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Examining the Impact of Complex Training on Bio-motor and Physiological Variablesamong Field Hockey Players

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Abstract

Modern fitness has evolved to incorporate traditional weightlifting with technological advancements. A combination of resistance and plyometric training is used in this intervention to optimize performance. It enables athletes to refine workouts effectively and maximize results through this fusion of these techniques. The current study examined the precise effects of the complex on the bio-motor and physiological responses of field hockey players, which shed light on the potential benefits these techniques may offer to athletes looking to improve their performance on the field. Thirty male field hockey players (mean; age: 19.40 ±1.12 years) were divided into two equal groups at random: the control group (CG) and the complex training group (CM). Three sessions of CM training interventions were conducted each week, with enough recovery time between sessions for each group. All of the chosen bio-motor variables, such as speed and agility and physiological variables, such as vital capacity (VC), VO2 max, and resting heart rate (RHR), have undergone baseline and after the 12-week training intervention evaluations. Since the CG group was practising field hockey every day, they were regarded as an active CG group. The study's findings demonstrated that 12-weeks of CM training intervention significantly improved participants' speed ($p<0.01$), agility ($p<0.01$), VC ($p<0.01$), and VO2 max ($p<0.01$). There was no discernible difference in the CG ($P>.05$). There was no discernible difference in RHR between CM and CG ($P>.05$). As a result of the intervention during the specified period, speed and agility significantly increased, as did VC and VO2 max; however, there was no significant change in RHR. It would be helpful to develop intervention tactics to deal with these problems in the future, as well as replicate studies involving athletes from a variety of sports disciplines beyond field hockey to better understand the fundamental processes that result in optimal performance.

Keywords: Agility, Complex training, Speed, Vital capacity, VO2 max

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Introduction

The game of field hockey is characterized by bouts of intermittent activity during which players perform repeated sprints, tackles, ball strikes, accelerations, decelerations, and changes of direction(Thapa *et al.*, 2023).Two teams of eleven players play field hockey to score goals by moving a ball past each other as quickly as possible(Hoskens *et al.*, 2023).Four 15-minute quarters of competitive field play are played between two teams of eleven players each, plus a goalkeeper and backup players. For 60 minutes, participants in the sport must run at a fast pace while accelerating, decelerating, and changing directions(Mcguinness *et al.*, 2017).However, field hockey players must excel in a variety of physical capacities to meet the multifaceted demands of the sport (high aerobic and anaerobic fitness), which adds to its appeal and necessitates extensive training regimens to maximize performance and lower injury risk(Manna, Khanna and Dhara, 2016).A hockey player needs to go through physiological development in order to keep up with the game's technological advancements, in addition to meeting the physical requirements necessary to compete at the highest levels. Furthermore, field hockey demands quick bursts of intense running, which may require an equal amount of aerobic and anaerobic energy to go farther(Kusnanik, Rahayu and Rattray, 2018). It is necessary to perform appropriate training and frequent monitoring in order to meet these physiological demands for optimal performance and to promote the general health status of the players.The benefits of various training methods on athletes' physiological and physical characteristics have been demonstrated, particularly isolated resistance training and plyometric exercises.According to studies, practising a plyometric exerciselowers their risk of injury and improves their overall performance on the field(Amrinder, Sakshi and Singh, 2014).Certain investigations revealed that strength training has been more beneficial than plyometric training(Hasan, 2023). In recent decades, two combination training methods have become popular for an efficient training program to improve sports performance among trainers and coaches. Complex training is described as combination training, wherein lighter-load power exercises (plyometric training) are alternated with biomechanically similar high-load weight training exercises, set for set, for example,a deadlift followed by a pike jump.According to certain theories, a high resistance stimulus enhances motoneuron excitability, which could lead to ideal training circumstances for ensuing explosive exercises, which enable the muscles to perform at an optimal level of potential(Cormier *et al.*, 2020).By using a strength power potentiation complex training protocol, one can take advantage of the temporary improvement in muscle contractile performance that occurs following a brief, near-maximum or maximal voluntary contraction; that condition is referred to as the post-activation potential(Poulos *et al.*, 2018).CM training primarily produces short-term benefits, according to previous research(Alves *et al.*, 2010). Bio-motor and physiological variables are important in evaluating training and determining the health, metabolism, and cardiovascular status of field hockey players. To train and select players at different ages, coaches may find it useful to regularly monitor physiological variables during training at different stages of growth and development. The current study aimed to determining how CM influences field hockey players' speed, agility, vital capacity, VO2 max, and resting heart is the main goal of the current study.

Material and methods

Participants

Participants required for the current study were determined using G* Power 3.1.9.6; the following variables were included in the a priori: compute required sample size - given, power, and effect size for the difference between two dependent means (matched pair). The computed sample size indicated that a minimum of 27 participants would be required to achieve statistical significance in the study. Beyond the minimal sample size, 35 male field hockey players were employed from Union Christian College Aluva, who had six years of experience in the field. Prior to the inclusion of the participants, the researcher gaveall ideas and potential objectives of the study verbally as well as written sheet. However, towards the remaining stages of the study,five field hockey players were excluded due to preexisting musculoskeletal injuries. While collecting the pre-test of the participants (mean (SD); weight: 63.70(4.10) kg, height: 1.68(.06) cm, and age: 19.40(1.12) yrs.) were considered as the study sample (n=45). According to the Helsinki Declaration, the study was approved by the Institutional Ethical Committee at Pondicherry University, India. All the participants were given the informed consent.

Study design

The study included participants who were recruited through a purposive sampling technique from Union Christian College in Aluva. After the pre-test, 30 field hockey players were randomly allocated in CM (n=15) and CG (n=15) groups. Before the commencement of 12 weeks of intervention, the researcher was given the two-week familiarization session, and 1 RM test was employed to fix the proper andprogressive training load for each individual. The dependent variables in this study were speed, agility, VC, VO2 max, and RHR, which fall under the categories of bio-motor and physiological variables, respectively.

Independent variable

Over the course of 12 weeks, CM training was held at Union Christian College, Aluva. Warming up, CM training, and cooling down were all included in the 60-minute training sessions. In each week, three training sessions were employed for the CM group, with ample recovery between the sessions. The CM training program alternates between biomechanically similar plyometric and resistance exercises, such as deadlifts and pike jumps. In the initial weeks of CM training, the intensity was started at 60% for each participant. 1-3rd weeks, the intensity of the training was 60-70%;in 4-6th weeks, 65-75%;in 7-9th weeks, 70-80, and in 10-12th weeks, the intensity was 75-85%. In between the exercises and sets, proper recovery was given.

Dependent variable

The current study utilized a range of dependent variables that contributed effective evidence to the conclusions of the study. The bio-motor variables include speed and agility, and physiological variables include VC, VO2 max, and RHR. For speed, the assessment was conducted using a 50 m dash, and the agility assessment was conducted using a shuttle run test. Moreover, vital capacity was assessed using a spirometer, and VO2 max assessment was conducted using the QueensCollege step test(Nabi, Rafiq and Qayoom, 2015). Finally, the resting heart rate was assessed using the palpation method(Sharma and Singh, 2020).

Statistical analysis

Microsoft Excel was used to tabulate all of the data, and for more reliable analysis, the Shapiro-Wilks and Kolmogorov-Smirnova tests were used to assess the data's normality.Analysis of variance was used to examine the participants' initial characteristics (weight, height, and age),and the effect size was evaluated through the use of eta square. Effect size (η_2) fell into the following categories: large is (≥ 0.14), the medium is (0.06-0.14), and small is (≤ 0.06)(Thapa *et al.*, 2023).A paired sample t-test was used to compare the changes after 12 weeks of intervention with baseline for both groups and all selected variables. Using Cohen's d values, the magnitude of change between the pre-and post-test assessments was computed.The magnitude of effect (Cohen's d) fell into the following categories: small: 0.2 to 0.6, moderate: 0.6 to 1.2, large: 1.2 to 2.0, very large: 2.0 to 4.0, nearly perfect: >4.0(Pramanik *et al.*, 2023).In order to display the statistical significance level,.05 was set. All statistical analysis was carried out using a Statistical Package for Social Sciences software.

Results

We used the Shapiro-Wilk and Kolmogorov-Smirnov tests to determine whether the participant's characteristics were normal. Table 1 displays the initial characteristics of the control group (CG) and the intervention group (CM). The selected characteristics of the participants did not significantly differ from one another for weight (p =.172) with a small effect, height (p =.209) with a small effect, and age (p =.776) with a small effect.

Table 2 presents the Kolmogorov-Smirnov and Shapiro-Wilks tests that were used to determine the normality of the pre-and post-test data for selected bio-motor and physiological variables (Speed, Agility, VC, VO2 max, and RHR). The Shapiro-Wilks test and the Kolmogorov-Smirnov test revealed that the data obtained from participants (selected variables) were normally distributed.

The descriptive statistics (Mean and SD) for the CM and CG are presented in Table 3. When considering the paired sample t-test presented in Table 4, speed had a significant difference in the CM (p<.001, d=1.03) group with a moderate effect, but the CG group did not show any significant difference (p>0.05). Agility had a significant difference in the CM (p<.001, d=2.11) group with a very large effect, but the CG group did not show any significant difference (p>0.05). VC had a significant difference in the CM (p<.001, d=2.87) group with a very large effect, but the CG group did not show any significant difference (p>0.05). VO2 max had a significant difference in the CM (p<.001, d=1.63) group with a large effect, but the CG group did not show any significant difference (p>0.05). RHR did not show any significant difference between the two groups. The magnitude of the effect is presented in Figure1.

Discussion

The results of the current study show that after 12 weeks of CM intervention, speed and agility significantly improved in the CM group as compared to the CG. Some of the previous studies are line with the current study findings (Ali *et al.,* 2019; Hammami *et al.,* 2019; Spineti *et al.,* 2019; Zghal *et al.,* 2019).Ten weeks of complex strength training improved the explosive muscle performance of junior female handball players significantly, according to one study's findings by Hammami et al (2019), which also included improvements in one of the four repeated sprint scores and sprint speed.In their study, Ali et al (2019) sought to compare how six weeks of complex training and contrast training affected the performance of soccer players using steroid hormones. A total of thirty-six male professional soccer players were placed into three groups at random: complex training, contrast training, and control. The complex training group showed higher gains in physical performance, including agility and a 20-meter sprint.In their study,Spineti et al (2019) examined the effects of complex and contrast training versus traditional strength training on young male soccer players. The intricate and contrast training regimen successfully increased sprint and direction-changing speed over the course of eight weeks.The study byZghal et al (2019) In order to compare the effects of resistance and plyometric/sprint training with either type of training alone, this study aimed to evaluate how young soccer players' muscle strength, power, and ability to change direction were affected. A combined plyometric training group or an active control group was randomly assigned to thirty-one youth soccer players. In order to improve strength, sprint, and jump performances, our results indicate that combined training is superior to either plyometric or control training.A key component of complex training is the integration of high-intensity resistance exercises right after plyometric exercises(Cormier *et al.*, 2020). The main mechanism used in this approach to improve athletic performance is neuromuscular adaptations, which are among the most important ones. In particular, the high-intensity resistance training portion of our regimen probably enhanced reflex potentiation and motor neuron excitability. This could result in higher recruitment of motor units, especially since the fatigue from the resistance training forced a higher activation during the plyometric phases. This increased recruitment of motor units produces an ideal training state, which is thought to be essential for the plyometric bouts that follow(Ali *et al.*, 2017). That may be the reason for the effective results of the present investigation.

The results of the current study showed that there were notable differences between the VC and VO2 max following the 12-week CM training intervention and the CG. Some of the previous studies are in consonance with the present study results (Kanniyan and Syed, 2013; Anitha *et al.*, 2018; Prasertsri and Padkao, 2021).The study by Prasertsri and Padkao (2021) explores that the University athletes' pulmonary function and respiratory muscle strength are improved by high-intensity interval resistance training. University athletes may see improvements in theirrespiratory muscle strength and pulmonary function after eight weeks of high-intensity interval resistance training.Anitha et al (2018) suggest that male volleyball players can increase their vital capacity by doing the circuit and plyometric training for six weeks.The study by Kanniyan & Syed (2013) indicates that improving cardio-respiratory endurance can be achieved through complex and contrast training. Finally, after a 12-week training intervention, it was reported that the CM was ineffective in raising the resting heart rate when compared to the initial stage. Based on baseline values, it is likely that the athletes had already reached the desired threshold through continuous participation, or it could be related to the 12-week training duration. After an intervention lasts longer than 12 weeks, notable outcomes might occur.

Conclusion

In conclusion, the study findings indicate that a 12-week intervention program led to notable enhancements in important bio-motor and physiological metrics. Compared to the CM group to the CG, the CM group demonstrated statistically significant improvements in speed, agility, vital capacity, and VO2 max. These results demonstrate how well these crucial components of physical fitness were targeted and enhanced by the intervention protocol that was used. The observed improvements indicate potential benefits for individuals who aim to improve their athletic abilities or daily physical activities. Speed and agility are essential elements of athletic performance and functional mobility. Improved cardiovascular fitness and aerobic capacity, which are essential to general health and endurance, are also reflected in increases in vital capacity and VO2 max.Although there were no significant differences in the groups' resting heart rates, the intervention's beneficial effects on different aspects of physical performance are highlighted by the noteworthy improvements in other measures. These results underline the potential advantages of structured interventions in promoting particular aspects of physical fitness and offer insightful information to the field of exercise science. Targeted interventions, such as the one employed in this study, may provide useful tactics for people looking to improve their general fitness and athletic performance.

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Table 1: Characteristics of the Field Hockey Players

Characteristics	CM	CG	p	η_2
	Mean (SD)	Mean (SD)		
Weight	64.73(4.33)	62.67(3.72)	.172	0.06
Height	1.70(.075)	1.67(.040)	.209	0.05
Age	19.47(1.19)	19.33(1.34)	.776	0.003

η_2: *Eta square*

Table 2: Tests of normality

Variables			Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
Speed	**CM**	Pre	.142	15	.200*	.924	15	.223*
		Post	.178	15	.200*	.892	15	.071*
	CG	Pre	.152	15	.200*	.934	15	.314*
		Post	.112	15	.200*	.977	15	.943*
Agility	**CM**	Pre	.154	15	.200*	.927	15	.242*
		Post	.146	15	.200*	.917	15	.176*
	CG	Pre	.198	15	.116	.883	15	.052*
		Post	.152	15	.200*	.886	15	.057*
Vital capacity	**CM**	Pre	.168	15	.200*	.955	15	.601*
		Post	.218	15	.054	.907	15	.123*
	CG	Pre	.212	15	.069	.917	15	.175*
		Post	.155	15	.200*	.897	15	.084*
VO2max	**CM**	Pre	.202	15	.100	.882	15	.050*
		Post	.189	15	.158	.948	15	.491*
	CG	Pre	.211	15	.071	.923	15	.217*
		Post	.205	15	.090	.884	15	.055*
RHR	**CM**	Pre	.209	15	.076	.910	15	.134*
		Post	.214	15	.063	.930	15	.276*
	CG	Pre	.217	15	.056	.937	15	.343*
		Post	.209	15	.076	.908	15	.126*

**Normally distributed*

Table 3: Descriptive statistics

Indicators	CM	CG

	Pre-test	Post-test	Pre-test	Post-test
Speed	*7.36±.377*	*7.04±.180*	*7.32±.331*	*7.33±.304*
Agility	*10.33±.313*	*9.72±.238*	*10.48±.356*	*10.50±.262*
VC	*3.83±.243*	*4.51±.194*	*3.77±.263*	*3.81±.252*
VO2max	*39.31±2.51*	*43.94±1.81*	*39.76±3.05*	*40.04±2.80*
RHR	*74.27±2.49*	*73.73±2.25*	*74.53±3.07*	*75.47±2.33*

Table 4: Paired t-test

Parameters	*Groups*	*df*	*T-Ratio*	*p*	*Cohen's d*
	CM	*14*	*3.991*	*.001**	*1.03*
Speed	***CG***	*14*	*.372*	*.716*	*0.10*
	CM	*14*	*8.189*	*.000***	*2.11*
Agility	***CG***	*14*	*.281*	*.783*	*0.07*
	CM	*14*	*11.129*	*.000***	*2.87*
VC	***CG***	*14*	*.627*	*.541*	*0.16*
	CM	*14*	*6.323*	*.000***	*1.63*
VO2max	***CG***	*14*	*.495*	*.628*	*0.13*
	CM	*14*	*.845*	*.413*	*0.22*
RHR	***CG***	*14*	*1.974*	*.068*	*0.51*

*Significant at .05, **Significant at .001

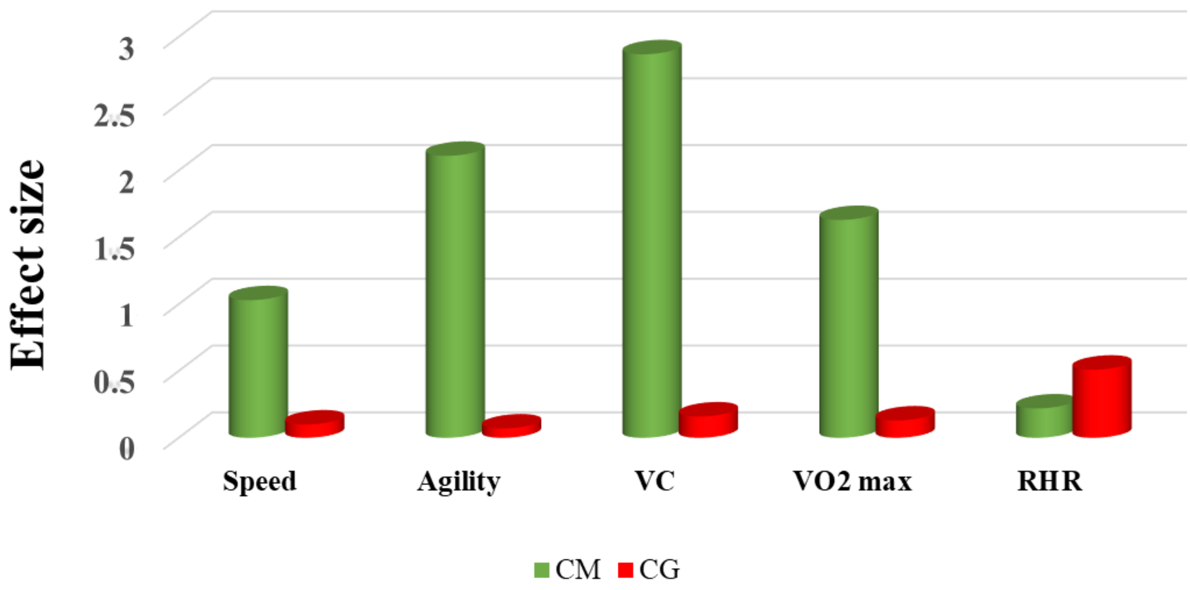

Figure 1:*Magnitude of effects of pre and post test*