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Research Article

Effects of Close Kinetic Chain Exercise on Hand Grip Strength in Young Adult Males

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Abstract

Background: Hand grip strength (HGS) is a key biomarker of overall muscular function, health status, and athletic performance. While open kinetic chain exercises are commonly employed to enhance HGS, the acute effects of close kinetic chain exercises (CKCE) on grip strength remain underexplored. *Objective:* This study aimed to investigate the immediate impact of CKCE on hand grip strength in healthy young adult males, focusing on both dominant and non-dominant forearms. *Methods:* Twenty-seven untrained male participants (mean age 19.56 ± 1.50 years) performed a standardized CKCE protocol involving wrist curls, grip crush, forearm squeezes, and fingertip push-ups. Hand grip strength was assessed at baseline (pre-test) and at 30 seconds, 2 minutes, and 5 minutes post-exercise using a digital grip dynamometer and EMG analysis. Repeated measures ANOVA with Bonferroni post hoc tests were conducted to evaluate within-subject changes. *Findings:* Significant reductions in HGS were observed post-exercise. In the dominant forearm, grip strength significantly declined at 2 minutes ($p = 0.004$) and 5 minutes ($p = 0.015$) compared to pre-test values. In the non-dominant forearm, a significant difference was noted between 30 seconds and 5 minutes' post-exercise ($p = 0.01$). The results suggest that CKCE induces acute muscular fatigue, leading to transient reductions in grip strength. *Conclusion:* CKCE elicits immediate but temporary reductions in hand grip strength due to neuromuscular fatigue. These findings are relevant for clinicians and trainers in designing exercise programs aimed at functional strength and recovery optimization.

Keywords

Fitness Parameter, CKCE, Anthropometric Parameter, Post-exercise Recovery

1. Introduction

Hand grip strength (HGS) is widely acknowledged as a crucial indicator of muscular strength and functional capacity, with significant relevance in both clinical and athletic domains. It serves not only as a predictor of upper limb functionality but also correlates with general health outcomes, including cardiovascular disease, disability, and mortality rates [1] Reduced grip strength has been linked to an increased risk of chronic conditions such as type 2 diabetes, kidney

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disease, and fragility fractures, reinforcing its value as a prognostic marker in health assessments [2] In athletic settings, HGS plays a vital role in performance, particularly in sports requiring grip-intensive force application, such as rock climbing, weightlifting, gymnastics, and racket sports. Additionally, superior grip strength enhances control and execution in combat sports such as wrestling and judo [8]. Traditional approaches to improving grip strength primarily focus on resistance-based training targeting the forearm and hand muscles. However, recent attention has shifted toward understanding the role of kinetic chain exercises in neuromuscular performance enhancement. Kinetic chain exercises are categorized into open kinetic chain (OKC) and closed kinetic chain (CKC) movements. OKC exercises allow unrestricted movement of the distal segment, whereas CKC exercises require the distal extremity to remain fixed, thereby engaging multiple joints and muscle groups simultaneously [3]. CKC exercises have been shown to promote greater joint stability, enhance proprioceptive feedback, and increase muscular co-contraction, factors that collectively contribute to improved strength and coordination [4]. Given their established benefits in rehabilitation and athletic conditioning, CKC exercises may offer additional advantages in augmenting isolated muscular outputs such as HGS.

One mechanism that may explain the acute enhancement of grip strength following CKC exercises is post-activation potentiation (PAP). PAP refers to a phenomenon where preceding muscular activation leads to transient increases in performance due to heightened neuromuscular readiness [5]. While PAP has been extensively studied in the context of explosive power and strength-based movements, its application to grip strength following CKC exercises remains underexplored. Given the increasing recognition of grip strength as a vital biomarker in health and athletic performance, investigating the acute effects of CKC exercises on HGS may provide valuable insights for rehabilitation professionals, sports scientists, and trainers.

Therefore, the objective of this study is to evaluate the immediate effects of CKC exercises on grip strength in a healthy adult population, focusing on both dominant and non-dominant forearms. By identifying potential neuromuscular adaptations associated with CKC exercises, this research aims to contribute to evidence-based practice in rehabilitation and strength training, ultimately improving functional outcomes for both clinical and athletic populations.

2. Methodology

2.1. Participation

Twenty-seven (27) young adult males were selected using convenience sampling methods. A priori power analysis was conducted with G*Power version 3.1 to determine the required sample size. Assuming an effect size of 0.5, an alpha level of 0.05, and a power of 0.80.

The means (Table 1) for age, height, weight, body mass index (BMI), dominant forearm circumference (DFAC), and non-dominant forearm (NDFRC) were as follows: age 19.56 ± 1.50 years, height 165.96 ± 5.95 cm, weight 61.89 ± 7.71 kg, BMI 22.18 ± 2.66 Kg/m^2, DFAC 9.87 ± 0.60 cm, and NDFRC 9.81 ± 0.59 cm.

The study included individuals who had not previously engaged in any fitness training programs, ensuring that their prior training experience would not affect the immediate impact of closed kinetic chain (CKC) exercises on forearm grip strength. Participants were excluded if they had sustained any injuries or undergone surgical procedures within the six months leading up to the study.

Table 1. *Anthropometric characteristics of the study participants.*

Anthropometric Characteristics	Age (year)	Height (cm)	Weight (kg)	BMI (kg/m^2)	DFAC (cm)	NDFAC (cm)
CKCE (n=27)	19.56±1.50	165.96±5.95	61.89±7.71	22.18±0.66	9.87±0.60	9.81±0.59

Value is presented as the mean and standard deviation (SD). CKCE: closed kinetic chain exercise; BMI: body mass index; DFAC: dominant forearm circumference; NDFAC: non-dominant forearm.

2.2. Instrumentation

Iworx Surface EMG analyzing software (Iworx System, Inc.), grip strength device (iwire-B3G), a grip dynamometer, and foam solid gel disposal electrodes (A-GC-7165, 5×54 mm) were used to collect grip strength raw data. Cotton wool and scrubbing gel (ref) were applied to clean the skin, and a razor was used to remove hair. A weighing machine, stadiometer, and measuring tape were utilized to measure anthropometric variables. BMI was calculated using the formula BMI = Body Weight in kg / Height in m ² SPSS (Statistical Package for the Social Sciences) software (IBM SPSS VERSION 20) was used for descriptive and repeated measures analysis of variance (ANOVA) with pairwise comparison, followed by Bonferroni methods.

2.3. Study Design

All chosen participants visited the exercise physiology laboratory at the Department of Physical Education, Jadavpur University, Kolkata, West Bengal, India, on a specified day during the study period. Before exercising, researchers recorded the anthropometric variables. Each participant then performed selected closed kinetic chain (CKC) exercises [13]. The Study design briefly describe in figure 1.

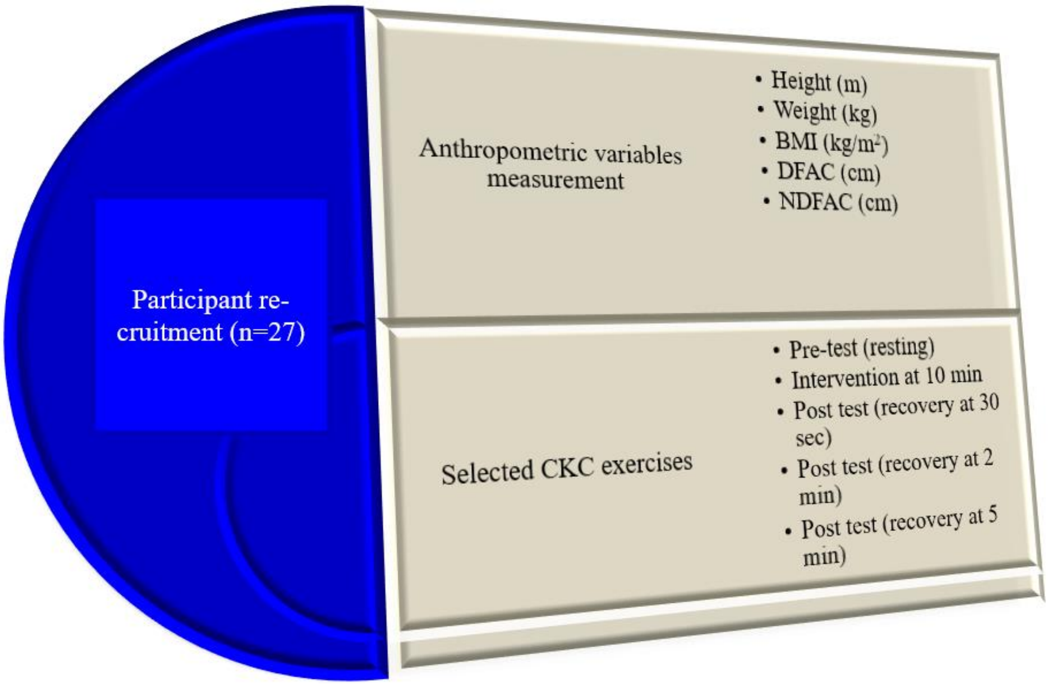
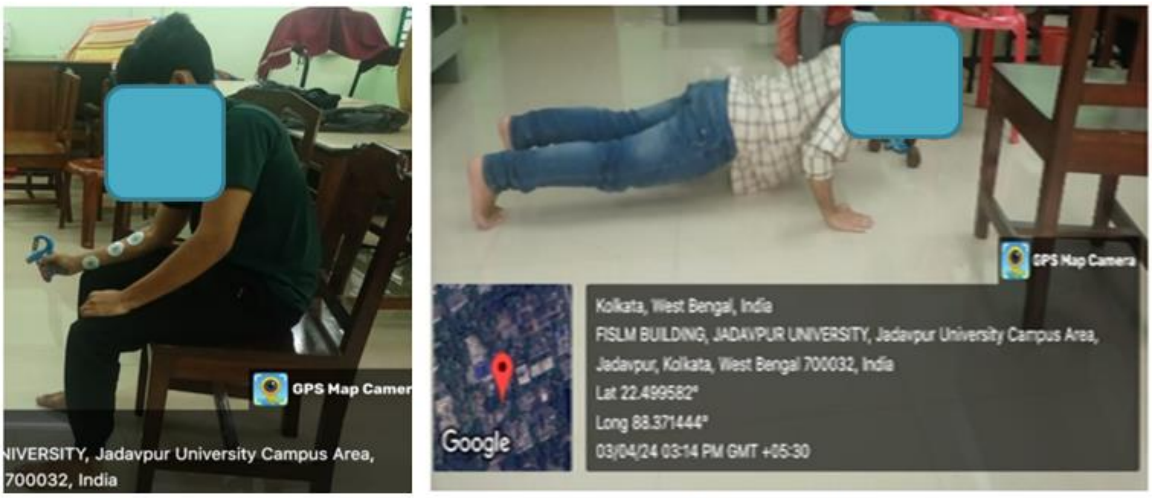


Figure 1. *Illustration of the "Experimental Design".*

2.4. Experimental Procedure of Exercise Protocol

Close Kinetic Chain (CKC) exercise was selected for this experimental research. Five exercises were taken, which have a significant role in developing forearm strength and grip strength.

(a) Palms-up wrist curl (b) Palms-down wrist curl (c) Grip crush



(d) Forearm squeeze (e) Fingertip's push-ups

Figure 2. *Represent of different types of exercise procedure on this photo, (a) Palms-up wrist curl, (b) Palms-down wrist curl, (c) Grip crush, (d) Forearm squeeze, and (e) Fingertip's push-ups.*

Palms-up wrist curl: Strengthens the wrist flexors (flexor carpi radialis, flexor carpi ulnaris). The subject should sit on a bench with their forearms resting on their thighs, wrists hanging over the edge, and palms facing up. Hold a 2 kg dumbbell, curl the weight upward, and then lower it slowly. Perform 2-4 sets of 10-15 repetitions (Figure 2(a)).

Palms-down wrist curl: Target the wrist extensors (extensor carpi radialis and extensor carpi ulnaris). Subjects were instructed to sit on a bench with their forearms resting, wrists hanging over the edge, and palms facing down. Curl the weight by extending the wrists, then lower it gradually. Perform 2-4 sets of 10-15 repetitions (Figure 2(b)).

Grip crush: Strengthens hand and forearm muscles through gripper squeezes. Hold a 2 kg dumbbell. Perform 2-4 sets of 10-15 repetitions, progressing resistance over time (Figure 2(c)).

Forearm squeeze: In the anatomical position, participants were asked to extend and flex their fingers to squeeze the forearm grips. They were instructed to hold the grip for 3-5 seconds, relax for one second, and then continue for a maximum intensity of 2 minutes (Figure 2(d)).

Fingertip's push-ups: Enhances grip and finger strength while engaging the upper body. Maintain balance on fingertips instead of palms during push-ups. Perform 2-4 sets of 10-15 repetitions, ensuring proper form to avoid injury (Figure 2(e)).

2.5. Data Processing

Hand grip strength was recorded using Iworx surface EMG analysing software (LabScribe) with a digital interface. Electrical activity was recorded using foam solid disposable gel electrodes (A-GC-7165, 5×54 mm) applied to the skin surface. In LabScribe software, filter settings were 10 Hz to 10 kHz with frequency resolution of 1 Hz. grip strength device (Iwire - B3G), a grip dynamometer (Figure 1), was used for collecting raw data on hand grip strength. Subjects were instructed to squeeze as maximally as possible to grip the dynamometer (Figure 3).

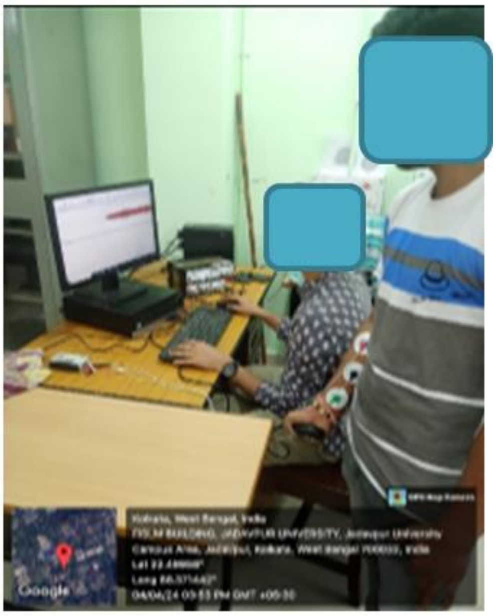


Figure 3. *Measurement of hand grip strength.*

2.6. Statistical Analysis

Statistical analysis of all collected data was performed using SPSS (Statistical Package for the Social Sciences) software (IBM SPSS Version 20) for Windows. Descriptive statistics were applied to analyze the general characteristics of the subjects, and the mean and standard deviation were calculated for the measured variables. The Shapiro-Wilk test was used to assess the normality of the measured variables. Repeated measure analysis of variance (ANOVA) with pairwise comparison using Bonferroni methods were employed to compare the changes among pre-test (resting), recovery at 30 seconds Immediately after exercise (R30SIAE), recovery at 2 minutes (R2MIAE), and recovery at 5 minutes (R5MIAE). The level of significance was set at α = 0.05.

3. Results

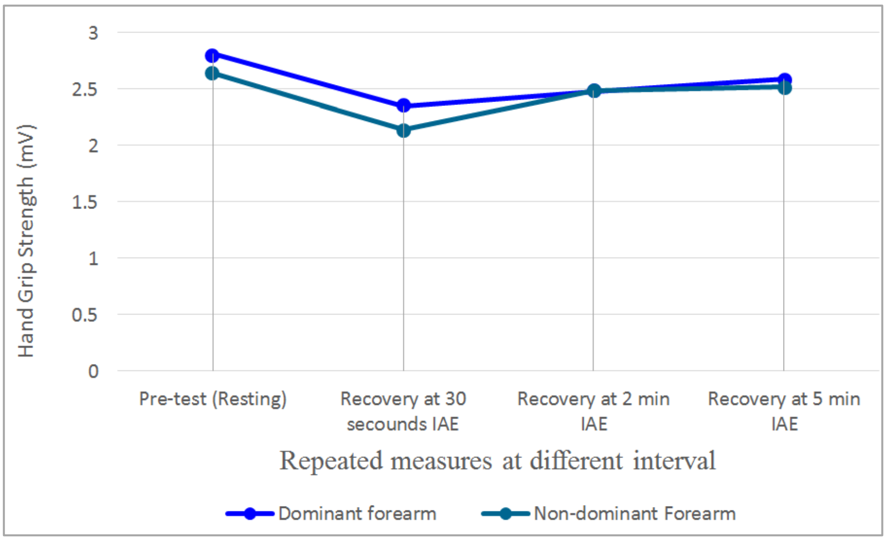


Figure 4. Descriptive statistics for the Hand Grip Strength in the dominant and non-dominant forearms.

The calculated mean and SD values for the dominant forearm were as follows: pre-test 20.94±5.49 kg, recovery at 30 seconds 19.73±4.31kg, recovery at 2 minutes 18.29±4.25kg, and recovery at 5 minutes 18.66±4.15kg. For the non-dominant forearm, the calculated mean and SD values were: pre-test 19.79±4.46kg, recovery at 30 seconds 14.95±4.51kg, recovery at 2 minutes 18.80±4.46kg, and recovery at 5 minutes 18.46±3.84kg.

Table 2. Repeated measure ANOVA and pairwise comparison by applying the Bonferroni method.

Dominant forearms Hand Grip Strength (Kg)				**Non - Dominant Forearm Hand Grip Strength.(Kg)**			
Test	**observation**	**Mean difference**	**P- value**	**Test**	**observation**	**Mean difference**	**P- value**
Pre-test	R30SIAE	1.22	0.174	Pre-test	R30SIAE	-0.16	1.00
	R2MIAE	2.64	0.004**		R2MIAE	0.99	1.00
	R5MIAE	2.28	0.015		R5MIAE	1.33	0.71
R30SIAE	Pre-test	-1.22	0.174	R30SIAE	Pre-test	0.16	1.00
	R2MIAE	1.43	0.000*		R2MIAE	1.15	0.12
	R5MIAE	1.07	0.069		R5MIAE	1.490	0.01*
R2MIAE	Pre-test	-2.65	0.004	R2MIAE	Pre-test	-0.99	1.00
	R30SIAE	-1.43	0.000*		R30SIAE	-1.15	0.11
	R5MIAE	-0.36	1.000		R5MIAE	0.35	1.00
R5MIAE	Pre-test	-2.28	0.015*	R5MIAE	Pre-test	-1.33	0.71
	R30SIAE	-1.07	0.069		R30SIAE	-1.50	0.01*

Dominant forearms Hand Grip Strength (Kg)				Non - Dominant Forearm Hand Grip Strength.(Kg)			
Test	observation	Mean difference	P- value	Test	observation	Mean difference	P- value
	R2MIAE	0.36	1.000		R2MIA+ E	-0.35	1.00

*R30SIAE; Recovery at 30 seconds immediately after exercise. *R2MIAE; Recovery at 2 min immediately after exercise. *R5MIAE; Recovery at 5 min immediately after exercise.

Table 2 presents the pairwise comparison of mean differences and indicates statistical significance. For the dominant forearm's hand grip strength, the calculated mean and standard deviation values were pre-test 20.94 ± 5.49 kg and recovery at 2 minutes 18.29 ± 4.25kg, revealing statistical significance (P = 0.004). Additionally, statistical significance (P = 0.00) was found in the comparison between recovery at 30 seconds (19.73 ± 4.31 kg) and recovery at 2 minutes (18.29 ± 4.25 kg). The comparison between recovery at 30 seconds (14.95 ± 4.51 kg) and recovery at 5 minutes (18.46 ± 3.84 kg) for the non-dominant forearm showed statistically significant results (P = 0.01).

4. Discussion

This study examined the immediate effects of closed kinetic chain exercises (CKCE) on hand grip strength (HGS) in healthy young males. A significant decline in HGS was observed post-exercise, particularly at 2 minutes in the dominant hand and at 30 seconds in the non-dominant hand. While partial recovery occurred by 5 minutes, HGS did not return to pre-exercise levels. These results suggest that short-term fatigue dominates the early post-exercise period, limiting maximal force output even after brief recovery.

"This study's results indicated. The mean hand grip strength values for the dominant forearm were 19.73 ± 4.31kg at 30 seconds IAE, 18.29 ± 4.25kg at 2 minutes IAE, and 18.66 ± 4.15kg at 5 minutes IAE.). These values represent decreases of 5.77%, 12.66%, and 10.88%, respectively, from the pre-test mean value of 20.94 ±5.49kg. Similarly, for the non-dominant forearm, the mean hand grip strength values were 14.95 ± 4.51kg at 30 seconds IAE, 18.80 ± 4.46kg at 2 minutes IAE, and 18.46 ± 3.84kg at 5 minutes IAE. These values reflect decreases of 24.46%, 5%, and 6.72%, respectively, from the pre-test mean value of 19.79 ± 4.46kg. so, it clearly noted that the IAE at 30 seconds, 2 minutes, and 5 minutes HGS decreased from the pre-test values. Additionally, the IAE at 2 minutes and 5 minutes HGS decreased compared to the IAE at 30 seconds. Furthermore, the IAE at 2 minutes HGS decreased compared to the IAE at 5 minutes.

The immediate effects of CKC exercises on hand grip strength depend on several factors, including exercise intensity, duration, and the individual's baseline strength [7]. In many cases, a balance between activation and fatigue determines whether grip strength improves or declines immediately after exercise.

this finding proves that Experiencing a decrease in hand grip strength immediately after exercise is a common occurrence, primarily due to muscle fatigue [3]. The findings align with previous work showing that muscular fatigue induced by strength or endurance exercise leads to transient reductions in performance [9]. Specifically, Bilajac et al. highlighted that fatigue-related reductions in grip strength occur even after moderate physical activity in older adults [8]. Jäkel et al. found a strong association between fatigability and HGS across different clinical conditions [7]. The lack of post-activation potentiation (PAP) observed here contrasts with results from studies such as Till & Cooke (2009), where PAP improved sprint and jump performance shortly after explosive exercise [5] In our case, fatigue seems to have overpowered any potentiating effects, likely due to the sustained and multi-joint nature of CKCE compared to the explosive, short-duration movements typically associated with PAP benefits.

Furthermore, Özüdoğru & Gelecek observed reduced pain and improved muscle strength after CKCE in knee osteoarthritis patients [10], reinforcing the broader functional benefits of such exercises even though acute fatigue is a limiting factor. Meng et al., stated a value of hand grip strength in normal-weight individuals is 24.82 kg [11, 12], which is closely related to the study results. Numerous researches point out that grip-involving workouts, such as pull-ups, deadlifts, and extended squeezing, might temporarily cause specific muscle fatigue. Reduced neural drive, lactic acid accumulation, and muscular fatigue are the causes of this sudden decrease in grip strength, which may get somewhat stronger or return to its baseline level when blood flow and muscle activation increase. Intense or prolonged physical activity can lead to the depletion of energy stores and the accumulation of metabolic by-products in the muscles, resulting in temporary weakness [9]. This is a normal physiological response and typically resolves with adequate rest and recovery. In cases where CKC exercises are performed at high intensity or for prolonged periods, the muscles involved in gripping may become fatigued, resulting in a temporary decrease in grip strength immediately after the exercise session [10].

The acute decline in HGS likely results from muscle fatigue rather than potentiation. Mechanistically, fatigue involves metabolic factors such as lactic acid build-up, ATP depletion, and altered calcium handling in muscle fibers, which collectively reduce force generation [12]. Neuromuscular fatigue also includes central factors like diminished motor unit recruitment and reflex inhibition [13]. These short-term decrements are common and usually reversible with rest, as seen in partial recovery by 5 minutes' post-exercise. Although PAP could theoretically enhance HGS through increased phosphorylation of myosin regulatory light chains and improved neural activation [5]. such effects may require different exercise conditions, such as maximal contractions and optimal rest intervals [14].

In summary, a decrease in hand grip strength immediately after exercise can be attributed to various physiological factors, including muscle fatigue, neuromuscular fatigue, reduced blood flow and oxygen supply [13]. Cleary et al., observed that, the onset of delayed-onset muscle soreness and electrolyte imbalances or dehydration [6, 15]. These findings hold relevance for strength training, rehabilitation, and clinical assessment. For athletic training, coaches should avoid testing grip strength immediately after CKCE sessions, as temporary fatigue can lead to underperformance. In rehabilitation, therapists should consider adequate rest intervals post-exercise to prevent overloading fatigued muscles. Additionally clinicians using HGS as a biomarker [16] should note that timing of assessment relative to exercise critically influences interpretation.

5. Conclusion

This study demonstrated that closed kinetic chain exercises (CKCE) produce a significant acute reduction in hand grip strength (HGS), particularly in the non-dominant forearm. In the dominant hand, HGS declined progressively post-exercise, with the most notable reduction occurring at 2 minutes, while the non-dominant hand exhibited a sharp decrease immediately after exercise. Although partial recovery was observed by 5 minutes, grip strength in both forearms remained below baseline levels throughout the observation period. These findings suggest that fatigue-related mechanisms outweigh any immediate potentiation effects during the early recovery phase. The differential response between dominant and non-dominant limbs highlights the role of neuromuscular conditioning. Practitioners should consider the timing of strength assessments and exercise prescriptions following CKCE. Future research should expand to include more diverse populations and extended recovery durations to better elucidate the interplay between fatigue and potentiation.

Abbreviations

ANOVA	Analysis of Variance
BMI	Body Mass Index
CKCE	Closed Kinetic Chain Exercises
DFAC	Dominant Forearm Circumference
HGS	Hand Grip Strength
IAE	Immediately After Exercise
NDFAC	Non-dominant Forearm
PAP	Post-activation Potentiation
R30SIAE	Recover at 30 Second Immediately After Exercise
R2MIAE	Recover at 2 Minutes Immediately After Exercise
R5MIAE	Recover at 5 Minutes Immediately After Exercise
SPSS	Statistical Package for the Social Science Software

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Author Contributions

Tajmed Khan: Investigation, experimentation, methodology, manuscript writing
Papan Mondal: Supervision
Sridip Chatterjee: Supervision
Najmun Nahar: manuscript editing
Chandra Sankar Hazari: Experimental design

Supporting Agencies

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Conflicts of Interest

The authors declare no conflicts of interest.

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