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Effect of Training on Anthropometric, Physiological and Biochemical Variables of Elite Field Hockey Players

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Abstract. The aim of study was to investigate the effect of training on selected anthropometric, physiological and biochemical variables of elite field hockey players. A total of 30 Indian male field hockey players (age: 23.00-30.00 yrs) volunteered for this study. The training sessions were divided into 2 phases (a) Preparatory Phase (PP, 8 weeks) and (b) Competitive Phase (CP, 4 weeks). The training programme consist of aerobic, anaerobic and skill development, and were completed 4 hrs/day; 5 days/week. Selected variables were measured at zero level (baseline data, BD) and at the end of PP and CP. A significant increase ($P<0.05$) in LBM, back and hand grip strength, serum level of urea, uric acid and HDLC; and a significant decrease ($P<0.05$) in body fat, sub-maximal exercise heart rate and recovery heart rate, hemoglobin, total cholesterol, triglyceride and LDLC were noted in PP and CP of training when compare to BD. No significant change was noted in stature, body mass, HR_{max}, resting heart rate, VO_{2max} and anaerobic power of the players after the training. Since the data on field hockey players are limited in India, the present study may provide useful information to the coaches to develop their training programme.

Key Words: body composition, heart rate, VO_{2max}, anaerobic power, strength, lipid profile

1. Introduction

Field hockey is a sport with a long history that has undergone quite rapid and radical changes. The advent of the synthetic playing surface has changed the technical, tactical and physiological requirements of the game at all levels, but in particular at the elite level. To achieve the best possible performance, the training has to be formulated according to the principles of periodization (Bompa, 1999). The training induced changes observed in various parameters can be attributed to appropriate load dynamics.

Physique and body composition have an important role for playing field hockey (Montgomery, 2006; Quinney et al., 2008; Tarter et al., 2009). In field hockey lots of movements and skills are involved so a high level of physical demand is required for match play (Montgomery, 2006; Quinney et al., 2008; Tarter et al., 2009). The game of field hockey involves walking, jogging, sprinting in varied directions with and without ball. As the players have to cover a big area in the ground during attack and defence therefore, the game demands for aerobic as well as anaerobic fitness (Bloomfield et al., 2007; Elferink-Gemser et al., 2006; Hinrichs et al., 2010). A high number of accelerations and decelerations, associated with the large number of changes in direction of play create an additional load to the muscles involved as in field hockey, those players better suited to cope with the demands of the game reach the elite level (Bloomfield et al., 2007; Elferink-Gemser et al., 2006). The intermittent high intensity pattern of activity during the match requires a high function of both the aerobic and anaerobic energy delivery pathways

During aerobic exercise the demand of oxygen increases at the working muscle, so an optimum level of hemoglobin is required to perform at the highest level with high intensity (Nielsen and Weber, 2007; Suhr et al., 2009). The serum level of urea and uric acid are used for assessment of training related stress (Urhausen

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(Bloomfield et al., 2007; Elferink-Gemser et al., 2006; Tarter et al., 2009). Moreover, power and strength has great impact over the game, which is required during sprinting and in execution of various skills with the ball (Bloomfield et al., 2007; Elferink-Gemser et al., 2006; Quinney et al., 2008).

and Kindermann, 2002). During the field hockey training these parameters may be evaluated at regular intervals to assess the training load imposed on the athlete. Lipids have important beneficial biological functions that include the use of triglycerides, for energy production or as stored fat in adipose tissue and use of cholesterol as a component, in conjunction with phospholipids of cellular membranes or in the synthesis of steroid hormones (Kelley and Kelley, 2009). Elevated plasma cholesterol concentrations have been implicated in the development of coronary artery disease (CAD) (Kelley and Kelley, 2009; Altena et al., 2006).

This study was focused on the field hockey players as the game is popular and played through out the world. The anthropometric, physiological and biochemical variables have important role for the evaluation of training of the athletes. Studies on these parameters of field hockey players particularly in the senior elite age group are lacking in India. In view of the above, a study was undertaken to investigate the effect training on selected anthropometric, physiological and biochemical variables of senior elite Indian male field hockey players.

2. Methods

2.1. Subjects and Training

Table 1: General training schedule for all the field hockey players

Athletes name	Training objectives															
	Performance		Test/Standards		Physical preparation			Technical preparation				Tactical preparation	Psychological preparation			
Competition type	Domestic											x x	x	x		x
Periodization	Training phase	Phase		Zero Level	Preparatory								Competitive			
		Sub-phase		Baseline	General preparation				Specific preparation				PC	Competition		
	Strength			-	AA			Maximal Strength					Power			
	Endurance			-	Aerobic			Anaerobic				Ergogenesis				
	Speed			-	Specific high				Specific							
	Skill Acquisition			-	Foundation			Advanced				Stimulation				
	Macro cycles			-	1				2				3		4	
	Micro cycles			-	1	2	3	4	5	6	7	8	9	10	11	12
Peaking index				-	4				4				3	2		
Testing dates				x								x				x
		%														
Training factors	Volume	100	1	-	80-90%				70-90%				70%	60-70%		
	Intensity	90	2	-	70-80%				80-90%				80%	80-90%		
	Peaking	80	3	-	70-75%								80%	>90%		
	Phys prep	70	4	-	50-55%				40-45%				30%	30%		
	Tech prep	60	5	-	40-45%				40-45%				35%	35%		
	Tact prep	50	Peaking	-	10%				10%				35%	35%		
	Psych prep	40		-					10%				20%	30-35%		
		30														
		20														
		10														

PC = Pre Competition, AA= Anatomical Adaptation.

A total of 30 senior elite Indian male field hockey players (age: 23.00-30.00 yrs) regularly playing competitive field hockey (playing for last 12-17 years) volunteered for this study. The sportsmen represented India in different International competitions including World cup, World Championship, Olympic Games and Asian Games.The selected physiological parameters were measured in the laboratory at the beginning of the training (baseline data, BD) and at the end of each training phase (Preparatory Phase and Competitive

Phase). Each test was scheduled at the same time of day (± 1 hour) in order to minimize the effect of diurnal variation. All the experiments were performed at 25 ± 1oC, with relative humidity of 60 - 65 %. The subjects were informed about the possible complications of the study and gave their consent. The study was conducted at Sports Authority of India and was approved by the Ethical Committee of the Institute.

After taking the base line data (BD, zero level) the players went through a training programme. The training sessions were divided into two phases (i) Preparatory Phase (PP, 8 weeks), and (ii) Competitive Phase (CP, 4 weeks). The volume and intensities of the training components also varies in each phase of training. In the preparatory phase, the volume and intensity of training increased gradually. On the other hand, in the competitive phase the training volume and intensity was changed according to the competition schedule. At the same time highly specified training related to field hockey and practice match play was followed in the competitive phase. The players generally completed an average of 2 hours of training in morning sessions, which was mostly performed to improve the physical fitness of the players. On the other hand, in the evening sessions 2 hours of technical and tactical training, which included dribbling, tackle, set up movements, penalty corner, penalty shoot out and match practice. The training sessions were followed 5 days/week, according to the requirement of the game and competitive demand. The training schedule, type of training, volume and intensity is shown in table 1.

2.2. Measurement of Anthropometric Variables

Body mass (weight) was measured with the accurately calibrated electronic scale (Seca Alpha 770, UK) to the nearest 0.1 kg, and stature (height) with stadiometer (Seca 220, UK) recorded to the nearest 0.5 cm (Jonson and Nelson, 1996). Body density was estimated from the sum of the skin-fold sites based on the standard procedure (Durnin and Womersley, 1974) and estimated percentage body fat was calculated using standard equation (Siri, 1956). Lean body mass (LBM) was calculated by subtracting fat mass from total body mass.

2.3. Measurement of Physiological Variables

Treadmill (Jaeger, LE 500, Germany) tests were performed to determine the cardiovascular status of the players during maximal exercise. The maximum oxygen consumption (VO_{2max}) was measured following standard methodology (Astrand and Rodhal, 1986). The subject was asked to run on the treadmill at a speed of 6 km/h for 2 min. thereafter, the workload was increased by 2 km/h for every 2 min. until volitional exhaustion. Expired gases were sampled and measured from a mixing chamber using computerized respiratory gas analyzer (Oxycon Champion, Jaeger, Germany). Heart rate responses during exercise and recovery were noted using sports testers (Polar). Anaerobic power was measured using cycle ergo-meter (Jaeger, LE 900, Germany) following the Wingate anaerobic test (Inbar et al., 1996). Strength of the grip and back was measured with the help of dynamometers following standard procedure (Jonson and Nelson, 1996).

2.4. Measurement of Biochemical Variables

A 5 ml of venous blood was drawn from an antecubital vein after a 12-hours fast and 24 hours after the last bout of exercise for the subsequent determination of selected biochemical parameters. The biochemical parameters were measured using standard methodology. All the reagents were supplied from Boehringer Mannhein, USA. Haemoglobin was measured using Cyanmethaemoglobin method (Mukharjee, 1997). Serum urea (Wybenga, 1971) and uric acid (Martinek, 1970) were determined calorimetrically. Serum triglycerides (Schettler and Nussei, 1975), serum total cholesterol (TC) (Wybenga et al., 1970) and high-density lipoprotein cholesterol (HDL-C) (Wybenga et al., 1970) were determined by enzymatic method. Low-density lipoprotein cholesterol (LDL-C) was indirectly assessed following standard equation (Friedewald et al., 1972).

2.5. Statistical Analysis

All the values of anthropometric, physiological and biochemical variables were expressed as mean and standard deviation (SD). Analysis of Variance (ANOVA) with repeated measures followed by multiple comparison tests was performed, to find out the significant difference in selected anthropometric, physiological and biochemical variables among the training phases. In each case the significant level was chosen at 0.05 levels. Accordingly, a statistical software package (SPSS) was used.

3. Results

3.1. Effect of training on Anthropometric variables of senior elite Indian field hockey players

A significant ($P<0.05$) reduction in percent body fat and fat mass were noted in PP and CP when compared to BD of the field hockey players. On the other hand, a significant ($P<0.05$) increase in LBM was observed among players in CP when compared to BD. However, no significant difference was observed in body mass and stature of the field hockey players after the training programme (Table 2).

Table 2: Effect of training on body composition on senior elite India field hockey players

Groups	Stature (cm)	Body mass (kg)	Body fat (%)	Fat mass (kg)	LBM (kg)
BD	$174.4^a \pm 5.2$	$68.9^a \pm 4.4$	$16.0^a \pm 0.5$	$11.05^a \pm 0.9$	$57.9^a \pm 3.6$
PP	$174.4^a \pm 5.2$	$69.3^a \pm 4.4$	$14.8^b \pm 1.0$	$10.3^b \pm 1.0$	$59.0^a \pm 3.8$
CP	$174.5^a \pm 5.0$	$69.9^a \pm 4.4$	$12.3^c \pm 2.3$	$8.6^c \pm 2.0$	$61.3^c \pm 3.2$

Each values represents mean ± SD. In each vertical column the mean with different superscript ($^{a,\ b,\ c}$) differ from each other significantly, $P<0.05$. BD= base line data, PP= preparatory phase, CP= competitive phase; LBM= lean body mass.

3.2. Effect of training on Physiological variables of senior elite Indian field hockey players

Heart rate recorded during sub-maximal exercise and recovery after maximal exercise decreased significantly ($P<0.05$) in PP and CP when compared to BD among the field hockey players. However, no significant change was observed in maximal heart rate (HRmax) and resting heart rate of the field hockey players following the training (Table 3). However, no significant change was noted in VO_{2max} and anaerobic power in PP and CP when compared to BD of the field hockey players (Figure 1a, b). On the other hand, strength of back and grip muscles increased significantly ($P<0.05$) in PP and CP when compared to BD of the field hockey players (Figure 2).

Table 3: Effect of training on heart rates of senior elite Indian field hockey players

Groups	RHR	HR1	HR2	HR_{max}	HRR1	HRR2	HRR3
BD	$66.1^a \pm 3.3$	$115.1^a \pm 7.3$	$134.0^a \pm 3.6$	$178.1^a \pm 4.7$	$148.0^a \pm 2.7$	$123.6^a \pm 1.8$	$115.9^a \pm 3.0$
PP	$65.1^a \pm 5.2$	$109.7^b \pm 3.8$	$128.1^b \pm 4.9$	$177.1^a \pm 3.6$	$146.4^b \pm 2.7$	$121.0^b \pm 1.3$	$112.3^b \pm 4.0$
CP	$66.0^a \pm 4.0$	$104.4^c \pm 5.0$	$120.1^c \pm 3.2$	$177.0^a \pm 5.2$	$142.7^c \pm 5.7$	$118.5^c \pm 3.8$	$106.0^c \pm 4.6$

Each values represents mean ± SD. In each vertical column the mean with different superscript ($^{a,\ b,\ c}$) differ from each other significantly, $P<0.05$. BD= base line data, PP= preparatory phase, CP= competitive phase; RHR= resting heart rate, HR1= sub-maximal heart rate 1st min, HR2= sub-maximal heart rate 2nd min, HR_{max}= maximal heart rate, HRR1= recovery heart rate 1st min, HRR2= recovery heart rate 2nd min, HRR3= recovery heart rate 3rd min.

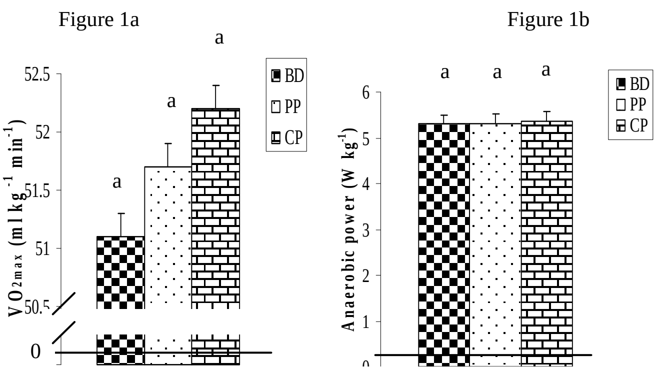

Figure 1: Effect of training on VO_{2max} and anaerobic power of senior elite Indian field hockey players.Each values represents mean ± SD. In each vertical column the mean with different superscript (a, b, c) differ from each other significantly, $P<0.05$. BD= base line data, PP= preparatory

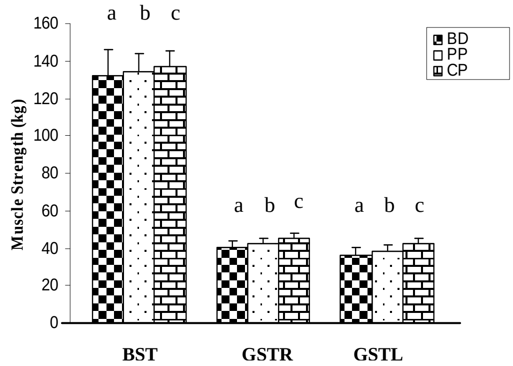

Figure 2: Effect of Training on back and grip strength of senior elite Indian field hockey players. Each values represents mean ± SD. In each vertical column the mean with different superscript (a, b, c) differ from each other significantly, $P<0.05$. BD= base line data, PP= preparatory phase, CP= competitive phase; BST= back strength, GSTR= grip strength right hand, GSTL= grip strength left hand.

3.3. Effect of training on Biochemical variables of senior elite Indian field hockey players

A significant reduction ($P<0.05$) in hemoglobin was noted in PP and CP when compared to BD of the field hockey players (Figure 3a). On the other hand, significant increase ($P<0.05$) in serum urea and uric acid were noted in PP and CP when compared to BD of the field hockey players (Figure 3b, c). Further, significant increase (P<0.05) in serum HDLC level was noted in PP and CP when compared to BD of the field hockey players (Table 3).However, significant reduction (P<0.05) in total cholesterol (TC), triglyceride (TG), LDLC, the ratio of TC to HDLC and LDLC to HDLC were noted in PP and CP when compared to BD of the field hockey players (Table 4).

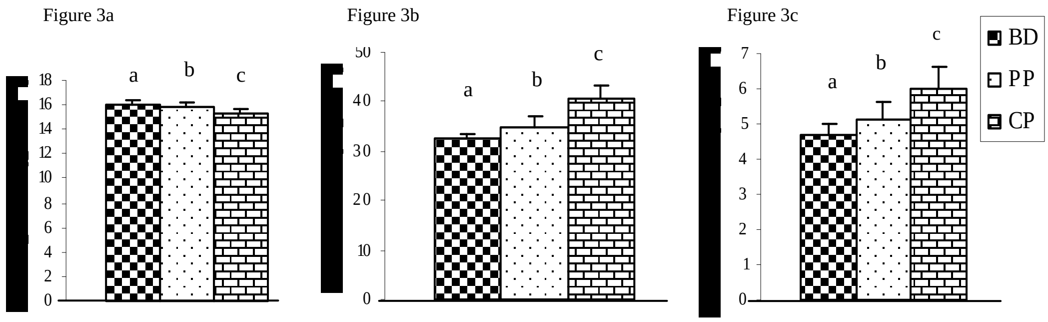

Figure 3: Effect of training on hemoglobin, serum urea and uric acid of senior elite Indian field hockey players. Each values represents mean ± SD. In each vertical column the mean with different superscript (a, b, c) differ from each other significantly, P<0.05. BD= base line data, PP= preparatory phase, CP= competitive phase.

Table 4: Effect of training on lipids profiles of senior elite Indian field hockey players.

Groups	TC (mg/dl)	TG (mg/dl)	HDLC (mg/dl)	LDLC (mg/dl)	TC/HDLC	LDLC/HDLC
BD	184.9^{a}± 7.6	103.1^{a} ± 13.4	39.2^{a}± 3.1	125.0^{a}± 7.9	4.7^{a}± 0.4	3.2^{a}± 0 .4
PP	175.1^{b} ± 7.8	89.5^{b}± 7.7	44.2^{b}± 2.7	113.0^{b}± 9.5	4.0^{b}± 0.4	2.6^{b}± 0.3
CP	161.3^{c}± 12.0	79.7^{c}± 11.9	48.5^{c}± 7.9	96.8^{c}± 14.9	3.4^{c}± 0.7	2.1^{c}± 0.6

Each values represents mean ± SD. In each vertical column the mean with different superscript ($^{a, b, c}$) differ from each other significantly, P<0.05. BD= base line data, PP= preparatory phase, CP= competitive phase; TC= total cholesterol, TG= triglyceride, HDLC= high density lipoprotein cholesterol, LDLC= low density lipoprotein cholesterol.

4. Discussion

Performance of the hockey players is affected by body composition and physique. A lean body is desirable for sports like field hockey (Montgomery, 2006; Quinney et al., 2008; Tarter et al., 2009). A low-body fat may improve athletic performance by improving the strength-to-weight ratio (Wilmore & Costill, 2005). Excess body fat adds to the load without contributing to the body's force-producing capacity (Wilmore & Costill, 2005). A significant (P<0.05) reduction in percent body fat and fat mass were noted in preparatory and competitive phase when compared to base line data of the field hockey players. On the other hand, a significant (P<0.05) increase in LBM was observed among players in competitive phase when compared to base line data. The possible reason for reduction in body fat and elevation of LBM might be due to endurance training which increases greater utilization of fat (Mc Ardle et al., 2006; Wilmore & Costill, 2005). Similar findings were also noted by some researchers, who studied on field hockey players and reported that percent body fat and fat mass were significantly lower in-season and postseason vs. preseason (Astorino et al., 2004). Therefore, it can be stated that field hockey players can accumulate body fat in the pre-season and lose body fat during preparatory phase and competitive phase of training. This might be due to intensive training during preparatory phase and high level of performance during the competitive phase. In this study no significant difference was observed in body mass among the field hockey players after the training programme. It might be due to the shorter duration of the training. It has been reported that short term exercise training has no significant effect on body mass of the sports persons (Mc Ardle et al., 2006; Wilmore & Costill, 2005).

Heart rate increases with an increase in work intensity and shows linear relationship with work rate (Astrand & Rodhal, 1986). The highest rate at which the heart can beat is the maximal heart rate (HRmax). Quick recovery from strenuous exercise is important in hockey which involves intermittent efforts interspersed with short rests (Mc Ardle et al., 2006; Wilmore & Costill, 2005). The heart rate recovery curve is an excellent tool for tracking a person’s progress during a training program (Mc Ardle et al., 2006). Heart rate recorded during sub-maximal exercise and recovery after maximal exercise decreased significantly

($P<0.05$) in PP and CP when compared to BD among the field hockey players. It has been observed that training reduces the rise in heart rate during exercise and hastens the fall in heart rate during recovery (Wilmore & Costill, 2005). Exercise cardio acceleration results from release of parasympathetic inhibition at low exercise intensities and from both parasympathetic inhibition and sympathetic activation at moderate intensities (Mc Ardle et al., 2006; Wilmore & Costill, 2005). Nevertheless, parasympathetic activation is considered to be the main mechanism underlying exponential cardio deceleration after exercise (Mc Ardle et al., 2006; Wilmore & Costill, 2005). The senior age group players might have been adapted to the load and no further increase in load dynamics might have been stressed on. During the match play the activities are not continuous; instead it is intermittent that means it involves short sprinting and casual recovery. Some times running with the ball and some times with out the ball. Thus less increase in heart rate during exercise and rapid fall in heart rate during casual recovery may help the player to perform better (Wilmore & Costill, 2005). On the other hand, no significant change was noted in HRmax and resting heart rate of the players after the training. This might be due to shorter duration of the training. It has been seen that short term exercise has no significant effect on HRmax (Wilmore & Costill, 2005). The results of the present study suggest that the strain on the circulatory system during playing hockey is relatively high. Exercising at this intensity should provide a good training stimulus, provided such participation is frequent enough.

Aerobic capacity certainly plays an important role in modern field hockey and has a major influence on technical performance and tactical choices. The present study showed an increasing trend but not significant change in maximal aerobic capacity (VO_{2max}) in the senior elite field hockey players in preparatory phase and competitive phase when compared to base line data. It might be due to the short duration of the training in elite group of players (Wilmore & Costill, 2005). Age may be a limiting factor too (Wilmore & Costill, 2005). Therefore, it can be stated that aerobic training of endurance and intermittent nature can improve the maximal aerobic capacity of the hockey players. Ideally, endurance training for hockey players should be carried out using the ball, because the player motivation is also normally considered to be higher when the ball is used. The players might then additionally develop technical and tactical skills similar to situations experienced during the game.

The game of hockey demands high anaerobic power as accelerate and decelerate quickly is the part of the game (Lakomy & Haydon, 2004; Spencer et al., 2004; 2005). It is acceleration that is critical to hockey performance rather than maximal speed (Lakomy & Haydon, 2004; Spencer et al., 2004; 2005). A high anaerobic power is essential for such activities. In the present study, no significant change was noted in anaerobic power of the field hockey players in preparatory phase and competitive phase of training when compared to base line data. This might be due to short duration of the training as well as to the age of the senior elite players. Playing field hockey involves intermittent activities i.e., short sprinting and casual recovery. Thus a high anaerobic power helps to develop sprint quality of the player. It would appear, therefore, that a high anaerobic power is desirable for success in top-class hockey (Reilly and Borrie, 1992). On the other hand, strength is the central component of a field hockey training program (Ebben et al., 2004; Spencer et al., 2004; 2005). Upper body strength allows players to shoot more powerfully and pass over a greater range of distances. In field hockey grip strength may have importance in handling the stick during execution of different skills in practice and competition. Many activities in field hockey are forceful and explosive (e. g. tackling, jumping, hitting the ball, turning and changing pace). The power output during such activities is related to the strength of the muscles involved in the movements. Thus, it might be beneficial for a hockey player to have a high muscular strength, which also diminishes the risk of injury (Reilly and Borrie, 1992; Gorger et al., 2001). The results of the present study have shown a significant increase in back and grip muscles in preparatory phase and competitive phase of training when compared to base line data of the field hockey players. Similar observation has been reported by many researchers (Ebben et al., 2004; Spencer et al., 2004; 2005). They studied on field hockey players and reported that the strength increased after training. The game requirements are for frequent, high intensity bursts of activity involving acceleration, deceleration and turning movements (Ebben et al., 2004; Spencer et al., 2004; 2005). Although the majority of the game is spent in low-level activity such as walking and light jogging, repeated back-to-back sprints make speed and tolerance to lactic acid an important characteristic in players (Ebben et al., 2004; Spencer et al., 2004; 2005). Therefore, sprint training regimens is beneficial to field hockey players (Ebben et al., 2004; Spencer et al., 2004; 2005).

Hemoglobin concentration in blood which is mainly used for the transport of oxygen from blood vessels to exercising muscles, and transport of carbon dioxide from working muscles to blood vessels. Hemoglobin also represents the iron status of the body (Suhr et al., 2009; Nielsen and Weber, 2007; Kargotich et al., 2007). In the present study a significant reduction ($P<0.05$) in hemoglobin was noted in the field hockey players in preparatory phase and competitive phase of training when compared to base line data. During the pre-training period the training load was lesser than preparatory phase and competitive phase; therefore, reduced hemoglobin level was observed in the latter two phases. Moreover, as the training load increased in the competitive phase, the declined in hemoglobin level was more prominent when compared with the pre-training period. Similar observations have been noted by many researchers in their recent studies (Suhr et al., 2009; Nielsen and Weber, 2007; Kargotich et al., 2007). Studies on professional athletes showed that hemoglobin values were higher at the beginning of the competition season, and then declined in well-trained athletes (Suhr et al., 2009; Nielsen and Weber, 2007; Kargotich et al., 2007). It can be suggested that the decline in hemoglobin level may be due to haemolysis (Suhr et al., 2009; Boning et al., 2007; Fujitsuka et al., 2005). Intravascular haemolysis is one of the most emphasized mechanisms for destruction of erythrocytes during and after physical activity (Pialouxet al., 2006; Francisco Javier et al., 2006). In addition, exercise training induced reduction in hemoglobin concentration also may be due to hemodilution which is a common physiological effect of endurance training also exist among the well trained athletes due to increased in plasma volume (Kargotich et al., 2007; Neumayr et al., 2005). A recent study reported declined haematocrit during the race and continued falling on the next day with a corresponding rises in plasma volume following an ultra endurance cycling. They reported that the impact on the plasma volume is pronounced leading to marked haemodilution post-exercise (Neumayr et al., 2005). Another study reported a decrease in hemoglobin concentration during the post race recovery period following an ultra marathon race and that the greatest reduction in hemoglobin concentration was observed 48 hours after the race (Dickson et al., 1982). They suggested that this reduction in hemoglobin concentration is due to hemodilution (Dickson et al., 1982).

The serum urea and uric acid level has been considered as an indicator of overtraining. In this study, significant increase ($P<0.05$) in serum urea and uric acid were noted in the field hockey players in preparatory phase and competitive phase of training when compared to base line data. Increased level of serum urea and uric acid were observed after training, but the urea and uric acid level were found to be within the normal range. The highest level of urea and uric acid were noted in the competitive phase when the training load was highest. It is believed that a pronounced increase in the urea and uric acid concentration indicates strong influence of a training session, whereas normalization of the urea and uric acid level in blood is an index of time to perform subsequent strenuous training sessions (Degoutte et al., 2006). The possible reason for the increased urea level is the breakdown of proteins. Similar observations have been reported by many researchers (Andersson et al., 2008; Kargotich et al., 2007). It has been reported that prolonged exercises have been shown to cause increased urea concentration in the blood, liver, skeletal muscles, urine, and sweat (Andersson et al., 2008; Kargotich et al., 2007; Neumayr et al., 2005; Bassini-Cameron et al., 2008). This considered as an augmented urea production. The increased uric acid level is also attributed the degradation of adenonucleotides (Andersson et al., 2008; Degoutte et al., 2006; Kargotich et al., 2007). Uric acid has been found in sweat and urine collected during exercise (Degoutte et al., 2006). In fact, despite being an end product of the purine nucleotide system, uric acid scavenges OH_2 radicals as well, and there is evidence that it may be an important biological scavenger against free radicals in human plasma and in skeletal muscle during and after acute hard exercise (Tsahar et al., 2006). This may be one of the reasons for increase in urea and uric acid level after exercise training (Tsahar et al., 2006).

Lipids and lipoprotein profile indicate the cardiovascular and the metabolic status of the athlete (Kelley and Kelley, 2009; Altena et al., 2006; Mazloom et al., 2008). Activity levels have impact on the lipids and lipoprotein levels of the athletes. As the training load increased from pre-training period to preparatory phase and competitive phase, the level of total cholesterol, triglyceride, LDL-C and the ratio of TC to HDLC and LDLC to HDLC were decreased where as the level of HDL-C increased gradually. Therefore, it can be stated that the training load has a significant negative relation with triglyceride and LDL-C and a positive relation with HDL-C level of the athletes. The possible reason for the reduction in total cholesterol, triglyceride and LDL-C; and elevation in HDL-C is that exercise especially, which increases metabolism and utilization of blood lipids and lipoprotein for energy production (Wilmore and Costill, 2005). Our findings are in conformity with the observations of other researchers in their recent studies. Cross-sectional studies also reported an increase in HDL-C level and decrease in triglyceride level after exercise (Kelley and Kelley, 2009; Heitkamp et al., 2008; Durstine et al., 2001; 2002). A recent study showed significant increase in HDL-C level and decrease in LDL-C level, with no change in triglyceride after 9 weeks of training (Degoutte et al., 2006). Another study reported that 4 weeks of aerobic exercise training significantly decreased the levels of total cholesterol, LDL-C, and increased HDL-C (Altena et al., 2006).

5. Conclusion

It may be concluded that these changes are due to training as well as due to participating in an increasing number of competitions. The introduction of synthetic playing surface has changed the game towards more of anaerobic side therefore, the game demands for high anaerobic power and strength. However, development of high aerobic capacity is essential for field hockey as the players has to cover a big area in the ground during the game. Regular monitoring of hemoglobin; serum urea and uric acid; lipids and lipoproteins profiles of the field hockey players is essential to optimize their health status which has direct relation with their performance. The unique profile should be taken into consideration while administering training to the players. As the studies on field hockey players are limited in India, the data of the present study can be a handy tool and can act as a frame of reference for monitoring of training of field hockey players of different age groups. This would enable the coaches to assess the current status of an athlete and the degree of training adaptability and provide an opportunity to modify the training schedule accordingly to achieve the desired performance.

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