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Original Research Article

Combined Impact of Open Kinetic Chain and Closed Kinetic Chain on Breath Holding Time and VO_2 Max among Inter-Collegiate Cricket Players

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Abstract

This study aimed to examine the effects of open and closed kinetic chain exercise interventions and to determine how these structured training programs influence selected physiological variables, specifically breathe holding time and VO_2 Max, among inter-collegiate cricketers. A total of 45 inter-collegiate male cricketers aged 18–25 years from AAA College of Engineering and Technology, Amathur, Sivakasi**,** Tamilnadu were selected for the study. The participants were randomly assigned into three groups: An Open Kinetic Chain Exercise Group (OKCEG), a Closed Kinetic Chain Exercise Group (CKCEG), and a Control Group (CG)**.** The experimental groups underwent their respective structured kinetic chain training programs for six weeks, while the control group continued with their regular physical activities. Breathe holding time and VO_2 Max was selected as the dependent physiological variable and were assessed using a standardized test. Pre- and post-intervention data were statistically analyzed using appropriate inferential statistical techniques to determine significant differences among the groups. The level of significance was set at $p < 0.05$. The results revealed significant improvements in breathe holding time and VO_2 Max in both the open and closed kinetic chain exercise groups when compared to the control group ($p < 0.05$). The control group did not exhibit any significant change in breathe holding time and VO_2 Max. The findings of the study indicate that structured open and closed kinetic chain exercise interventions are effective in enhancing breathe holding time and VO_2 Max among inter-collegiate cricket players. Both training methods proved superior to regular activity alone, highlighting the importance of incorporating kinetic chain exercises into cricket training programs to improve physiological performance.

Keywords: Open kinetic chain, closed kinetic chain, breathe holding time and VO_2 Max physiological performance.

INTRODUCTION

The kinetic chain pertains to the interconnections throughout the organism. During movement, no individual muscle or joint component remains still. All components function in a chain, which may be either open or closed.

The terms open and closed kinetic chain may appear technical, although they represent a relatively straightforward concept. Understanding the appropriate timing and methodology for employing open exercises to achieve your or your client's fitness objectives is essential. Employing an appropriate combination of workouts will facilitate the attainment of your goals more swiftly and efficiently.

The kinetic chain comprises the muscles, joints, and connective tissues that collaborate to generate specific movements. Every movement you execute engages a kinetic chain due to the interconnectedness of bodily systems. A movement in one part can influence other segments. These additional segments can be classified as either proximal (nearer to the torso) or distal (farther from the torso) in position.

For instance, contemplate the act of swinging a pickleball racket during a match. The motion initiates in the lower body to generate force, progresses through the core muscles for stabilisation and rotational capability, and culminates in the upper body with actions involving the shoulder, elbow, and wrist joints.

Open Kinetic-Chain Exercises

Open kinetic-chain exercises emphasise a heightened workload on a specific joint or muscle. Typically, open kinetic chain exercises involve single-joint movements. For instance, during the leg extension exercise, movement is confined solely to the knee joint. This engages the quadriceps muscles. In this instance, the lower leg is the most distal section in motion. The unrestricted movement of the lower leg in space throughout the activity categorises it as an open kinetic-chain workout.

Any exercise in which the distal end of the body traverses' space is classified as an open chain movement. Presented below are few representative instances:

Bicep curls (elbow flexion) Triceps kickbacks and extensions

- Shoulder Presses
- Chest press exercises
- The chest flies

Latissimus dorsi pull-downs Seated or bent-over row

- Hip adduction
- Hip abduction

Leg extension (knee extension) Leg curl (knee flexion) Seated leg press exercise

Single-joint workouts, such as the biceps curl or leg extension, focus on a singular movement and a specific muscle group. The significance of single-joint workouts lies in their role in enhancing muscle activation. Enhancing muscular activation via training enables the muscle to function more efficiently. During these motions, one should concentrate on correct movement mechanics and isolating the target muscle, avoiding any form of cheating.

Rectifying movement inefficiencies in single-joint workouts will enhance your performance in complicated movements. This alleviates discomfort and mitigates the risk of harm.

Initially, it is crucial to fortify the muscles. When individual motions and muscles function correctly, they can collaborate with other movements and muscles to execute complicated actions safely. Each movement is coordinated, functioning in harmony with the complete movement system.

Closed kinetic-chain exercises

Closed kinetic-chain workouts emphasise the movement of the body against a fixed point, such as the ground. In the squat exercise, the feet are firmly anchored to the ground and remain stationary. The body moves in opposition to the earth. During the descent of the squat, the knees and hips flex while the feet remain stationary. The feet represent the distal component of this exercise and remain immobile. Consequently, the squat constitutes a closed kinetic-chain workout.

Which workout movements are classified as closed kinetic chain activities? Examples that require the hands to be secured to a stationary object include:

Closed kinetic chain exercises with fixed feet comprise:

- Chin up pull ups pushups deadlift leg press lunge squat wall slide

REVIEW OF LITERATURE

Prokopy *et al.,* (2008) This study analysed variations in shoulder strength, power, and throwing velocity among athletes who primarily trained the upper body using either CKCRT (a system including ropes and slings) or OKCRT. Fourteen female volunteers from National Collegiate Athletic Association Division I softball were obstructed and randomly assigned to two groups: CKCRT and OKCRT. Blocking guaranteed an equal distribution of seasoned players and novices within each training group. Training was conducted thrice weekly for a duration of 12 weeks as part of the team's supervised off-season regimen. The intensity and volume of Olympic, lower-body, core, and upper-body training in OKCRT and CKCRT were standardised across groups. The criterion variables assessed before and after training comprised throwing velocity, bench press one-repetition maximum (1RM), dynamic single-leg balance, and isokinetic peak torque and power (PWR) at 180°·s−1 for shoulder flexion, extension, by 2.0 mph (3.4%, $p < 0.05$), while the OKCRT group exhibited an improvement of 0.3 mph (0.5%, NS). A notable interaction was detected ($p < 0.05$). The CKCRT group enhanced its 1RM bench press by 1.9 kg, equivalent to the improvement observed in the OKCRT group ($p < 0.05$ for each group). The CKCRT group enhanced all metrics of shoulder strength and power, while OKCRT resulted in minimal alterations in shoulder torque and power ratings. Despite being an open-chain movement, adjustments from CKCRT may enhance subsequent performance. Strength coaches can integrate upper-body CKCRT without compromising improvements in maximal strength or performance metrics related to athletic open-chain movements like throwing.

Mi-Kyoung Kim, (2017) This study aimed to examine the impact of open kinetic chain and closed kinetic chain workouts on the static and dynamic balance of ankle joints in young, healthy women. Twenty women in their twenties were randomly allocated into two groups of ten: one for open kinetic chain exercises and the other for closed kinetic chain exercises. Each group executed five sets of exercises thrice weekly for a duration of four weeks. The exercise intensity was elevated once after a duration of two weeks. The subjects' Romberg test outcomes and stability limitations were assessed to determine their static and dynamic balance. A two- way repeated measures analysis of variance test was employed for data analysis. The findings of Romberg's test indicated a significant difference in trace length with eyes closed, attributed to the main effect of time (Effect size: d=0.97). The analysis of stability limits

revealed a substantial interaction effect in the backward direction, whereas the main group effect demonstrated a significant difference in the forward direction. Conclusion Both open kinetic chain and closed kinetic chain exercises enhanced the subjects' balance. The closed kinetic chain exercise was more efficacious in enhancing the dynamic balance of young healthy women compared to the open kinetic chain exercise.

(Hatem Jaber, 2017) The objective is to address lateral ankle sprains, prevalent sports injuries that frequently cause structural and functional changes, resulting in chronic ankle instability (CAI). Deficiencies in proprioception, neuromuscular control, and strength are proposed as contributory reasons to chronic ankle instability (CAI). Open Kinetic Chain (OKC) and Closed Kinetic Chain (CKC) exercises typically form the foundation of ankle-specific training prior to advancing to more complex training regimens. Despite their prevalent usage in the management of CAI, an agreement on their effectiveness for physical therapy outcomes remains elusive. This study aimed to examine the effects of open kinetic chain (OKC) and closed kinetic chain (CKC) exercises on dynamic postural control, self-reported functionality, and perceived instability in individuals with chronic ankle instability (CAI). Methods: Participants with unilateral chronic ankle instability (CAI) were randomly allocated into three groups: open kinetic chain (OKC) (n=5), closed kinetic chain (CKC) (n=6), and control (n=6). Outcome measurements were the star excursion balancing test (SEBT) reach distance, centre of pressure (COP) sway velocity, sway area, path length, and the Foot and Ankle Ability Measure-Sport Subscale. The intervention groups engaged in six weeks of exercises. Additionally, participants completed a Global Rating of Change (GROC) form at six weeks following the intervention. Results: Post-intervention, both the OKC and CKC groups exhibited substantial enhancements in outcome measures, reflecting gains in dynamic postural control and subjective function; however, the CKC group demonstrated superior advancements compared to the OKC group. The control group exhibited no enhancements. GROC demonstrated a notable disparity in median scores for the CKC group relative to the OKC and control groups (p=0.04 and p=0.03, respectively). Conclusion: The 6-week OKC and CKC exercise regimens enhanced postural control metrics and subjective function in participants with CAI. CKC exercises, however, proved to be more efficacious than OKC exercises. Therefore, fitness regimens ought to be more utilitarian and task-oriented. Additional research is required in a more extensive cohort to ascertain the effects of both training programs on risk factors for ankle joint injuries.

METHODOLOGY

Study Participants

Sixty Male young collegiate players were randomly assigned to 4 groups (i.e., OKCG, CKCG, COCKCG and GG). using the method of randomly permuted blocks using Research Randomizer, a program published on a publicly accessible official website (www.randomizer.org) their ranged from 18 to 25 years. All subjects were advised not to decrease or increase their daily sports and regular activities over the course of the study.

Procedures

To minimize learning effects, participants underwent two familiarization sessions for the testing procedures and three sessions to acquaint themselves with Open kinetic chain training, closed kinetic chain training, and the combined open and closed kinetic chain training prior to the intervention. These sessions were conducted just before the baseline assessments. Demographic data was collected, and participants were advised to maintain a clean, healthy diet, abstain from caffeine for at least three hours before testing, and refrain from engaging in intense physical activity for 24 hours prior. To account for daily variability, pre- and post-tests were scheduled at consistent times for all participants, and specific workouts were assigned to the same days. Testing followed a standardized protocol, maintaining uniformity in procedures and sequence. On test days, participants performed a ten-minute general warm-up before starting the assessments.

Training intervention

The AAA College of Engineering and Technology, Amathur, Sivakasi and their age ranged between 18 and 25 years. India, in collaboration with qualified trainers and research scholars, has gathered a comprehensive range of resources to support effective training programs. These resources are carefully curated to ensure that individuals receive well-rounded guidance in physical fitness, sports performance, and overall wellness. For eight weeks, weight training, ladder training, combined weight and ladder training was conducted on alternative 3 days and 2 days for game practices, with two non-consecutive sessions each week. In along to the weight training, ladder training, combined weight and ladder training, which was integrated into their game related training routine, the kabaddi players also completed 60-minute workouts per week and participated in two game day. Each training session began with a prescribed warm-up, including dynamic and static stretches lasting about ten minutes, followed by progressively faster running, guided by research scholars. The weight training, ladder training, combined weight and ladder training program, designed to enhance agility, explosive power, muscular strength endurance, functional and skill performance, included exercises such as weight. These movements targeted multiple muscle groups, improving core stability, mobility, and endurance The intensity of the training was measured using a 1RM test and the number of kettlebell swings, with volume and complexity increasing weekly. A technique-based 1RM progression was used to determine exercise intensity. For kabaddi players, kettlebell

training intensity was measured by weight, repetitions, rest intervals, agility, power output, and heart rate, with all swings and lifts performed with maximum effort The training protocol was discussed with qualified. The training program was developed using

Outcomes of Breath Holding Time

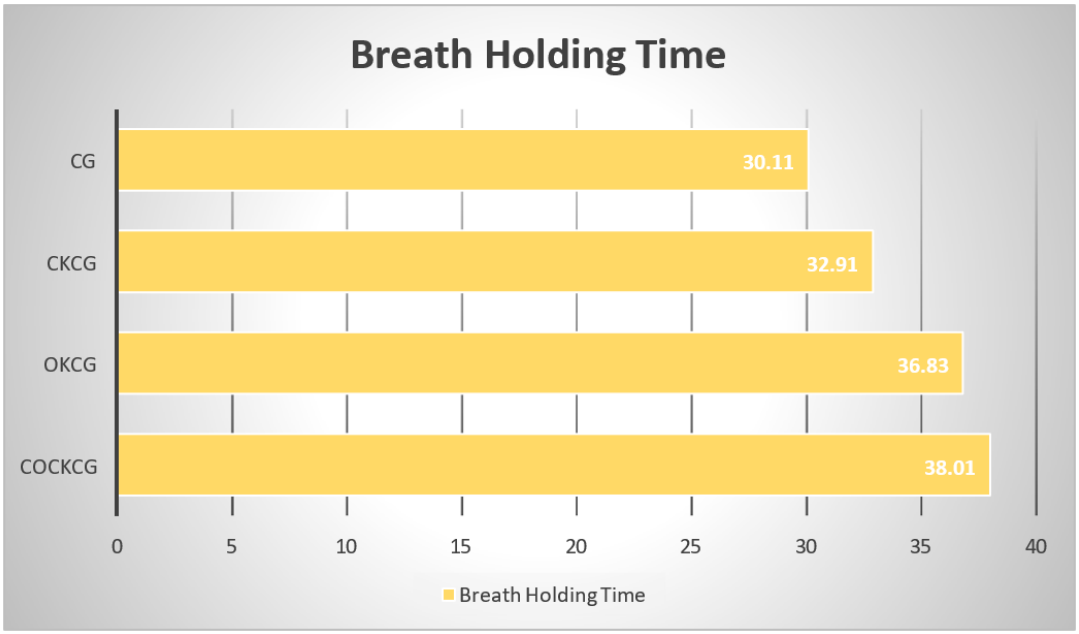
The analysis of paired sample- 't' test on the data obtained for the breath holding time of the pretest and post-test means of the Combined Open & Closed Kinetic Chain Group, Open Kinetic chain Group, closed kinetic Group and control group has been analyzed and presented in table 1.

Table 1: Computation of Analysis of Co-Variance on Breath Holding Time

Adjusted post-test means				Sources of Variance	Sum of square	Df	Mean squares	F ratio
COCKCG	**OKCG**	**CKCG**	**CG**	**Between**	130.81	3	43.60	
38.01	36.83	32.97	30.11	**Within**	63.80	55	1.16	**37.59***

*Significant at 0.05 level of confidence (The table value required for significance at 0.05 level with df 3and 55is 3.24)
COCKCG – Combined Open & Closed kinetic chain Group, **OKCG** – Open Kinetic chain Group, **CKCG** – closed kinetic Group and **CG** – Control Group

The adjusted post-test means of Combined Open & Closed Kinetic Chain Group, Open Kinetic chain Group, closed kinetic Group and Control Group are 38.01, 36.83, 32.97 and 30.11 respectively. The obtained f-ratio of 37.59 which is higher than the table value 3.24 with df 3 and 55 required for significance. The result of the study indicates that there are significant mean differences on breath holding time among the adjusted post-test means of Combined Open & Closed kinetic chain Group, Open Kinetic chain Group, Closed Kinetic Group and control group at 0.05 level. Hence it is clear that the Combined Open & Closed kinetic chain Group, Open Kinetic chain Group and Closed Kinetic Group had significantly improved the breath holding time of the Participants. Among these three training groups Combined Open & Closed Kinetic Chain Group seems to be the better than the other two experimental groups.



Outcomes of VO2 MAX

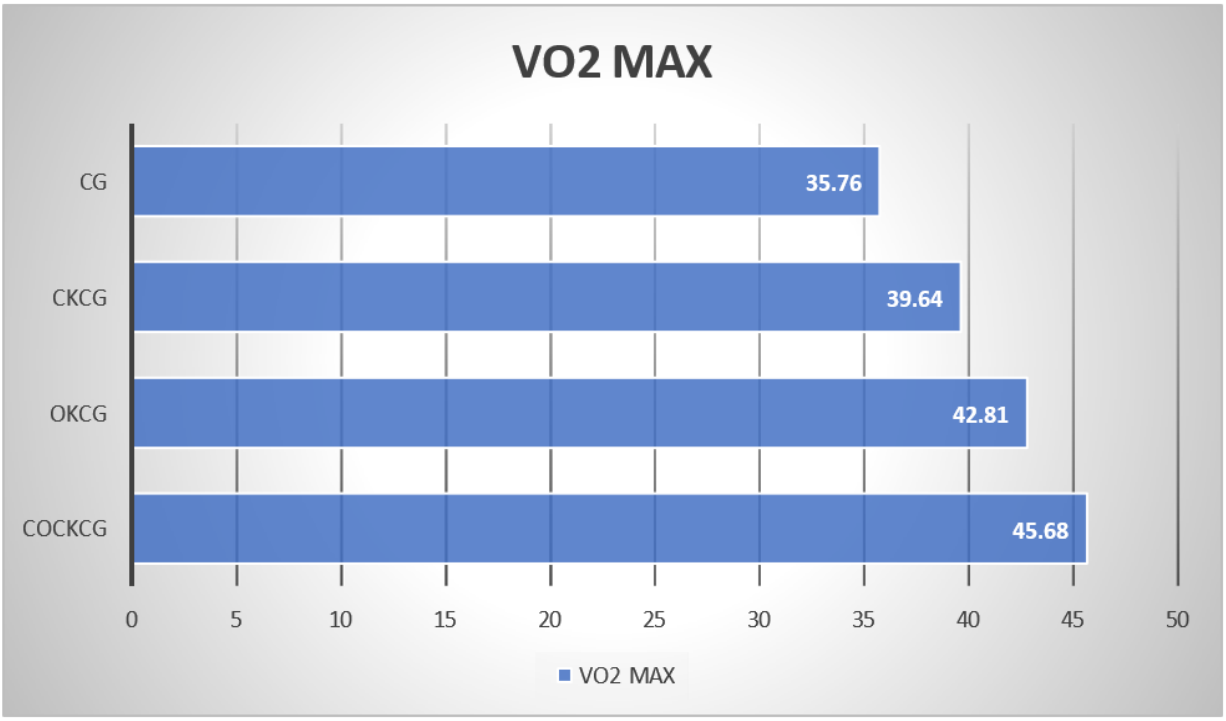
The analysis of paired sample- 't' test on the data obtained for the breath holding time of the pretest and post-test means of the Combined Open & Closed Kinetic Chain Group, Open Kinetic chain Group, closed kinetic Group and control group has been analyzed and presented in table 2.

Table 2: Computation of Analysis of Co-Variance on VO2 MAX

Adjusted post-test means				Sources of Variance	Sum of square	Df	Mean squares	F ratio
COCKCG	**OKCG**	**CKCG**	**CG**	**Between**	949.71	3	316.57	
45.68	42.81	39.64	35.76	**Within**	347.05	55	6.31	**50.17***

*Significant at 0.05 level of confidence (The table value required for significance at 0.05 level with df 3and 55is 3.24)
COCKCG – Combined Open & Closed kinetic chain Group, **OKCG** – Open Kinetic chain Group, **CKCG** – closed kinetic Group and **CG** – Control Group

The adjusted post-test means of Combined Open & Closed Kinetic Chain Group, Open Kinetic chain Group, closed kinetic Group and Control Group are 45.68, 42.81, 39.64 and 35.76 respectively. The obtained f-ratio of 50.17 which is higher than the table value 3.24 with df 3 and 55 required for significance. The result of the study indicates that there are significant mean differences on breath holding time among the adjusted post-test means of Combined Open & Closed kinetic chain Group, Open Kinetic chain Group, Closed Kinetic Group and control group at 0.05 level. Hence it is clear that the Combined Open & Closed kinetic chain Group, Open Kinetic chain Group and Closed Kinetic Group had significantly improved the breath holding time of the Participants. Among these three training groups Combined Open & Closed Kinetic Chain Group seems to be the better than the other two experimental groups.



DISCUSSION ON FINDINGS

The result of study indicates that there was significant improvement on selected physical, physiological and skill performance variables such as vo2 Max, breath holding time intercollegiate players due to the impact of Combined Open & Closed Kinetic Chain Group, Open Kinetic chain Group, closed kinetic Group training programmes. Together, these combining training modalities contribute to better overall athletic performance, enhancing players' ability to execute skills effectively during matches. However, the control group had not shown any significant changes on selected physical, physiological and skill performance variables among players. In addition to this, the following references were also strongly supporting the formulated

CONCLUSION

This combined approach proved to be more effective than using either method on its own, showing the value of a diverse training program. By utilizing the unique benefits of both techniques, this well-rounded strategy helps players enhance their overall performance and reach their highest potential.

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