EFFECT OF IMMEDIATE USE OF DRY CUPPING ON MUSCLE STRENGTH IN NORMAL ADULTS

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Abstract
This study aimed to explore the immediate outcome of dry cupping (DC) on muscle strength (MS). Eighty-four students were randomly allocated into two groups (A and B). The experimental group (A) performed biceps curl exercises concurrently with the application of DC, whereas control group (B) executed same exercises without DC. A dynamometer was employed to measure biceps MS to evaluate the immediate effect. The findings demonstrated a notable improvement in average force (ES = 0.55) and peak force (ES = 0.56) of biceps muscle in group A relative to group B, with percentage changes in average and peak force for group A being 25.01% and 17.97%, respectively. Implications for physiotherapy practice: The MS could be enhanced in sports training and competitions by implementing cupping therapy at the appropriate moment and for the appropriate duration. Study registration: Clinical trial approval ID was NCT06969976.
Keywords: Adults, Biceps; Dry Cupping; Dynamometer, Muscle strength.

INTRODUCTION

Muscle strength (MS) is essential for physical performance, athletic capability, and overall health, and multiple therapeutic strategies are under investigation to improve muscular function and recovery. Resistance training is a key approach for strength development, producing favorable adaptations at both the structural (Morton, Colenso-Semple, & Phillips, 2019 and Marwa et al., 2024) and neural (Duchateau, Stragier, Baudry, & Carpentier, 2021; Suchomel, Nimphius, Bellon, & Stone, 2018) levels. As noted by Marcolin et al. (2018) and Nunes et al. (2020), resistance exercises engage not only the prime movers responsible for executing the movement but also the stabilizing muscles that support the joint or joints involved in the action.
The biceps curl is a widely used resistance exercise targeting the upper limb muscles. It is characterized by wrist

supination or pronation, dynamic or predominantly isometric arm flexion, and elbow flexion (Moon et al., 2013; Naito, 2004). The primary muscles engaged are the elbow flexors, namely the biceps brachii, brachialis, and brachioradialis. Execution may rely on external resistance provided by dumbbells, cables, barbells, or iso-load mechanisms (Nunes et al., 2020). Strength training represents the most common modality for enhancing musculoskeletal strength (Hass et al., 2001), with potential physiological adaptations such as increased maximal strength, augmented fat-free mass, thickening of connective tissues, muscular hypertrophy, and improved motor performance (Rhea et al., 2003). Evidence from the past decade indicates that performing multiple sets (MS) of an exercise yields greater gains in strength compared to single-set protocols (Galvão & Taaffe, 2005). This outcome has been repeatedly validated by meta-analyses, which recommend MS as a superior strategy for strength development in trained and untrained populations (Peterson, Rhea, & Alvar, 2004).

Cupping therapy, a centuries-old therapeutic practice, has been applied in a broad spectrum of illnesses management (Ullah, Younis, & Wali, 2007). According to Al-Bedah et al. (2016), multiple forms of cupping therapy exist, with the two principal types being dry cupping (DC) and wet cupping. In wet cupping, the skin is intentionally lacerated to facilitate the extraction of blood into the cup, whereas in DC, the skin is drawn into the cup without scarification (Kim, Lee, Lee, Boddy, & Ernst, 2011). This modality has been employed in treating various conditions such as carpal tunnel syndrome, neck pain, headaches, and low back pain (Ahmadi, Schwebel, & Rezaei, 2008; Farhadi et al., 2009; Lauche et al., 2012; Michalsen et al., 2009). When combined with movement patterns or functional exercises, it is anticipated to constitute a novel development in sports medicine (LaCross, 2014; Musumeci, 2016).

Previous research has categorized the effects of cupping therapy into two primary domains: mechanical and chemical. As described by Guimberteau et al. (2010) (Guimberteau, Delage, McGrouther, & Wong, 2010), mechanical effects enhance lubrication within the superficial fascia located between the skin and the deep fascia, facilitating unrestricted gliding of the deep fascia and underlying muscles. This mechanism mitigates the constraints imposed by deep fascia adhesions, thereby facilitating autonomous muscle mobility during intensive cupping therapy application (Tham, Lee, & Lu, 2006). Furthermore, evidence suggests that cupping therapy enhances normal body function by inducing prompt reactions within the skin and fascia (Benjamin, 2009). It also addresses mechanical impairments and pain-related tension in soft tissues by promoting effective tissue repair (Malliaropoulos, Papalexandris, Papalada, & Papacostas, 2004).

Initially, cupping therapy was classified into two primary types: DC and moist cupping (Teut et al., 2012). In 2013, a formal classification system was introduced, dividing cupping therapy into five distinct groups. The classification system was updated in 2016, extending it to six distinct categories. The first, termed 'technical types,' comprises DC, wet cupping, massage cupping, and flash cupping. The second, 'power of suction,' includes light, medium, and vigorous cupping. The third, 'method of suction,' covers electrical vacuum cupping, hand-operated vacuuming, and fire-based suction. The fourth category, previously referred to as 'materials inside cups,' incorporates herbal, ozone, needle, moxa, water, and magnetic cupping. The fifth category, based on treatment area, includes facial, abdominal, gender-specific, and orthopedic cupping, while the sixth covers other forms such as cosmetic, sports, and aquatic cupping. In this article, categories five and six are merged into a unified category, 'condition and area treated,' as part of a proposed update to the classification framework. Additionally, aquatic cupping has been reassigned to the fourth category, which is redefined and renamed as 'added therapy types.' This proposed modification aims to provide a clearer, more systematic framework for categorizing the diverse forms of cupping therapy (Al-Bedah et al., 2016).

DC involves the placement of a suction cup on the skin to create localized negative pressure (Afsharnezhad & Khaleghi, 2021). A pressure gradient, often produced by heating the cup’s internal air, permits the cup to remain fixed on the skin. (Ge, Leson, & Vukovic, 2017). Previous studies have evaluated the therapeutic efficacy of cupping therapy in managing various conditions, including gastrointestinal disorders, dermatological problems, musculoskeletal pain, and chronic low back pain (Bamfarahnak, Azizi, Noorafshan, & Mohagheghzadeh, 2014; Bridgett, Klose, Duffield, Mydock, & Lauche, 2018). In recent years, cupping therapy has gained popularity among athletes for its potential to enhance athletic performance, stimulate blood flow, and reduce pain (Bamfarahnak et al., 2014). The technique applies a negative pressure gradient to the targeted tissues, causing compression at the cup’s rim while elevating the tissues into the cup. This pressure gradient promotes vasodilation, thereby increasing local blood flow. Theoretically, the enhanced microcirculation associated with cupping therapy has been correlated with improved physical performance (Qureshi, Alkhamees, & Alsanad, 2017).

In comparison with wet cupping, DC is a non-invasive modality considered safer, easier to perform, and associated with a lower risk of adverse effects (Cramer et al., 2020). Variations in the suction technique may exist when applying DC; in some instances, suction is generated manually using a hand pump, a method described in the literature as both simple and safe (Aboushanab & AlSanad, 2018).

Evidence from studies examining the chemical effects of cupping therapy indicates that it enhances blood circulation and facilitates the removal of toxins from the deep fascia, thereby contributing to efficient physical recovery (El Sayed et al., 2014; Tham et al., 2006; Yoo & Tausk, 2004). Application of cupping therapy to the skin has also been shown to stimulate small nerve fibers within the muscles, triggering the release of endorphins in the brain (Tham et al., 2006). Although cupping therapy has been practiced for centuries across various cultures and societies and has been scientifically demonstrated to exert beneficial effects (Ahmadi et al., 2008; El Sayed et al., 2014; Farhadi et al., 2009; Hanan & Eman, 2013; Lauche et al., 2012; Michalsen et al., 2009; Tham et al., 2006; Yoo & Tausk, 2004), research remains limited regarding its influence on muscle activity, muscle length, and pain thresholds (Afsharnezhad & Khaleghi, 2021). The authors hypothesize that DC has no effect on MS in healthy adults. Accordingly, the present study aims to assess the immediate impact of DC on MS.

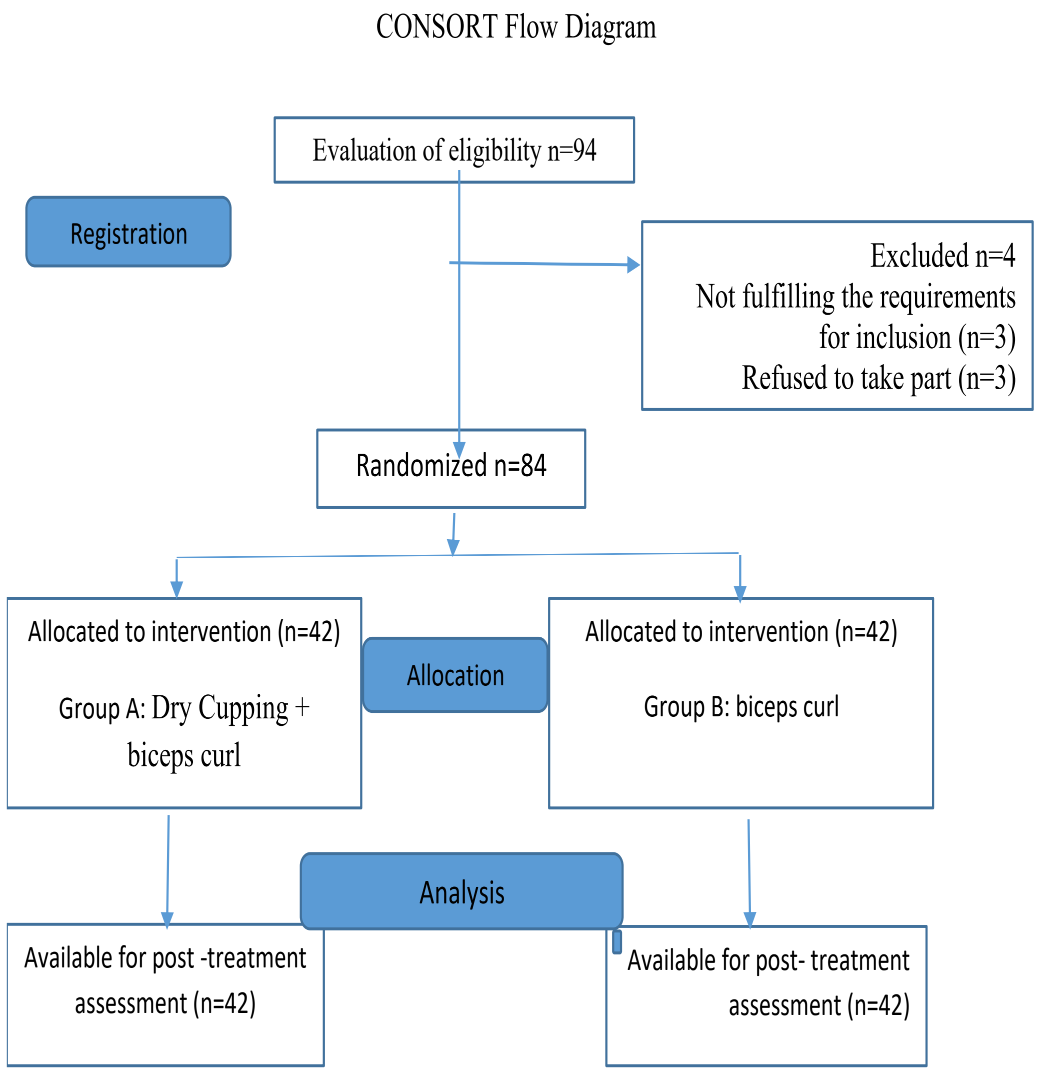
MATERIALS & METHODS

Study design

This research used a single blinded randomized control design to examine the effect of immediate use of DC on MS in normal individuals, conducted from April to November 2024.
Eighty-four male students taken part in this study, as described in (Fig.1); students were recruited via word of mouth from 6th of October, Ahram Canadian and Misr for science and technology universities Faculty of Physical Therapy and medicine. Following an explanation of the study's objectives and methods, participants signed a consent form, and underwent an eligibility screening. inclusion criteria consisted of: a) age from 20 to 25 years; b) normal BMI; c) sedentary life style for 6 months; d) The assessment is done on the dominant hand. Participants were excluded if they had cervical disorders affecting upper limb, cardiovascular problems, and musculoskeletal disorders affecting dominant upper limb.

Sample size

Pilot study data served as the basis for prior estimates in determining the sample size. The analysis used G*Power 3.1.9 (Heinrich-Heine-University, Düsseldorf, Germany), assuming $\alpha = 0.05$, 80% power, an effect size of 1.102, and balanced allocation between groups. The analysis indicated that a minimum of 80 students was required; this number was increased to 84 to compensate for potential dropouts, resulting in 42 participants per group.



(Fig. 1): Flow chart of patients

Randomization
Data were gathered at baseline and immediately after a resistance training protocol. Allocation concealment was performed using opaque sealed envelopes. Participants were randomly assigned using a random number generator scheme from a website (https://www.random.org/) to one of two groups: traditional resistance training (control group), resistance training with DC (experimental group).

Procedures:
To assess MS average force and peak force was measured at baseline and immediately after resistance training program using active force 2 dynamometer (AF; Activbody, San Diego CA). As indicated in (fig. 2).
All tests were conducted in a standard standing stance. Elbow flexion was examined with the arm fully adducted, the elbow at ninety degrees flexion, and the forearm in supination, participants were instructed to stand erect and avoid any shoulder shrugging. The hand-held dynamometer is fixated on wrist joint line of each participant's dominant hand using a long strap attached to a fixed chair.
The test consisted of 2 successive trials of maximal isometric voluntary contractions before and after exercise except for 10 students (3 in group A and 7 in group B) due to time constraints. For each experiment, standardized verbal orders ("push as hard as possible, push, push, push") were given for three seconds each. The AF device does not show the force. The system connects remotely to a cell phone and displays the test score as mean score of two trials. Then the participants rested for 30 sec before starting the exercise protocol, and after finishing the exercise protocol they rest for 30 sec and begin the post assessment.
Students in group (A) perform a single session of strengthening exercise program for biceps brachii muscle of the dominant hand in form of biceps curl movement (a movement of the elbow joint from 0 extension to 135 degree flexion and then back to 0 degree extension, arm fully adducted and forearm supinated), participants were instructed to stand erect and avoid any shoulder shrugging. Students perform the exercise with a dumbbell weight 2 kg in their hands with DC applied using 2 silicon cups at the origin and insertion of the tested muscle, for four sets (15 repetitions in each set) with 30 seconds of rest period between each set. As indicated in (fig. 3).
Students in group (B) perform a single session of strengthening exercise program for biceps brachii muscle of the dominant hand in form of biceps curl movement (a movement of the elbow joint from 0 extension to 135 degree flexion and then back to 0 degree extension, arm fully adducted and forearm supinated), participants were instructed to stand erect and avoid any shoulder shrugging. Students perform the exercise with a dumbbell weight 2 kg in their hands, for four sets (15 repetitions in each set) with thirty seconds of rest period between each set.

Figure 2. Active force 2 dynamometer

Statistical analysis
All statistical analyses were performed using SPSS version 25 for Windows (IBM SPSS, Chicago, IL, USA). Between-group comparisons of age, weight, height, and BMI were conducted using the unpaired t-test, while Chi-squared test was applied to examine differences in dominant side distribution. Data normality was assessed with Shapiro–Wilk test, and variance homogeneity was evaluated using Levene's test. A mixed-design MANOVA was employed to analyze within- and between-group effects on average and peak force, with Bonferroni-adjusted post-hoc tests applied where applicable. Values of p below 0.05 were regarded as significant.

Figure 3. Cups placement

RESULTS

Subjects' characteristics:

Baseline demographic and anthropometric variables—age, height, weight, BMI, and limb dominance—were comparable between groups (p > 0.05). Table 1

Table 1. Subject characteristics.

	Group A Mean ± SD	Group B Mean ± SD	MD	t- value	p-value
Age (years)	21.85 ± 1.26	21.67 ± 1.31	0.18	0.64	0.53
Weight (kg)	74.40 ± 7.20	74.81 ± 8.02	-0.41	-0.24	0.81
Height (cm)	178.26 ± 5.45	177.98 ± 5.01	0.28	0.25	0.80
BMI (kg/m²)	23.38 ± 1.54	23.61 ± 2.19	-0.23	-0.55	0.59
Dominant side, n (%)					
Right	40 (95.2%)	41 (97.6%)		χ^2 = 0.35	1
Left	2 (4.8%)	1 (2.4%)			

MD, mean difference; SD, standard deviation; χ^2, Chi squared value; p-value, level of significance

Table 2. Mean average and peak force pre and post treatment of group A and B:

	Group A Mean ±SD	Group B Mean ±SD	MD (95% CI)	P value	ES
Average force (N)					
Pre treatment	185.12 ± 50.08	196.18 ± 56.74	-11.06 (-34.29: 12.17)	0.34	
Post treatment	231.41 ± 47.50	204.11 ± 51.81	27.3 (5.73: 48.88)	0.01	0.55
MD (95% CI)	-46.29 (-56.27: -36.32)	-7.93 (-17.91: 2.04)			
% of change	25.01	4.04			
P value	**p = 0.001**	**p = 0.11**			
Peak force (N)					
Pre treatment	240.84 ± 65.91	245.80 ± 69.84	-4.96 (-34.44: 24.52)	0.73	
Post treatment	284.12 ± 64.57	250.18 ± 57.45	33.94 (7.41: 60.47)	0.01	0.56
MD (95% CI)	-43.28 (-55.16: -31.41)	-4.38 (-16.26: 7.49)			
% of change	17.97	1.78			
P value	**p = 0.001**	**p = 0.46**			

SD, Standard deviation; CI, Confidence interval; MD, Mean difference; p-value, Level of significance; ES, Effect size

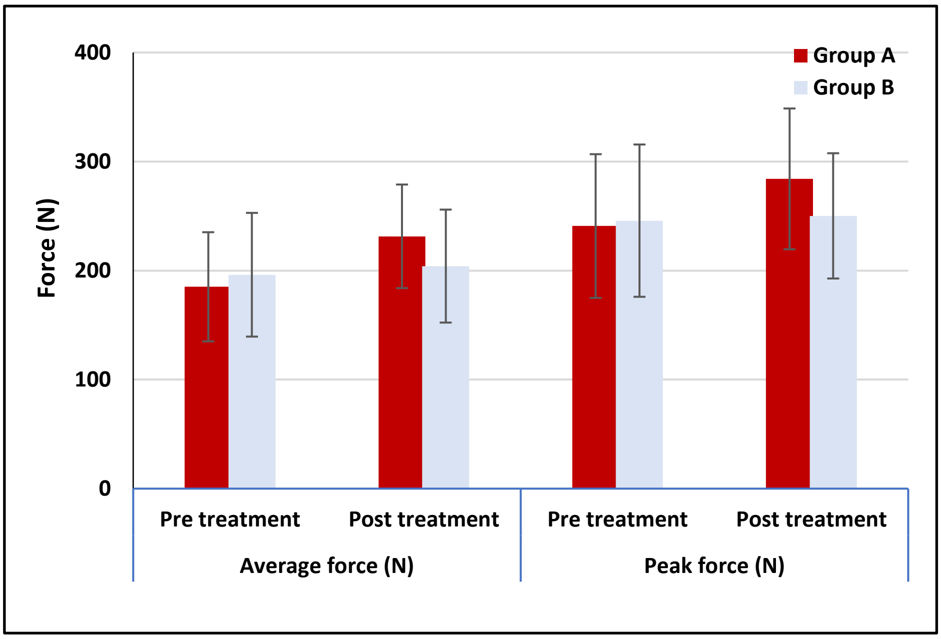


Figure 4. Average and peak muscle force at baseline and post-intervention for Groups A and B

Effect of treatment on average and peak force:

A significant interaction between treatment and time was observed ($F = 16.18$, $p = 0.001$, $\eta^2 = 0.29$). Time demonstrated a substantial main effect ($F = 30.13$, $p = 0.001$, $\eta^2 = 0.43$), whereas the main effect of treatment was not substantial ($F = 0.67$, $p = 0.51$, $\eta^2 = 0.02$).

Within group comparison

In group A, post-treatment measurements demonstrated a significant increase in both average and peak biceps force compared with pre-treatment values ($p < 0.001$), with percentage changes of 25.01% and 17.97%, respectively. In contrast, group B showed no substantial alterations in either parameter ($p > 0.05$). Table 2, Figure 1.

Between groups comparison

No considerable variations were detected between groups at pre-treatment ($p > 0.05$). Post-treatment comparison showed a substantial elevation in average force (ES = 0.55) and peak force (ES = 0.56) in group A relative to group B ($p < 0.01$). Table 2, Figure 4.

DISCUSSION

DC therapy, a traditional complementary medicine modality, involves the application of cups to generate localized negative pressure. Although it is extensively utilized in sports rehabilitation and pain management, its direct influence on MS —particularly in the biceps—has not been investigated. Therefore, the present study aimed to examine the immediate effect of DC on biceps strength.

The findings demonstrated a notable improvement in average force (ES = 0.55) and peak force (ES = 0.56) of biceps muscle in group A relative to group B, with percentage changes in average and peak force for group A being 25.01% and 17.97%, respectively. These findings demonstrated that DC therapy had an immediate and substantial impact on the development of MS. However, the mechanism of action has yet to be entirely understood. Initially, the application of DC results in a reduction in microcirculation, and metabolic acidosis with lactate accumulation in application area. Subsequently, it is proposed that there is an elevation in microcirculation and vasodilation (Emerich, Braeunig, Clement, Lüdtke, & Huber, 2014).

This study involved the most frequently employed muscle groups in upper limb movements. By applying cups to the origin and insertion of biceps muscle, we aimed to enhance the recovery by accelerating regeneration, and eventually increase performance.

The significant enhancement in MS by DC therapy may be attributed to the variations in the rate of intramuscular hydrogen ion (H+) removal following cupping therapy (Sahlin, Tonkonogi, & Söderlund, 1998). The discharge of H+ may be enhanced by cupping therapy, which has the potential to increase blood flow (Hou et al., 2021). The binding of H+ to Ca2+ on troponin C could inhibit the binding of Ca2+ to troponin and restrain the releasing Ca2+ into sarcoplasm, resulting in a high [H+] within the muscle (Goodall, Charlton, Howatson, & Thomas, 2015). Additionally, it could reduce the ATPase activity (Mesin, Cescon, Gazzoni, Merletti, & Rainoldi, 2009). These disturbances, which induce, have the potential to directly impact excitation-contraction coupling and

decrease the formation of cross-bridges (Allen, Lamb, & Westerblad, 2008).
The pressure of cupping therapy can induce petechiae and vasodilation, which facilitates the easy passage of intramuscular H+ into biceps circulation (Tham et al., 2006). However, the complete restoration of muscle pH to pre-exercise levels may necessitate a minimum of 60 minutes following intensive exercise-induced fatigue (Neric, Beam, Brown, & Wiersma, 2009). In the current study, the instantaneous effect after cupping therapy was significant and had a positive impact on MS. This impact is because the reduction of [H+] may be achieved during exercise and may last within a day of cupping therapy in addition to decreasing the mechanical load on the the muscle that produce damage to muscle tissue during muscle contraction, particularly an eccentric contraction (Al-Bedah et al., 2016; Lowe, 2017; Torres, Ribeiro, Alberto Duarte, & Cabri, 2012).
In contrast, Uludağ (Uludağ & Yapıcı Öksüzoğlu, 2022) found that the dry cup administered to football players resulted in an increase in knee and hip flexion but did not result in an elevation in hip and knee strength. In the same context, Murray and Clarkson (Murray & Clarkson, 2019) proposed that a single-dose, mobile cup application enhanced the the hip and knee movements in 21 athletes but did not result in an increase in isokinetic knee flexion strength. Additionally, Kargar-Shoragi et al.(Kargar-Shoragi, Ghofrani, Bagheri, Emamdoost, & Otadi, 2016) reported that cupping and exercise resulted in elevated CK and LDH values in male handball players, which are indicators of muscle injury.
Although cupping therapy has become increasingly prevalent in sport activities in recent years (Lowe, 2017), there is limited scientific evidence regarding its ability to increase MS. However, our findings revealed that cupping therapy had a substantial immediate effect on increasing MS.

IMPLICATIONS FOR PHYSIOTHERAPY PRACTICE

Consequently, the MS could be enhanced in sports training and competitions by implementing cupping therapy at the appropriate moment and for the appropriate duration.

RECOMMENDATION

Future suggestions include assessing MS and activity as well as researching various approaches in various students age groups to gauge the relationship between DC and MS and activity.

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Conflicts of Interest: The authors declare no conflicts of interest.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Ethical approval statement: The study received approval from the ethical committee of the Faculty of Physical Therapy 6th October University in Egypt O6U.PT.REC/024/002001. The study was conducted following the code of ethics of the world Medical Association's Declaration of Helsinki for human experimentation.

Patient Consent Statement: All participants signed an informed consent form.

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