ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

Change in Heart Rate Recovery, Optimal Muscular Strength, and Fatigue Rate of Indian National Field Hockey Athletes in a Pre-Competitive Training Micro-cycle

Mohor Chattopadhyay and Sunil G Purohit*

Central University of Rajasthan, Ajmer, India

***Corresponding Author:** Sunil G Purohit, Central University of Rajasthan, Ajmer, India.

Received: December 12, 2022; **Published:** December 26, 2022

Abstract

Field hockey is a team sport that demands a lot from its players in terms of stamina, strength, and speed as well as agility and game-specific skills. To determine the consequences of this pre-competitive micro-contribution cycle's to enhancing muscular systems' endurance and strength, this study measured changes in heart rate recovery, post-training 1 RM capacity, and rating of fatigue scale values. While a lower 1 RM compared to previous studies implied the requirement of improvement in muscular strength, this study has observed an increase in rating of fatigue from day 1 to day 6 (1.25 ± 1.28), a decrease in body weight from day 1 to day 6 (1.49 ± 0.70 kg), and an improvement in post exercise heart rate recovery from day 1 to day 6(18.12 ± 6.85 to 24.00 ± 7.48 in 1 minutes). These findings suggest that this micro-cycle has led to better conditioning of cardiovascular and muscular endurance. The study's findings suggest that the parameters may be improved by this micro-cycle, but further research on other distinct micro-cycles and a larger sample size are required to pinpoint the precise factors that influence competitive performance.

Keywords: *Musculo-Skeletal Parameters; Fatigue; Hockey Players; Pre-Competitive Micro-Cycle; Heart Rate Recovery; Field Hockey*

Introduction

Despite the known positive effects of acute exercise and various micro-cycles of training periodization during different phases of the annual training macro-cycle, the effects of each pre-competitive training micro-cycle on optimal muscular strength, neuro-muscular fatigue, cardiovascular and muscular endurance are unknown [1-3]. In open skill sports like field hockey, a player's ability to adapt and perform a specific action, such as physiological demands for the sport, determines skill. Field hockey has become one of the most fast-paced team sports, and the ability to anticipate, adapt, and respond successfully is dependent on superior perceptual-cognitive factors [4].

The duration of the game and the distance run by field hockey players require a high aerobic contribution to the energy supply. Field hockey also involves short, more intense periods of running, which may require equal proportions of aerobic and anaerobic energy to run longer distances in the game. The phosphate, lactic, and aerobic energy systems each contributed 30%, 20%, and 50% to the field hockey game, respectively [6]. The centre/midfield position required the most energy expenditure (833 $kJmin^{-1}$), while the left wing required the least (611 $kJmin^{-1}$). Data on the distance covered by male field hockey players during the second World Cup in 1973. Field hockey appears to be aerobically demanding, but it also requires frequent, albeit brief, anaerobic efforts. During a match, the average energy expenditure of 9 elite male field hockey players in South Africa was 742 ± 630 $kJmin^{-1}$ (X ± SD) [7,8]. For Indian national male senior field hockey players, the average game heart rate was 157 bpm. This value was comparable to the end-of-game heart rate of South African field hockey players (158 bpm). At the end of the games, these values were higher than the mean heart rate of University and National League Female Water Polo players (148 bpm) and the mean heart rate of Indian National Male Kabaddi players [7,9-11].

Additionally, field hockey competitions need a significant level of aerobic stamina, quickness, and muscular strength. It is uncertain how these physical fitness metrics alter from preseason preparation to postseason recuperation [20]. Although some research has been conducted into physiological responses to playing field hockey, there has been only limited investigation in India for heart rate recovery, muscular strength, and fatigue during each pre-competitive training micro-cycle. As a result, the goal of this study is to determine the physiological demands, improvements, and effects of one micro-cycle on cardiovascular endurance, muscular endurance, strength, and fatigue by monitoring training plan, recovery heart rate, one repetition maximum for squats and bench press (1 RM), and R.O.F. and R.P.E. scale ratings, as well as changes in body weight, R.O.F., and 1 RM capacity.

Aim of the Study

The main goal of the current study was to observe changes in physical performance over the course of a field hockey season's pre-competitive micro-cycle training phase in order to determine whether pre-competitive conditioning optimizes physical fitness.

Materials and Methods

Eight elite Indian national field hockey players of 18 - 22 years age group were monitored during a pre-competitive micro-cycle of training (Figure 2), with the consent of both the players and the coaches. Field hockey players first engaged in preseason conditioning, which included measurements of body weight, muscle strength, level of fatigue, and post-exercise heart rate recovery. To ascertain how each physical fitness parameter evolves during the pre-competitive season, some of these tests were repeated before and after the micro-cycle training phase. Before agreeing to participate in the study, each subject gave their informed consent and answered questions about their health history, attesting to the fact that they did not have any conditions that would have prevented them from taking part. Without affecting their all 11 training sessions of the whole micro-cycles pre- and post micro-cycle training body weight, height, and post exercise one minute of heart rate recovery, Fatigue scale rating values were measured (Figure 1).

To study the muscular strength of upper and lower extremities the last set weight and number of repetitions were recorded for Squats and bench press exercises during the resistance training session (Day 6, Session 11) and from that 1 RM (repetition maximum) was calculated using Brzycki Equation [12,13] as described in (i):

$$1\ RM\ CAPACITY = \frac{(100 \times wt\ in\ kg)}{\{192.78 - (2.78 \times no.of\ repetitions\ (\ from\ 3\ to 10))\}} \ldots \text{(i)}$$

To measure the heart rate recovery for 1 minute, OxyWatch® (ChoiceMMed™), a portable, non-invasive fingertip pulse oximeter, is used, immediately muscular endurance circuit training of day 1, session 1 and day 6, session 11. Fatigue is determined from the 0 - 10 ranged R.O.F (Rate of fatigue) scale during the same time [14,15] and Borg CR10 R.P.E. scale value (Rated perceived exertion) was also considered after day 1, session 1 [16]. Data analysis and the calculations of mean, standard deviation (S.D.), Scatter plot graphical representations, R^2 value were obtained using Microsoft Excel.

Results and Discussion

This study on eight top-level male field hockey players looks at how their body weight, upper and lower body muscle strength, fatigue, aerobic fitness, and cardiovascular endurance change over the course of a pre-competitive training micro-cycle that lasts a week and includes 12 training sessions lasting 100 minutes each. Previous research on professional hockey players [17] between the ages of 17 and

19 (n = 136) projected that the 1 repetition maximum (1 RM) for this age group would be 107.0 kg, with the highest values being 128.1 kg for those between the ages of 25 and 29 (n = 274). The athletes included in this study demonstrated lesser upper body strength in comparison, with a predicted 1 RM bench press value of 59.16 ± 9.17 kg.

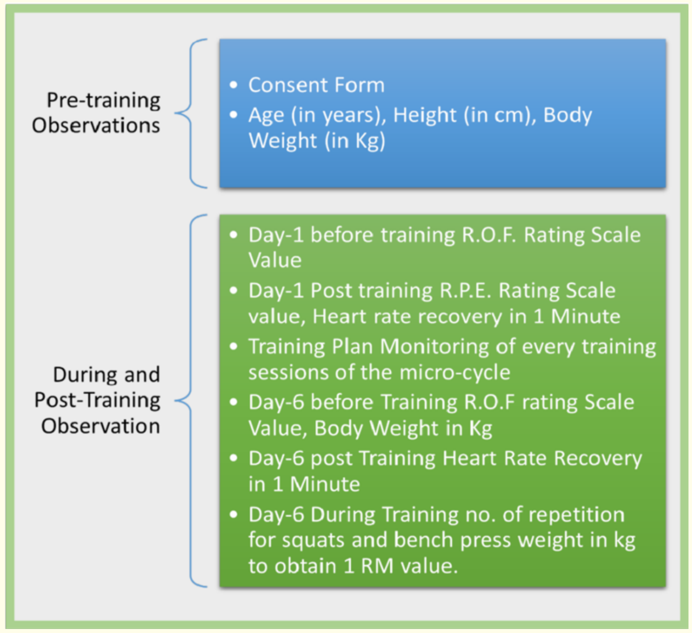

Figure 1: *Methodology of data collection and observations during training.*

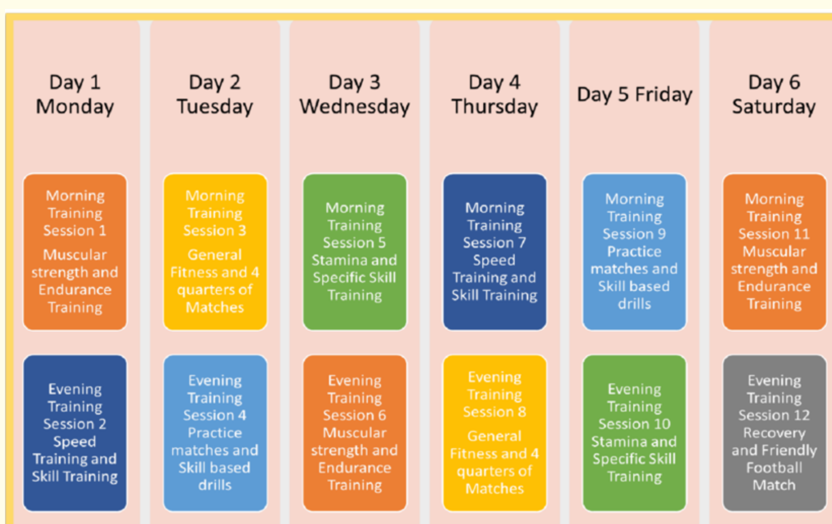

Figure 2: *Monitored training micro-cycle of 12 training sessions, each of 100 minutes.*

During this training cycle individual and mean body weight of the athletes were deceased at the amount of 1.49 ± 0.70 kg and Gains in body mass of the professional hockey players during training were associated with an increase in upper body strength [17] implying this decrement of body weight might be an indication of improvement of muscular endurance instead of increase in muscle mass or muscular strength. Study has reported the mean heart rate of the players at the end of the second half was 10 bpm lower than that of the first half of the game [18].

As in this micro-cycle an improved heart rate recovery one minute is observed at the sixth day of the micro-cycle an improved game performance may imply. Morphological and physiological fitness for match play depends upon the work rate requirements for the athlete's physical training regimen, frequency of competition, stage of the competitive season, etc [19].

Improvement in heart rate recovery speed with extended load in a pre-competitive training micro-cycle may lead to performance improvement and achieving optimal performance level during competitive phase. Studies have reported that pre-season trainings are effective in decreasing body fat and increasing cardio-vascular endurance yet a loss of muscular strength [20].

According to the findings, preseason conditioning that encompasses weight training, plyometrics, aerobic activity, and game participation improves physical fitness by accelerating heart rate recovery. A more intense in-season resistance-training strategy may be able to prevent the poor muscle strength that was discovered due to a reduction in training volume. Overall, strenuous preseason conditioning develops stamina and endurance, two qualities essential to field hockey success. Moreover, competitive field hockey athletes are markedly stronger and have less BF than their age matched peers [20].

Age (Years) (mean ± S.D.)	Height (cm) (mean ± S.D.)	Weight (kg) Day-1 (mean ± S.D.)	Weight (kg) Day-6 (mean ± S.D.)
19±1.31	176.25±3.49	65.41±5.42	63.93±5.33

Table 1: *Demographic profile of the athletes.*

Parameters	Mean ± S.D.	Parameters	Mean ± S.D.
R.O.F Day-1 Rating Scale Value	0.125 ± 0.35	Post-training immediate Heart Rate Day-1 (bpm)	122 ± 9
R.O.F. Day-6 Rating Scale Value	1.375 ± 1.5	Heart recovery value after 1 min Day-1	18. 125 ± 6.85
R.P.E. Day-1 Rating Scale Value	1.375 ± 1.06	Post-training immediate Heart Rate Day-6 (bpm)	127.38 ± 12.02
Change in R.O.F. Rating Scale Value	1.25 ± 1.28	Heart recovery value after 1 min Day-1	24 ± 7.48
1 RM in Squats (Brzycki Equation)	129.85 ± 20.86	Change in 1 min Heart Rate Recovery	5.87 ± 4.67
1 RM in Bench Press (Brzycki Equation)	59.16 ± 9.17		

Table 2: *Observations of the physiological parameters of the athletes.*

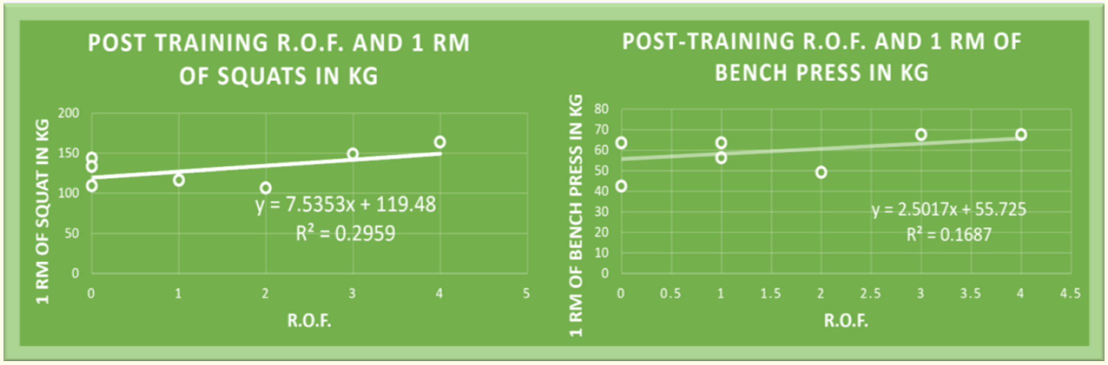

Figure 3: *Graphical representations of 1 RM capacities and R.O.F scale value.*

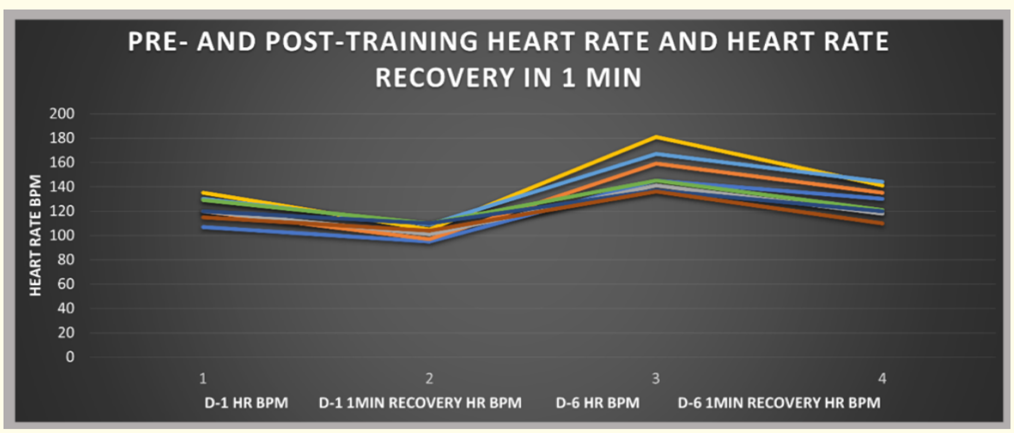

Figure 4: *Graphical representations of the change in heart rate recovery before and after the micro-cycle of training.*

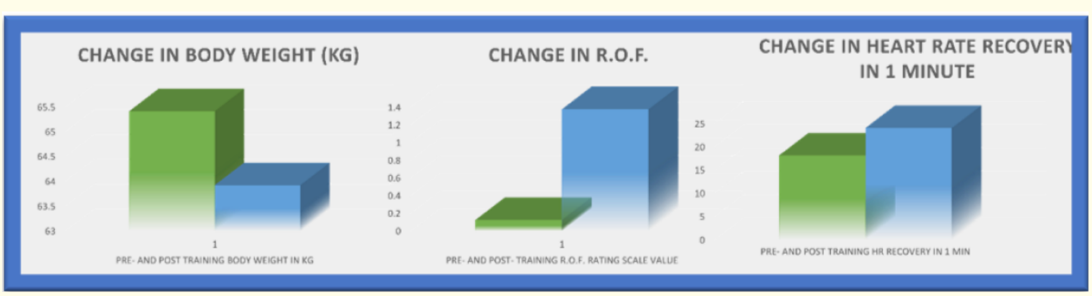

Figure 5: *Graphical representation of the changes during the training micro-cycle.*

The increased HR recovery may be because of the training stimulus of interval running in match-play combined with regular cardiovascular workouts and sprinting during training. Despite field hockey players having more strength than their age-matched counterparts, a pronounced drop in strength was seen during in-season training. Since both frequency and intensity of training were decreased prior to the competition, a drop in resistance training volume is the most likely explanation for this outcome [20]. However, field hockey competition also requires athletes to run continuously at moderate intensities, therefore competitors need to have an adequate aerobic capacity. Despite the majority of play involving off-the-ball action, it has been reported that competitive field hockey is roughly 60% aerobic and 40% anaerobic [21].

Conclusion

Due to the short trial period and limited sample size, there were no significant differences in many measures, including muscular strength. With the determination of muscle strength level, R.P.E., and the increase in fatigue rate at the end of the micro-cycle training session, this study has concluded with impacts of improved heart rate recovery, decreased body weight, and increased fatigue rate. Because field hockey is predominantly an aerobic sport punctuated with spurts of intensive exercise, it is unknown whether this strength loss is long-term or typical and affects field hockey performance. To stop this strength loss, however, coaches might need to implement more intensive in-season resistance training.

Muscular strength is low in-season, but the absence of statistically meaningful results shouldn't undermine the main message of our data. It is conceivable that a test testing speed, such as a 40- or 60-yard dash, may have been implemented because field hockey requires quickness and agility.

Bibliography

1. Allard F and Burnett N. "Skill in sport". *Canadian Journal of Experimental Psychology* 39 (1987): 294-312.
2. Starkes JL. "Skill in field hockey: the nature of the cognitive advantage". *The Journal of Sport and Exercise Psychology* 9 (1987): 146-160.
3. Williams AM and Jackson RC. "Anticipation in sport: fifty years on, what have we learned and what research still needs to be undertaken?" *Psychology of Sport and Exercise* 42 (2019): 16-24.
4. Sunderland C and Nevill ME. "High-intensity intermittent running and field hockey skill performance in the heat". *Journal of Sports Sciences* 23 (2005): 531-540.
5. McMorris T and Graydon J. "The effect of exercise on cognitive performance in soccer-specific tests". *Journal of Sports Sciences* 15 (1997): 459-468.
6. Roberts AD. "Physiological Capacity for Sports Performance". In Pyke, F S Better Coaching Advanced Coach's Manual. Canberra. Australian Coaching Council (1991).
7. Boyle PM., *et al*. "The Competitive Demands of Elite Male Field Hockey". *The Journal of Sports Medicine and Physical Fitness* 34.3 (1994): 235-241.
8. Reilly T and Borrie A. "Physiological Applied to Field Hockey". *Sports Medicine* 14.1 (1992): 10-26.
9. Ghosh AK., *et al*. "Heart Rate and Blood Lactate Response in Field Hockey Players". *Indian Journal of Medicine and Research* 94 (1991): 351-356.
10. Konstantaki M., *et al*. "The Relationship Between Blood Lactate and Heart Rate Responses to Swim Bench Exercise and Women's Competitive Water Polo". *Journal of Sports Sciences* 16 (1998): 251-256.

11. Khanna GL., *et al*. “A Study of Physiological Responses During Match Play in Indian National Kabbadi Players”. *British Journal of Sports Medicine* 30 (1996): 232-235.

12. Lesuer DA., *et al*. “The accuracy of prediction equations for estimating 1-RM performance in the bench press, squat, and deadlift”. *The Journal of Strength and Conditioning Research* 11 (1997): 211-213.

13. Brzycki M. “Strength testing – predicting a one-rep max from reps to fatigue”. *JOPERD: Journal of Physical Education, Recreation and Dance* 64 (1993): 88-90.

14. Al Salman A., *et al*. “The rating of fatigue scale (ROF)”. *Medicine and Science in Sports and Exercise* 45.5-1 (2013): 282.

15. Micklewright D., *et al*. “Development and Validity of the Rating-of-Fatigue Scale”. *Sports Medicine* 47 (2017): 2375.

16. Nerys Williams. “The Borg Rating of Perceived Exertion (RPE) scale”. *Occupational Medicine* 67.5 (2017): 404-405.

17. Sarkar S., *et al*. “Comparison of body composition, physical fitness parameters and skeletal muscle damage indices among young Indian male soccer and hockey players”. *Baltic Journal of Health and Physical Activity* 11.2 (2019): 1-10.

18. W Kusnanik., *et al*. “Physiological Demands of Playing Field Hockey Game at Sub Elite Players IOP”. *IOP Conference Series: Materials Science and Engineering* 288 (2018): 012112.

19. Chatterjee S., *et al*. “Validity of Queen’s College Step Test for estimation of maximal oxygen uptake in female students”. *Indian Journal of Medical Research* 121.1 (2005): 32-35.

20. Astorino Todd A., *et al*. “Changes in Physical Fitness Parameters During a Competitive Field Hockey Season”. *Journal Of Strength and Conditioning Research* 18.4 (2004): 850-854.

21. Sharkey B. “Coaches guide to sport physiology”. Champaign, IL: Human Kinetics (1986).

Volume 14 Issue 1 January 2023