Central European Journal of Sport Sciences and Medicine | Vol. 42, No. 2/2023: 45–53
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2023.2-04

CORE STRENGTH AS A PARAMOUNT CONTRIBUTOR FOR POTENTIAL UPPER LIMB ISOMETRIC STRENGTH – A CORRELATIONAL STUDY

Harsirjan Kaur[A, B, C, D]

Gurugram University, Gurugram, Haryana, India
ORCID: 0000-0002-5631-5568

Sarika Chaudhary[A, C, D]

MYAS-GNDU Department of Sports Sciences and Medicine G.N.D.U, Amritsar, India
ORCID: 0000-0002-5631-5568 | e-mail: sarikamyas@gmail.com

Charu Chhabra[C, D]

K R Mangalam University, Sohna Road, Gurugram, Haryana, India
ORCID: 0000-0003-3587-5299

[A]Study Design; [B]Data Collection; [C]Statistical Analysis; [D]Manuscript Preparation

Abstract It is believed that a strong core will enable an athlete to effectively transfer forces from the lower extremities through the torso to the upper extremities. Control of the shoulder girdle force is important for the proper function of the upper extremities, although stabilising forces from the trunk and pelvis are also important. The purpose of this study is to determine the association between shoulder isometric push-up/pull-down strength and isometric strength of the abdominal muscles. Using the HUR Rehab-Line 5310 & 5120, isometric upper limb and core strength was measured. The statistical analysis revealed a moderate but significant positive association between the strength of the back muscles and isometric push-ups. Additionally, there was a weak and significant connection between isometric push-ups and abdominal strength. The study therefore draws the conclusion that there is a link between isometric upper limb performance and core musculature strength/stability. The abdominal and back muscles' isometric strength is closely tied to the isometric push-up, which is attributable to the contraction of the Pectoralis Major, Deltoid, and Triceps Brachii. The only muscle group identified to have a substantial and positive correlation with isometric pull-down strength is the abdominal muscles.

Key words: core strength, female athletes, push-up, pull-down, isometric strength

Introduction

The muscles in the core are in control of generating force, which leads to motion in the joints of the extremities (Rivera, 2016). For the functioning of the extremities and the transfer of force, a sturdy base is necessary, which the muscles of the core provide (Shinkle et al., 2012). The pelvic floor and hip girdle muscles serve as the bottom of the lumbo-pelvic hip complex, the diaphragm serves as the roof, the abdominals and obliques are in the front, and the paraspinals and gluteals are in the rear (Akuthota & Nadler, 2004).

Engaging the gleno-humeral and trunk muscles simultaneously is necessary for any overhead sport or training exercise. When engaging in various sports, such as throwing or running, the trunk's stability is crucial for generating the most force and minimising the strain on the joints (Krause et al., 2018). A lack of core stability has been associated with injuries to the shoulders and elbows (Burkhart et al., 2003). The forces and biomechanics of upper-extremity movements can be altered by aberrant neuromuscular control in any link in the chain, according to the kinetic chain theory (Kibler et al., 2006; Silfies et al., 2015).

It is believed that a strong core will enable an athlete to effectively transfer forces generated by the lower extremities through the torso to the upper extremities (Behm et al., 2005; Cissik, 2002; McGill., 2006). The disruption of energy flow caused by a weak core is thought to impair athletic performance and raise the possibility of damaging a muscle group that is already underdeveloped or weak. By providing a basis for higher force/power production in the limbs, trunk stability has been shown to enhance athletic performance. Control of the shoulder girdle force as well as trunk and pelvic stabilising force are necessary for the upper extremities to function perfectly (Burkhart et al., 2003). To get the best core stability, local and global stabilisers are employed. Large global stabilisers like the erector spinae, latissimus dorsi, and hip abductors provide the strength and stability required for upper extremity activities (Sciascia & Cromwell, 2012). If the trunk and pelvis complex is unstable, the shoulder and elbow muscles will need to work more to produce energy. The kinetic and kinematic interplay of the pelvis and trunk was assumed to affect the movement of the shoulder, elbow, and wrist during overhead motion (Ben Kibler, 1998).

Thus, the aim of this study is to evaluate the relationship between shoulder isometric push-up/pull-down isometric strength and core musculature isometric strength. Further, this study aims at quantifying the relationship between upper limb and core strength.

Methods

Participants

67 female athletes of various sports namely handball, volleyball, basketball, badminton etc. were approached and recruited for participation in the study. The sample size was estimated using statistical G power 3.1.9.7 software. The power of the study was set to 80% ($\beta = 0.84$). and the level of significance at 0.05. Those females aged between 18–25 years were included in the study that had been playing for the last 2 years and involved in training with a frequency of at least 3 sessions per week. Subjects with any recent injury or musculoskeletal pain in upper limb were excluded. Out of 67 female athletes, 4 were excluded based on exclusion criteria and 3 participants dropped out during the testing. Finally, data of 60 female overhead athletes (Age 20.72 ±2.043, height 1.67 ±0.081 m, and weight 61.03 ±.07.94 kg) were recorded. All procedures were approved by the Ethics Committee of Guru Nanak Dev University, Amritsar, Punjab (No. 37/HG, Dated 12/1/2022).

Procedure and Data Collection

The subjects after reviewing for inclusion and exclusion criteria were asked to fill the consent form before undertaking the procedure. For the anthropometric data, a stadiometer was used to examine the height and digital weight machine was used to measure the weight. Participants were asked to warm up for 5–10 minutes. The following measurements were taken in kilograms.

<u>Isometric Abdomen/Back Strength by HUR Rehab Line 5310-Abdomen/Back Rehab</u>

Equipment adjustment: Separate performance recorder device was attached to the machine. The distance between the seat and the rollers was adjusted, allowing for a suitable exercising position for all participants. The rear foot of the seat was lifted by the black handles and the seat was moved to the desired position. Height of the seat was adjusted by lifting it from the back with both hands so that the lever arm cushion was above the chest.

1. Abdomen exercise: The lever arm was held against the player's chest while she was seated. Exercise was done by holding the roller gently in the hands and pulling the lever arm downward with the abdominals.

2. Abdomen lLeft exercise: The participant sat onto the left-facing seat in a sideways position. Pushing the lever arm downward and sustaining resistance throughout the return movement required the athlete to use her abdominal muscles.

3. Abdomen right exercise: The player sat on the seat with her right side up. Pushing the lever arm downward and maintaining resistance throughout the return movement required the athlete to use her abdominals.

4. Back exercise: The player was seated so that the lever arm rested against her shoulder blades. Her arms were crossed on her chest as she exercised by pressing the lever arm down with the muscles in her lower back. (HUR Analogue Machines Owner's manual (3310 / 5310 Abdomen/Back 2021) (Figure 1).

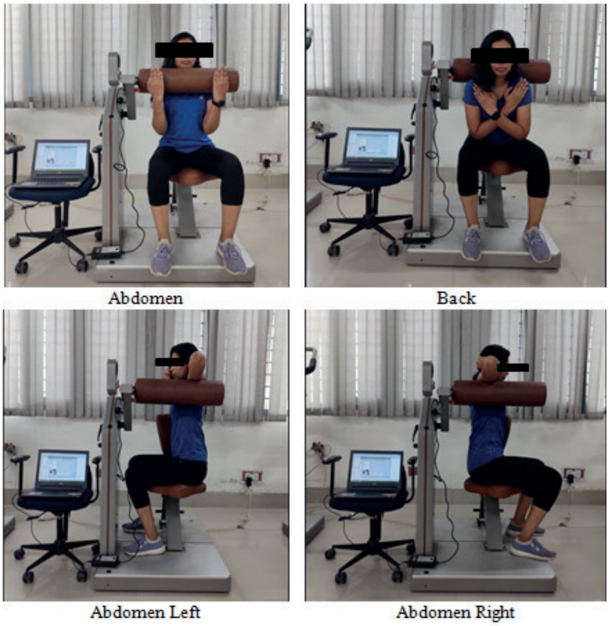


Figure 1. Subject Position for Measurement Isometric Abdomen/Back Strength by HUR Rehab Line 5310-Abdomen/Back Rehab

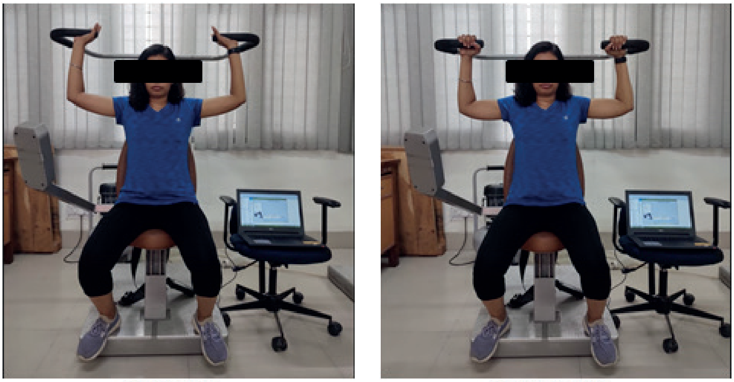
Isometric Shoulder Strength by HUR Rehab Line 5120-Push Up/Pull Down Rehab

Player was instructed to do proper stretching of trapezius and shoulder girdle muscles prior to testing. Separate performance recorder device was attached to the machine. Then height of the seat was adjusted regarding players height and safety belt was attached.

1. Push Up exercise (Pectoralis Major, Deltoid, Triceps Brachii): The exercise was carried out by the player lifting the lever arms up with their hands while leaning against the back support and maintaining straight wrists.

2. Pull down exercise (Biceps Brachii, Latissimus Dorsi, Infraspinatus, Teres Major and Teres Minor): The exercise was carried out by the player by pulling the lever arms down with their hands. (HUR Analog Machines Owner’s manual (3120 / 5120 Push Up / Pull Down), 2021) (Figure 2).

Data was collected by asking players to apply their maximum force at a specific angle for a predetermined amount of time. The participant was given three tries with ten seconds of rest in between each trial. The best measurement, which took into account the measured force, actual force, and actual torque during the test, was taken into consideration.



Push Up Pull Down

Figure 2. Subject Position for Measurement of Isometric Shoulder Strength by HUR Rehab Line 5120-Push Up/Pull Down Rehab

Statistical Analysis

IBM Statistical Package for Social Sciences 26 (SPSS) software was used for analysis. The arithmetic mean and standard deviation were calculated to prepare a summary of statistics. The data was found normally distributed by Shapiro-Wilk test. Therefore, Pearson’s Correlation Test was used to analyse the relationship between upper limb and core parameters. The level of significance was set at 0.05.The classification of the correlation coefficient is as follows: 0 = no correlation, 0 $<| r |>$ 0.2 = very weak correlation, 0.2 $< | r |>$ 0.4 = weak correlation, 0.4 $< | r |>$ 0.6 = medium correlation, 0.6 $< | r |>$ 0.8 = strong correlation, 0.8 $< | r | >$ 1 = very high correlation, 1 = perfect correlation.

Results

Descriptive analysis of anthropometric measurements was done (Table 1). The data was found normally distributed and Pearson's correlation test was used to analyse relationship between Abdomen (kg), Back (kg), Abdomen-Left (kg), Abdomen-Right (kg), Push Up (kg) and Pull Down (kg).

Table 1. Descriptive Statistics of Parameters

Parameters (kg)	Mean	Standard Deviation
Abdomen	132.115	17.64
Back	177.940	44.04
Abdomen-Left	146.440	30.53
Abdomen-Right	154.670	35.61
Push-Up	263.840	38.85
Pull-Down	220.780	37.70

The analysis showed significant positive moderate correlation between isometric push-up and back muscle strength. Further, there occurred a positive but weak correlation between isometric push-up and abdomen strength. This suggests that abdomen and back muscle strength ultimately influences the multi-joint push up movement in upper limbs. The oblique's and the push-up strength were found to have insignificant and weak correlation (Table 2).

Table 2. Pearson's Correlation Coefficient between Isometric Push up Strength and Core parameters

CORE PARAMETERS	Isometric PUSH UP Strength (kgs)	
(ISOMETRIC)	Level of Significance	Correlation Coefficient
Abdomen (kgs)	0.004*	0.369
Back (kgs)	0.000*	0.458
Abdomen Left (kgs)	0.080	0.228
Abdomen Right (kgs)	0.200	0.167

(* denotes significant p-value at 0.05 level)

Also, the result of the study showed significant positive and moderate correlation between isometric pull down and abdomen muscle strength. Surprisingly, the obliques of only left side i.e. abdomen-left isometric strength showed significant but weak correlation with isometric pull-down strength (Table 3). Hence, the results suggest that there exists a positive correlation between the potential strength of upper limbs and the core musculature strength.

Table 3. Pearson's Correlation Coefficient between Isometric Pull Down Strength and Core parameters

CORE PARAMETERS	Isometric PULL DOWN Strength (kgs)	
(ISOMETRIC)	Level of Significance	Correlation Coefficient
Abdomen (kgs)	0.000*	0.468
Back (kgs)	0.111	0.208
Abdomen Left (kgs)	0.027*	0.286
Abdomen Right (kgs)	0.090	0.221

(* denotes significant p-value at 0.05 level)

Discussion

The aim of this study was to evaluate relationship between shoulder isometric push-up/pull-down and core musculature isometric strength.

The study found a significant positive correlation between the strength of the abdominal/back muscles and the comparable upper limb (push-up/pull-down) isometric strength. The same can be explained by previously published research on how trunk stability affects the functioning of the distal extremities. It has been demonstrated that trunk stability enhances athletic performance by laying the foundation for the limbs to produce more force and power (Willardson, 2007). For a range of sport-specific movements, including forehand and backhand strokes in tennis, and overhead throwing in baseball, the synergistic interaction between the muscles of the core and limbs has been observed (Zemkova, 2018; Ellenbecker and Roetert, 2004; Aguinaldo et al., 2007; Stodden et al., 2001). Glenohumeral and trunk muscles must be activated simultaneously for any overhead sport or training task. In a variety of actions, from throwing to sprinting, trunk stability is crucial for generating the most force and minimising joint load (Krause et al., 2018).

Core stability and upper limb strength are moderately correlated (Ahmed et al., 2022). When moving their upper or lower limbs, people with enough core strength employ their trunk muscles in a feed-forward manner (Brumitt & Dale, 2009; Willardson, 2007; Arora et al., 2021). When the extremities begin moving, the body prepares for the likelihood of spinal instability, which initiates this feed-forward process (Richardson, 2004). In some isometric shoulder movements, the trunk muscles are engaged. Standing unilateral horizontal shoulder abduction and bilateral shoulder extension both result in the greatest activation of the trunk muscles. When performing unilateral horizontal abduction, the multifidus and longissimus muscles (maximum activation on the contralateral side) were most active, however when performing bilateral shoulder extension, the external obliques and rectus abdominis muscles were most active (Tarnanen et al., 2008). While simultaneously enhancing the power and endurance of peripheral joints and enabling energy to be transported to distal segments, strong core stabilisation lowers pressure on the spinal column (Hazar et al., 2017).

Hodges and Richardson (1997) stated that trunk muscle action, in particular the activation of the transversus abdominis and multifidus, occurs prior to the initiation of arm motion to aid in stabilising the surrounding joints, controlling position within the base of support, and advancing with smooth upper body movements on a stable base (Arora et al., 2021). Due to the principle of force production, transfer, and control of force and motion to the terminal segment in integrated kinetic chain activities, the musculature of the trunk is also crucial for controlling the motions of the upper limbs and maximising the production of strength in the shoulder (Kibler et al., 2006); this energy production is best absorbed when the muscles of core and extremities are strong (Lattimer et al., 2018; Oliver et al., 2013; Guirelli et al., 2021).

While deep muscles are small and control intervertebral motions, superficial muscles move the lumbar vertebrae, allowing for big arm movements. According to these findings, regional muscles such as the transversus abdominis and deep multifidus fibers are intersegmental motion stabilisers. When maintaining posture is hampered by voluntary arm movement, the direction of the shoulder's movement determines if the deep and superficial Multifidus fibres are activated. When the shoulder is flexed voluntarily, deep and superficial fibres exhibit feedforward activity in relation to the deltoid, suggesting that multifidus activation occurs before deltoid activation (Abiko et al., 2015).

Additionally, Tarnanen and colleagues hypothesised that dynamic unilateral upper limb workouts differed in how they stimulated the muscles on the ipsilateral and contralateral sides. The obliquus externus abdominis, longissimus, and multifidus muscles were shown to have the most changes between the ipsilateral and contralateral sides following shoulder flexion and extension exercises, whereas the rectus abdominis muscles had the least differences. Additionally, by generating torque in the torso, standing upper-limb workouts strengthen the core and back muscles. By changing upper limb postures (lever arm) and movement direction (pushing vs. pulling), one can create selective core muscle engagement (Tarnanen et al., 2012).

Practically, cross-country skiing, rowing, and tennis are just a few examples of activities and sports that demand for controlled use of the back and abdominal muscles while using the upper limbs (Tarnanen et al., 2012). In a study of 20 university-level fencers, a 6-week core-strengthening regimen resulted in significant gains in agility and upper-limb strength as judged by the 1-minute push-up test (Paul, 2019). Additionally, it has been noted that basketball players perform better with their upper extremities when they have a higher level of core activation. When compared to no core exercise, there was a significant improvement in the one arm hop test and modified upper quarter Y balance performance scores with intentional core activation (Arora et al., 2021).

Therefore, it can be safely suggested that strong core musculature has a positive influence on the potential strength of upper limb in female athletes indulging in overhead sports.

Conclusion

According to the study's findings, there is a relationship between core muscle strength and stability and isometric upper limb performance. The isomteric strength of the abdominal and back muscles is closely related to the isomteric push-up strength that is attributed to contraction of the pectoralis major, deltoid, and triceps brachii. The only muscle group identified to have a substantial and positive correlation with isometric pull-down strength is the abdominals. T the left side's oblique (internal and external) revealed a significant correlation with the isometric pull down strength. Therefore, this research reveals that core strength and stability are two such criteria that need to be measured and addressed for successful and efficient performance in overhead athletes. Furthermore, attention should be directed into getting the core muscles prepared to provide the most stability at peak performance if any player, despite consistent and rigorous upper limb strength training, exhibits no improvement in upper limb strength and power. This is likely to benefit the athletes in improving their game.

Acknowledgements The authors gratefully accept the contributions of all of the volunteers who took part in this research. The authors are also grateful to the coaches for their assistance during the research.

References

Abiko, T., Shimamura, R., Ogawa, D., Abiko, Y., Hirosawa, M., Momose, N., Tsuchihashi, W., Suzuki, T., & Takei, H. (2015). Difference in the electromyographic onset of the deep and superficial multifidus during shoulder movement while standing. *PLOS ONE*, *10*(7), e0122303. https://doi.org/10.1371/journal.pone.0122303

Aguinaldo, A. L., Buttermore, J., & Chambers, H. (2007). Effects of upper trunk rotation on shoulder joint torque among baseball pitchers of various levels. *Journal of Applied Biomechanics*, *23*(1), 42–51. https://doi.org/10.1123/jab.23.1.42

Ahmed, S., Saraswat, A., & Esht, V. (2022). Correlation of core stability with balance, agility and upper limb power in badminton players: A cross-sectional study. *Sport Sciences for Health*, *18*(1), 165–169. https://doi.org/10.1007/s11332-021-00789-w

Akuthota, V., & Nadler, S. F. (2004). Core strengthening. *Archives of Physical Medicine and Rehabilitation*, *85*(3 Suppl. 1), 86–92. https://doi.org/10.1053/j.apmr.2003.12.005

Arora, C., Singh, P., & Varghese, V. (2021). Biomechanics of core musculature on upper extremity performance in basketball players. *Journal of Bodywork and Movement Therapies*, *27*, 127–133. https://doi.org/10.1016/j.jbmt.2021.02.023

Behm, D. G., Leonard, A. M., Young, W. B., Bonsey, W. A., & MacKinnon, S. N. (2005). Trunk muscle electromyographic activity with unstable and unilateral exercises. *Journal of Strength and Conditioning Research*, *19*(1), 193–201. https://doi.org/10.1519/1533-4287(2005)19<193:TMEAWU>2.0.CO;2

Ben Kibler, W. B. (1998). The role of the scapula in athletic shoulder function. *American Journal of Sports Medicine*, *26*(2), 325–337. https://doi.org/10.1177/03635465980260022801

Brumitt, J., & Dale, R. B. (2009). Integrating shoulder and core exercises when rehabilitating athletes performing overhead activities. *North American Journal of Sports Physical Therapy*, *4*(3), 132–138.

Burkhart, S. S., Morgan, C. D., & Kibler, W. B. (2003). The disabled throwing shoulder: Spectrum of pathology Part I: pathoanatomy and biomechanics. *Arthroscopy*, *19*(4), 404–420. http://dx.doi. https://doi.org/10.1053/jars.2003.50128

Burkhart, S. S., & Morgan, C. D. (2003). Wholesale cheap OEM/ODM plastic artificial leaves products cheap price-green link new materials Co., Ltd. The disabled throwing shoulder: Spectrum of pathology. Part I: pathoanatomy and biomechanics. *Arthroscopy*, *19*, 404–420.

Cissik, J. M. (2002). Programming abdominal training, Part I. *Strength and Conditioning Journal*, *24*(1), 9–15. https://doi.org/10.1519/00126548-200202000-00002

Ellenbecker, T. S., & Roetert, E. P. (2004). An isokinetic profile of trunk rotation strength in elite tennis players. *Medicine and Science in Sports and Exercise*, *36*(11), 1959–1963. https://doi.org/10.1249/01.mss.0000145469.08559.0e

Guirelli, A. R., Dos Santos, J. M., Cabral, E. M. G., Pinto, J. P. C., De Lima, G. A., & Felicio, L. R. (2021). Relationship between upper limb physical performance tests and muscle strength of scapular, shoulder and spine stabilizers: A cross-sectional study. *Journal of Bodywork and Movement Therapies*, *27*, 612–619. https://doi.org/10.1016/j.jbmt.2021.05.014

Hamed Ibrahim Hassan, I. H. I. (2017). The effect of core stability training on dynamic balance and smash stroke performance in badminton players. *International Journal of Sports Science and Physical Education*, *2*(3), 44–52. https://doi.org/10.11648/j.ijsspe.20170203.12

Hazar Kanik, Z., Pala, O. O., Gunaydin, G., Sozlu, U., Alkan, Z. B., Basar, S., & Citaker, S. (2017). Relationship between scapular muscle and core endurance in healthy subjects. *Journal of Back and Musculoskeletal Rehabilitation*, *30*(4), 811–817. https://doi.org/10.3233/BMR-150497

Hodges, P. W., & Richardson, C. A. (1997). Feedforward contraction of transversus abdominis is not influenced by the direction of arm movement. *Experimental Brain Research*, *114*(2), 362–370. https://doi.org/10.1007/pl00005644

Kibler, W. B., Press, J., & Sciascia, A. (2006). The role of core stability in athletic function. *Sports Medicine*, *36*(3), 189–198. https://doi.org/10.2165/00007256-200636030-00001

Krause, D. A., Dueffert, L. G., Postma, J. L., Vogler, E. T., Walsh, A. J., & Hollman, J. H. (2018). Influence of body position on shoulder and trunk muscle activation during resisted isometric shoulder external rotation. *Sports Health*, *10*(4), 355–360. https://doi.org/10.1177/1941738118769845

Lattimer, L. J., Lanovaz, J. L., Farthing, J. P., Madill, S., Kim, S. Y., Robinovitch, S., & Arnold, C. M. (2018). Biomechanical and physiological age differences in a simulated forward fall on outstretched hands in women. *Clinical Biomechanics*, *52*, 102–108. https://doi.org/10.1016/j.clinbiomech.2018.01.018

McGill, S. (2006). *Ultimate back fitness and performance* (pp. 325). Backfitpro Incorporated.

Oliver, G. D., Sola, M., Dougherty, C., & Huddleston, S. (2013). Quantitative examination of upper and lower extremity muscle activation during common shoulder rehabilitation exercises using the Bodyblade. *Journal of Strength and Conditioning Research*, *27*(9), 2509–2517. https://doi.org/10.1519/JSC.0b013e31827fd4c2

Paul, M. (2019). Core strength training based research on agility and upper limb strength of fencing players. *International Journal of Yogic, Human Movement and Sports Sciences*, *4*(1), 157–159.

Richardson, C. (2004). *Therapeutic exercise for lumbopelvic stabilization: A motor control approach for the treatment and prevention of low back pain*. Churchill Livingstone.

Rivera, C. E. (2016). Core and lumbopelvic stabilization in runners. *Physical Medicine and Rehabilitation Clinics of North America*, *27*(1), 319–337. https://doi.org/10.1016/j.pmr.2015.09.003

Sciascia, A., & Cromwell, R. (2012). Kinetic chain rehabilitation: A theoretical framework. *Rehabilitation Research and Practice*, *2012*, 853037. https://doi.org/10.1155/2012/853037

Shinkle, J., Nesser, T. W., Demchak, T. J., & McMannus, D. M. (2012). Effect of core strength on the measure of power in the extremities. *Journal of Strength and Conditioning Research*, *26*(2), 373–380. https://doi.org/10.1519/JSC.0b013e31822600e5

Silfies, S. P., Ebaugh, D., Pontillo, M., & Butowicz, C. M. (2015). Critical review of the impact of core stability on upper extremity athletic injury and performance. *Brazilian Journal of Physical Therapy*, *19*(5), 360–368. https://doi.org/10.1590/bjpt-rbf.2014.0108

Stodden, D. F., Fleisig, G. S., McLean, S. P., Lyman, S. L., & Andrews, J. R. (2001). Relationship of Pelvis and Upper Torso kinematics to pitched baseball velocity. *Journal of Applied Biomechanics*, *17*(2), 164–172. https://doi.org/10.1123/jab.17.2.164

Tarnanen, S. P., Siekkinen, K. M., Häkkinen, A. H., Mälkiä, E. A., Kautiainen, H. J., & Ylinen, J. J. (2012). Core muscle activation during dynamic upper limb exercises in women. *Journal of Strength and Conditioning Research*, *26*(12), 3217–3224. https://doi.org/10.1519/JSC.0b013e318248ad54

Tarnanen, S. P., Ylinen, J. J., Siekkinen, K. M., Mälkiä, E. A., Kautiainen, H. J., & Häkkinen, A. H. (2008). Effect of isometric upper-extremity exercises on the activation of core stabilizing muscles. *Archives of Physical Medicine and Rehabilitation*, *89*(3), 513–521. https://doi.org/10.1016/j.apmr.2007.08.160

Willardson, J. M. (2007). Core stability training: Applications to sports conditioning programs. *Journal of Strength and Conditioning Research*, *21*(3), 979–985. https://doi.org/10.1519/R-20255.1

Zemkova, E. (2018/06/23). Science and practice of core stability and strength testing. *Physical Activity Review*, *6*, 181–193. https://doi.org/10.16926/par.2018.06.23

Cite this article as: Kaur, H., Chaudhary, S., & Chhabra, C. (2023). Core Strength as a Paramount Contributor for Potential Upper Limb Isometric Strength – A Correlational Study, *Central European Journal of Sport Sciences and Medicine*, *2*(42), 45–53. http://doi.org/10.18276/cej.2023.2-04