of sports activities, regulation of core strength, balance and motion will maximize all kinetic chains of upper and lower extremity function.

Performing an overhead throw is akin to a kinetic chain exercise, which calls for individual muscles to work in unison like linked links in a chain. To complete a throw, one needs to time the activation of one's muscles appropriately and in a coordinated method over multiple segments, working from the proximal to the distal joints. The kinetic chain can readily be split down into three key components from proximal to distal the lower extremities, the lumbopelvic-hip complex, and the upper extremity.

The main component of the kinetic chain that controls both the proximal and distal ends is the lumbopelvic-hip complex. The lumbopelvic-hip complex is made up of the abdominal, proximal lower limb, hip, pelvic, trunk, and spinal muscle groups. The lumbopelvic-hip complex's primary function in throwing is to keep the body steady, allowing for maximum transmission of force from the lower to the upper body. About half of the energy in a throw comes from the legs, and if those forces are diminished by 20%, the shoulder takes on an additional 34% of the load. Any interruption in one part of the kinetic chain will affect the complete system in a dynamic movement Gilmer, et. al., 2019)

The kinetic chain connects body segments and distributes energy from one body segment to the next during motion such as throwing. In overhead throwers, the legs and core transfer more than half of the kinetic energy to the upper extremity. The typical sequence of actions during a general throwing motion includes the stride, pelvis rotation, upper torso rotation, elbow extension, shoulder internal rotation, and wrist flexion.

Shoulder injuries are common among overhead throwers because to weaknesses in the kinetic chain, which includes the core, spine, hip, glenohumeral range of motion, and scapular kinetics.

Safely transferring energy from the legs to the projectile release requires precise sequencing of muscle activation and synchronization. All parts of the body must coordinate their efforts for the kinetic chain to be effective.

Loading strains emerge at unfamiliar locations of musculoskeletal tissues when certain features of segmental coordination are disrupted. Reduced range of motion in the hips and shoulders, immobility in the spine, and weakening in the muscles all contribute to increased mechanical stress of tissues further along the kinetic chain. The danger of getting hurt is raised as a result of this. When the hips, core, legs, and spine can't move efficiently, it puts extra stress on the rest of the body (Zaremski, Wasser & Vincent, 2017).

Improving neuromuscular control is just as important as strengthening the lumbopelvic-hip complex to stop uncontrolled and compensatory movements (Chaudhari, et. al., 2014).

OBJECTIVES OF THE STUDY

- To determine the impact of lumbopelvic hip complex exercises on upper extremity range of motion, strength and functional performance among collegiate overhead athletes.

HYPOTHESIS

Null Hypothesis [H_0]

There is no significant impact of lumbopelvic hip complex exercise hip complex on upper extremity ROM, strength and functional performance among collegiate overhead athletes.

Alternate hypothesis [H_1]

There is a significant impact of lumbopelvic hip complex exercise on upper extremity ROM, strength and performance among collegiate overhead athletes.

METHODOLOGY

Source of Data

- Padmashree group of institutions

Inclusion Criteria:

1. Collegiate over-head athletes
2. Age Group: 18 - 25 years
3. Both male and female subjects
4. Shoulder pain questionnaire used as a diagnostic criterion for inclusion.

Exclusion Criteria:

1. Slap lesions
2. Recent sports injuries to shoulder
3. Shoulder dislocation

Method of collection of data

- Population: Collegiate overhead athletes.
- Sampling method: Convenience sampling.
- Sample size: 40 subjects
- Study design: Single Group Pre-Post-test Experimental design
- Type of study: pre to post Experimental study
- Duration: 6 months

Materials Required:

- Pen
- Paper
- Goniometer
- Hand held dynamometer

Methodology

Based on the selection criteria, 46 people were recruited, however, only 40 of them did the lumbopelvic hip complex exercise. Six people were drop outs as they didn’t meet the loads of the exercise

Before the intervention, the subjects gave their consent after being told what would happen. Before the intervention, all of the subjects’ age, gender, height, weight, and body mass index (BMI) were documented. Before starting the lumbopelvic hip complex exercises, all of the people were given tests to measure their upper extremity range of motion (ROM), strength, and functional performance.

The subjects who took part did two sets of ten repetitions five days a week for twelve weeks. The order of the exercises was chosen by each person. All of the people on the intervention team were given a moderate level of resistance, which they used for the whole study. After the intervention, ROM, strength, and functional performance were all checked again.

The range of motion of the shoulder abductors, external rotators, and internal rotators was measured with a universal goniometer. The strength of the shoulder abductors, external rotators, and internal rotators was measured with a hand-held dynamometer. The functional performance of the upper extremity was measured with a closed kinetic chain upper extremity stability test (Chaudhari, McKenzie, Borchers & Best, 2011).

Exercises

Pelvic Bridge

The participants were told to lie on their backs with their knees extended and their feet flat on the ground. The participants were taught to lift their pelvis and back off the ground while drawing their belly button in toward their spine. They had been told to keep their hands in the “up” posture for two seconds.

Figure 1. Pelvic bridge

Standing Hip Abduction

Participants were taught to execute standing hip abduction while wearing a resistance band around their ankles. The verbal cue to keep the ankle dorsiflexed and the knee extended was given to the participants.

Figure 2. Standing Hip abduction

Standing Hip Extension

Participants were given a resistance band to wrap around their ankles, then told to stand with their knees extended and extend their hips.

Figure 3. Standing hip extension

Deep Squat

Participants were asked to perform a deep squat with their arms extended in front of them while wearing a resistance band above the knee. To prevent knee valgus during the squat, the resistance band was employed to stimulate hip abduction muscle activation (Chaudhari, et. al., 2011).

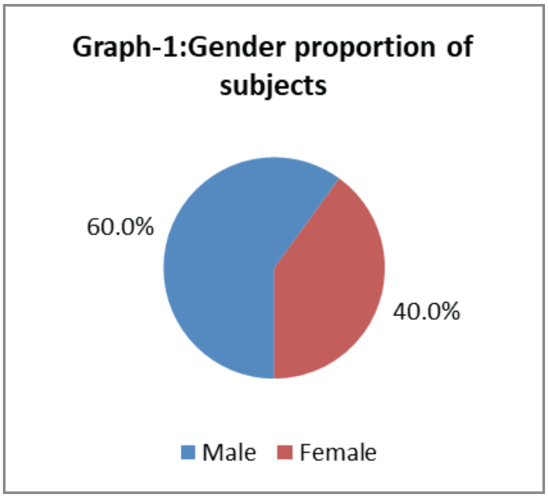
Figure 4. Deep squat

RESULTS:

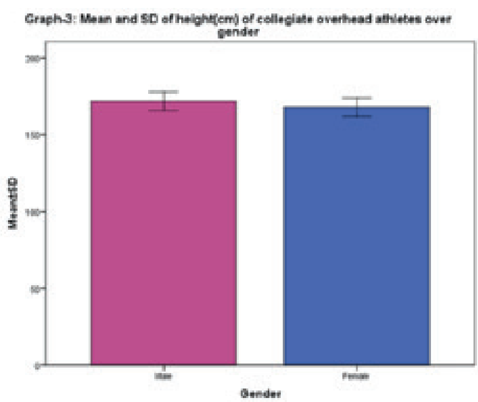
Table 1. *Distribution of collegiate overhead athletes according to gender, age, height, weight and BMI*

S.No.	Background variables	Male (24,60.0%)		Female (16, 40.0%)		Unpaired t-value, p-value
		Range	Mean ± SD	Range	Mean ± SD	
1	Age	19-24	24.79±1.47	18-23	20.50±1.63	t=2.601, p<0.05
2	Height(cm)	158-185	171.63±.5.97	130-176	168.00±6.08	t=1.835, p>0.05
3	Weight(kg)	60-83	70.46±7.45	52-65	57.38±4.39	t=6.311, p<0.05
4	BMI	20.3-29.4	24.09±2.57	17.8-25.8	20.21±1.91	t=5.149, p<0.05

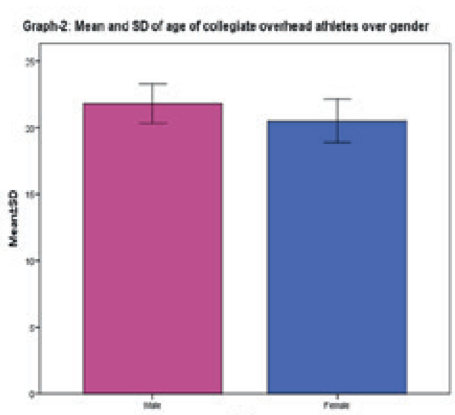
Note: *Significant (p<0.05): Not significant (p>0.05)*



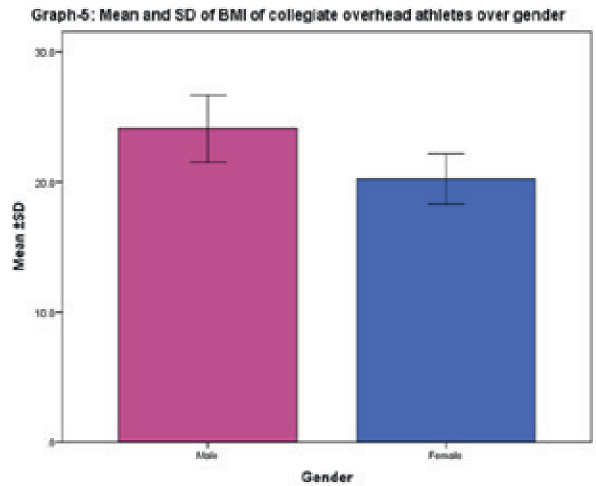
Graph 1. *Show gender proportion of the subjects were the males 60.0% and females 40.0%*



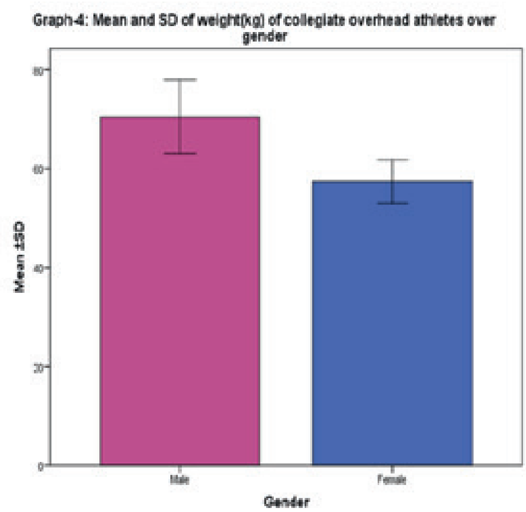
Graph 2. *Mean and SD of collegiate overhead athletes over gender*



Graph 3. *Mean and SD of height (cm) of collegiate overhead athletes over gender*



Graph 4. *Mean and SD of collegiate overhead athletes over gender*

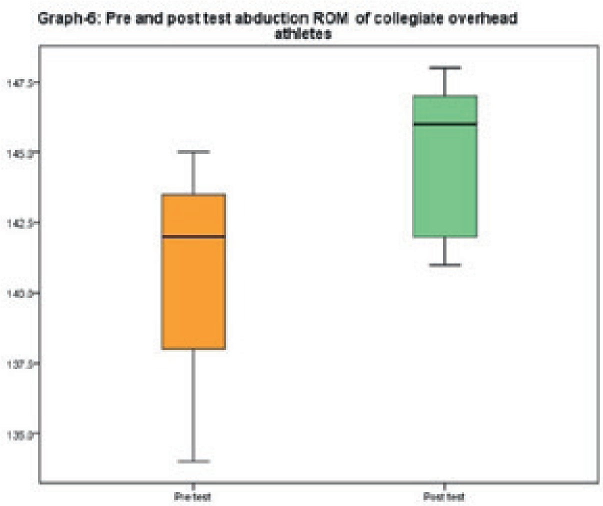


Graph 5. *Mean and BMI of collegiate overhead athletes over gender*

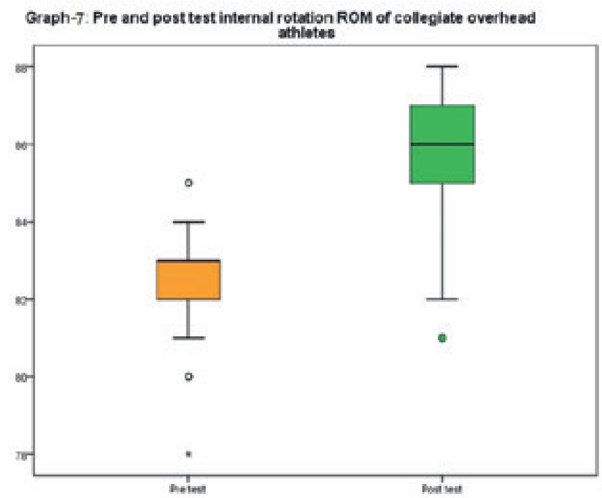
Table 2. *Range, mean and SD of outcome measures of ROM of collegiate overhead athletes.*

S.No.	Shoulder ROM (Rt)	Pre test		Post test		Paired t-tes	p-value
		Range	Mean ±SD	Range	Mean ±SD		
1	Abduction	134-145	141.15±2.84	141-148	145.02±2.36	t=13.065*	p<0.001
3	Internal rotation	76-85	82.45±1.37	81-88	85.93±1.84	t=13.286*	p<0.001
5	External rotation	76-86	81.80±2.18	78-88	84.05±2.39	t=6.324*	p<0.001

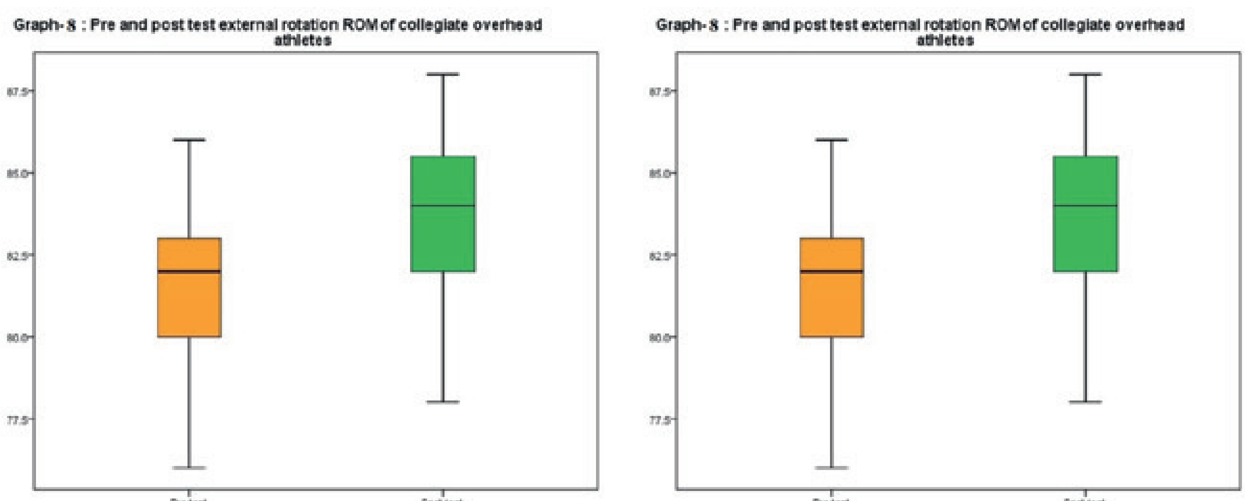
Note: ** denotes –Significant. (p<0.05).*



Graph 6. *Pre and post test abduction ROM of collegiate overhead athletes*



Graph 7. *Pre and post test internal rotation ROM of collegiate overhead athletes*

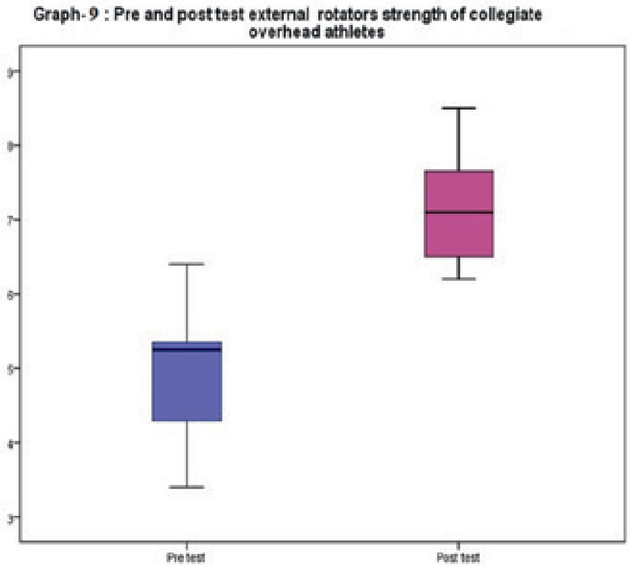


Graph 8. *Pre and Post test external rotation ROM of collegiate overhead athletes*

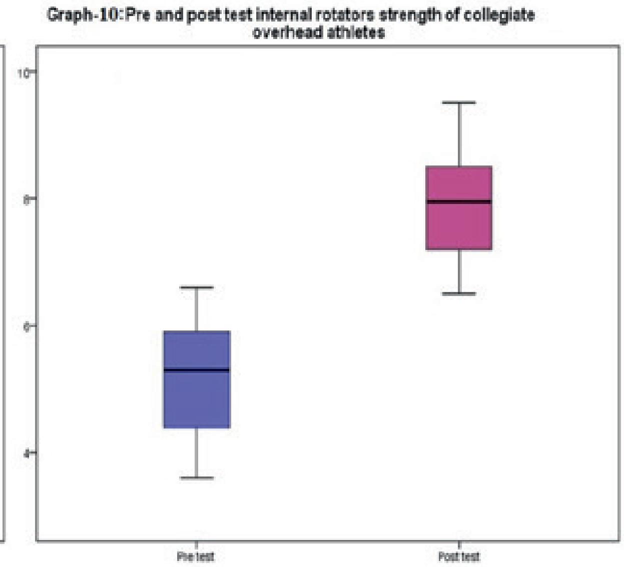
Table 3. *Range, mean and SD of outcome measures of strength and functional performance of collegiate overhead athletes.*

S. No.	Strength	Pre test		Post test		Paired t-test	p-value
		Range	Mean ±SD	Range	Mean ±SD		
1	Abductors Right side	6.90-10.00	8.46±0.93	9.5-12.5	11.24±0.81	t=16.552*	p<0.001
2	Internal rotators right side	3.6-6.6	5.19±0.98	6.5-9.5	7.94±0.89	t=13.833*	p<0.001
3	External rotators right side	3.4-6.4	4.95±0.75	6.2-8.5	7.24±0.64	t=13.190*	p<0.001
4	Functional Performance	17-22	19.32±1.55	18-25	21.37±1.71	t=18.458*	P<0.001

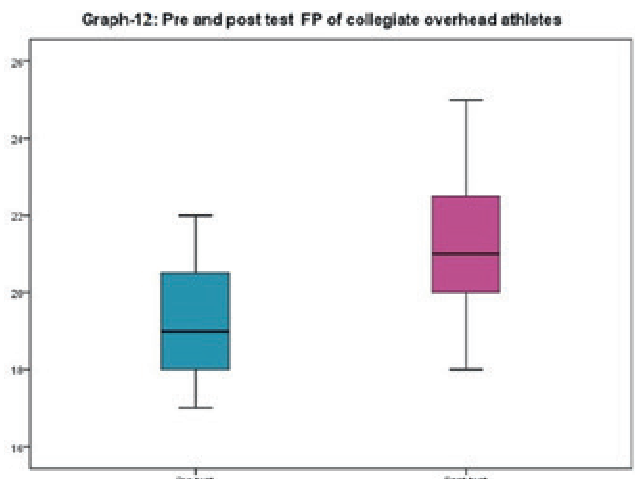
Note: ** denotes –Significant., (p<0.05).*



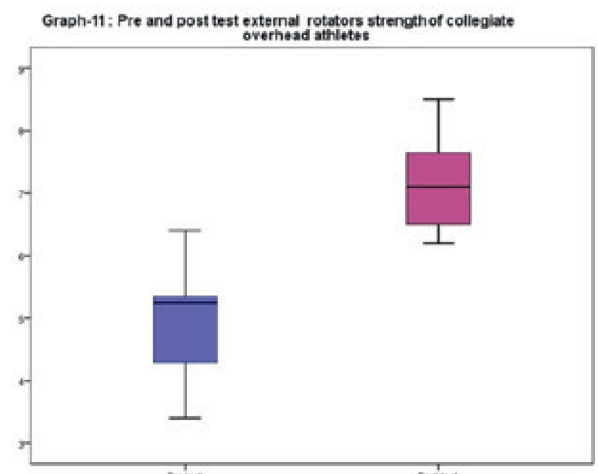
Graph 9. Pre and post test external rotators strength of collegiate overhead athletes



Graph 10. Pre and post test internal rotators strength of collegiate overhead athletes



Graph 11. Pre and post test external rotators strength of collegiate overhead athletes



Graph 12. Pre and post test FP of collegiate overhead athletes

Discussion

The purpose of this research was to examine the effect of lumbopelvic hip complex training on the range of motion, strength, and functional performance of the overhead limbs in collegiate athletes. Research has shown a substantial effect on the outcome variables.

In 2011, researchers Chaudhari, McKenzie, Borchers & Best, concluded that the lumbopelvic hip complex is responsible for the transmission of force and motion across the kinetic chain. Energy flow from the lower extremities through the torso to the throwing hand has been shown in previous research to theoretically necessitate excellent lumbopelvic control. Athletes who throw from above might potentially create more force and transfer it more effectively to the throwing hand by contracting the hip, pelvic, and thoracic muscles with good lumbopelvic control (Lee & Kim, 2015). The lumbopelvic hip complex serves as the pivot point between the upper and lower extremities. All motions of the extremities involve feed-forward activity in the lumbopelvic hip complex, suggesting that these muscles contract in advance of limb movement. The lumbopelvic hip complex helps the body move efficiently to complete a job by acting as a link in a kinetic chain (Kibler, Press & Sciascia, 2006).

In 2021, high school baseball players Downs, Wasserberger & Oliver,studied the effects of a pre-throwing program designed to strengthen the lumbopelvic-hip complex on their shoulder range of motion and isometric strength.

The intervention group now includes four low-impact, high-competition (LPHC) activities in their pre-workout regimen. Passive bilateral shoulder range of motion and isometric strength were measured before and after the season for both the control and intervention teams. When compared to the control group, the intervention group saw substantial increases in both shoulder range of motion and isometric strength. Moreover, the intervention group was able to keep their shoulder range of motion steady by working on their lumbopelvic hip complex strength and control. This is consistent with the latest research, which found that exercises targeting the lumbopelvic hip complex increased flexibility in collegiate overhead athletes (Chaudhari, et. al., 2011).

Shoulder range of motion in upper limb abduction (141.152.284-145.022.36), (t=13.065), IR (82.451.37-85.931.84), (t=13.286), and ER (81.802.18-84.052.39), (t=6.324), were all significantly different before and after the intervention. The mean pre- and post-test scores were compared using a paired t-test, and there was a statistically significant difference (p0.001).

Consistent with previous research, this study found that an intervention program centered on the lumbopelvic hip complex led to increased muscular activation and strength in the upper extremities.

Hodges & Richardson, 1997 and Oliver, et. al., 2015, results from this study show that collegiate athletes can improve their performance and reduce their risk of injury by increasing their lumbopelvic control, as measured by changes in their abduction (8.460.93-11.240.81), internal rotation (190.98-7.940.89), and external rotation (4.950.45-7.240.64) mean and standard deviation (SD) pre- and post-test (Cope, Wechter, Stucky, Thomas & Wilhelm, 2019). Alterations in biomechanics and insufficient force production and transfer could lead to poor athletic performance and injury if the lumbopelvic hip complex was weak while the extremities were strong. When the lumbopelvic hip complex is robust, an athlete is better able to execute complicated, quick movements in unison, which boosts performance (Bullock, et. al., 2018).

College athletes' upper-extremity performance was examined in a 2022 study by Parmanand Jha1 et al. Both groups continued their regular training regimens throughout the study, but the experimental group also completed a five-week core training routine (three days/week). The core stabilization program is designed to strengthen the abdominal, low back and pelvic floor muscles over the course of five weeks. The study found that collegiate athletes' upper limb performance indicators including UQ-YBT and FTPI might be enhanced by participating in a progressive core stability training program over the course of five weeks (Jha, et. al., 2022).

College overhead athletes showed statistically significant improvement in functional performance when CK-CUEST was employed to describe performance (19.321.55-21.371.71) (t=18.458). The results of a paired t-test reveal a statistically significant (i.e. $p<0.001$) difference when the means are compared.

It has been proposed that strengthening the lumbopelvic region can increase power, and hence performance, during the pitching action. However, this region may also be crucial in reducing the stress applied to the shoulder and elbow during the throwing motion. For the reason that adjusting one's lumbopelvic control can have a profound effect on one's proprioception strength and flexibility in the upper extremities (Gilmer, Gascon & Oliver, 2018).

Therefore, the results of the study showed that the range of motion, strength, and functional performance of collegiate overhead athletes all benefited more from exercises targeting the lumbopelvic hip complex. There was a statistically significant difference between pre- and post-test measurements of outcomes including ROM, strength, and functional performance.

Limitations:
Few subjects have engaged in compensatory/trick movements during the strength tests. Results may have been impacted if the documented values would have differed.

Recommendations:
We urge further research comparing the effects of lumbopelvic hip complex exercise and core stability exercise on upper extremity performance, as well as testing these interventions on a more representative sample of the population.

Conflict of Interest: *None*

Funding: *Self- Funding*

References

Bullock, G. S., Schmitt, A. C., Chasse, P. M., Little, B. A., Diehl, L. H., & Butler, R. J. (2018). The relationship between trunk rotation, upper quarter dynamic stability, and pitch velocity. *The Journal of Strength & Conditioning Research*, *32*(1), 261-266.

Chaudhari, A. M., McKenzie, C. S., Borchers, J. R., & Best, T. M. (2011). Lumbopelvic control and pitching performance of professional baseball pitchers. *The Journal of Strength & Conditioning Research*, *25*(8), 2127-2132.

Chaudhari, A. M., McKenzie, C. S., Borchers, J. R., & Best, T. M. (2011). Lumbopelvic control and pitching performance of professional baseball pitchers. *The Journal of Strength & Conditioning Research*, *25*(8), 2127-2132.

Chaudhari, A. M., McKenzie, C. S., Pan, X., & Oñate, J. A. (2014). Lumbopelvic control and days missed because of injury in professional baseball pitchers. *The American journal of sports medicine*, *42*(11), 2734-2740.

Cope, T., Wechter, S., Stucky, M., Thomas, C., & Wilhelm, M. (2019). The impact of lumbopelvic control on overhead performance and shoulder injury in overhead athletes: a systematic review. *International journal of sports physical therapy*, *14*(4), 500.

Downs, J., Wasserberger, K., & Oliver, G. D. (2021). Influence of a pre-throwing protocol on range of motion and strength in baseball athletes. *International Journal of Sports Medicine*, *42*(02), 183-190.

Gilmer, G. G., Gascon, S. S., & Oliver, G. D. (2018). Classification of lumbopelvic-hip complex instability on kinematics amongst female team handball athletes. *Journal of science and medicine in sport*, *21*(8), 805-810.

Gilmer, G. G., Washington, J. K., Dugas, J. R., Andrews, J. R., & Oliver, G. D. (2019). The role of lumbopelvic-hip complex stability in softball throwing mechanics. *Journal of sport rehabilitation*, *28*(2), 196-204.

Hodges, P. W., & Richardson, C. A. (1997). Relationship between limb movement speed and associated contraction of the trunk muscles. *Ergonomics*, *40*(11), 1220-1230.

Jha, P., Nuhmani, S., Kapoor, G., Al Muslem, W. H., Joseph, R., Kachanathu, S. J., & Alsaadi, S. M. (2022). Efficacy of core stability training on upper extremity performance in collegiate athletes. *Journal of Musculoskeletal & Neuronal Interactions*, *22*(4), 498.

Kibler, W. B., Press, J., & Sciascia, A. (2006). The role of core stability in athletic function. *Sports medicine*, *36*, 189-198.

Laudner, K., & Sipes, R. (2009). The incidence of shoulder injury among collegiate overhead athletes. *Journal of Intercollegiate Sport*, *2*(2), 260-268.

Lee, D. R., & Kim, L. J. (2015). Reliability and validity of the closed kinetic chain upper extremity stability test. *Journal of physical therapy science*, *27*(4), 1071-1073.

Oliver, G. D., Stone, A. J., Weimar, W. H., Lemak, L., Washington, J. K., & Dougherty, C. P. (2015). Upper extremity muscle activation during Bodyblade exercises following six weeks of intervention focusing on the lumbopelvic-hip complex. *Sports*, *3*(3), 188-201.

Wilk, K. E., Meister, K., & Andrews, J. R. (2002). Current concepts in the rehabilitation of the overhead throwing athlete. *The American journal of sports medicine*, *30*(1), 136-151.

Wilk, K. E., Yenchak, A. J., Arrigo, C. A., & Andrews, J. R. (2011). The advanced throwers ten exercise program: a new exercise series for enhanced dynamic shoulder control in the overhead throwing athlete. *The Physician and sportsmedicine*, *39*(4), 90-97.

Zaremski, J. L., Wasser, J. G., & Vincent, H. K. (2017). Mechanisms and treatments for shoulder injuries in overhead throwing athletes. *Current sports medicine reports*, *16*(3), 179-188.

Primljen: 28. januar 2023. / Received: January 28, 2023
Prihvaćen: 11. maj 2023. / Accepted: May 11, 2023