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Effect of Training on Morphological, Physiological and Biochemical Variables of Under 23 Years Soccer Players

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Abstract. Purpose of the study was to find out the effect of training on selected morphological, physiological and biochemical variables of under 23 years soccer players. A total of 30 Indian male under 23 years soccer players (U23, age: 19.00-22.99 yr, mean age: 20.9 ± 1.0 yr playing for last 8-11 years) volunteered for this study. The training sessions were divided into 2 phases (i) Preparatory Phase (PP, 8 weeks) and (ii) 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 morphological, physiological and biochemical variables were measured at zero level (baseline data, BD) and at the end of PP and CP. A significant increase ($P<0.05$) in VO_{2max}, anaerobic power, grip and back strength, urea and uric acid levels; and a decrease ($P<0.05$) in percent body fat, hemoglobin, total cholesterol, and triglyceride levels have been noted in PP and CP when compare to BD. However, no significant change was noted in stature, body mass, lean body mass, maximal heart rate, HDL-C and LDL-C levels of the players after the training. This study would provide useful information for training and selection of soccer players of under 23 age groups.

Keywords: body fat, VO_{2max}, anaerobic power, strength, lipid profile, soccer

1. Introduction

Soccer (football) is unarguably the world’s most popular sport. 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 morphological, physiological and biochemical parameters can be attributed to appropriate load dynamics (Hoff, 2005; Reilly, 2005). Physique and body composition have an important role for playing soccer (Gil et al., 2007). Since soccer is a physical contact sport and lots of movements and skills are involved in playing the game, and a high level of physical demand is required for match play (Hoff, 2005; Reilly, 2005). As the players have to cover a big area in the ground during attack and defense therefore, the game demands for high aerobic fitness (Reilly, 2005; Popadic Gacesa et al., 2009). 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 of soccer players, which indicating a high need of both the aerobic and anaerobic energy delivery pathways (Reilly, 2005; Popadic Gacesa et al., 2009; Miller et al., 2007). Moreover, power and strength has great impact over the game, which is required during sprinting and in execution of various skills with the ball (Hoff, 2005; Reilly, 2005).

Oxygen is transported to muscle primarily by haemoglobin (Nielsen and Weber, 2007). 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. As soccer performance depend much on the aerobic component of the athlete, therefore the players need to maintain normal haemoglobin level to optimise performance. The serum level of urea and uric acid are sometimes used for assessment of training related stress (Urhausen and Kindermann, 2002). During the soccer 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

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membranes or in the synthesis of steroid hormones (Kelley and Kelley, 2009; Altena et al., 2006). Elevated plasma cholesterol concentrations have been implicated in the development of coronary artery disease (CAD) (Kelley and Kelley, 2009; Altena et al., 2006). Regular monitoring of this health related variables of soccer players can provide valuable information about their health, metabolic and cardiovascular status.

This study has been focused on the soccer players as the game is most popular and played through out the world. The morphological, physiological and biochemical variables have important role for the evaluation of training and to assess the health, metabolic and cardiovascular status of the players. Studies on this aspect are lacking in India particularly in under 23 years soccer players. In view of the above, the present study has been designed.

2. Methods

2.1. Subjects and Training

A total of 30 Indian under 23 years male (U23, age: 19.00-22.99 yr, mean age: 20.9 ± 1.0 yr) regularly playing competitive soccer for last 8-11 years, volunteered for this study. The sportsmen were selected from a training camp at Sports Authority of India. Sportsmen under 23 year age group participated in different International competitions including World cup, World Championship, Olympic Games and Asian Games.

The players went through a training programme after taking the base line data (BD, zero level). The training sessions were divided into 2 phases: (i) Preparatory Phase (PP, 8 weeks), and (ii) Competitive Phase (CP, 4 weeks). The volume and intensities of the training components varies in each phase of training. In the preparatory phase, the volume and intensity of training increased gradually. In the competitive phase the training volume and intensity was changed according to the competition schedule.

Table 1: General training schedule for the Under 23 years soccer players

Athletes name					Training objectives											
	Performance			Test/Standards	Physical preparation			Technical preparation			Tactical preparation			Psychological preparation		
Competition type	Domestic										x	x	x	x		x
	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			
Periodization	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
		%														
	Volume	100	1	-		80-90%					70-90%		70 %		60-70%	
	Intensity	90	2	-		70-80%					80-90%		80 %		80-90%	
Training factors	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		-		10%					10%		35 %		35%	
	Psych prep	40	Peaking	-							10%		20 %		30-35%	
		30														
		20														
		10														

PC = Pre Competition, AA= Anatomical Adaptation.

At the same time highly specified training related to soccer 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. In the evening sessions 2 hours of technical and tactical training was given, including dribbling, tackle, set up movements, penalty corner, penalty shootout and match practice etc. 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.

The selected morphological, physiological and biochemical 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, PP and Competitive Phase, CP). 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 ± 1^{o}C, 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.

2.2. Measurement of Morphological Variables

Body mass was measured with the accurately calibrated electronic scale (Seca Alpha 770, UK) to the nearest 0.1 kg, and stature 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 also noted. 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 et al., 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 morphological, 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 morphological, 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 Morphological Characteristics of Under 23 years Soccer Players

A significant ($P<0.05$) reduction in percent body fat was noted in preparatory and competitive phase of training when compared to base line data of the soccer players. However, no significant difference was observed in stature, body mass and LBM of the players after the training programme (Table 2).

Table 2: Effect of Training on Morphological Characteristics of Under 23 years Soccer Players

Parameters	F value (df)	BD	PP	CP
Stature (cm)	0.22^{NS} (2, 89)	173.8 ± 4.5	173.8^{NS} ± 4.6	173.9^{NS} ± 4.7
Body Mass (kg)	2.65^{NS} (2, 89)	64.7 ± 5.0	63.1^{NS} ± 5.0	63.0^{NS} ± 5.2
Body Fat (%)	4.92* (2, 89)	13.9 ± 2.2	12.1* ± 2.2	12.1* ± 1.5
Lean Body Mass (kg)	2.69^{NS} (2, 89)	51.3 ± 4.3	52.5^{NS} ± 4.4	52.7^{NS} ± 4.4

ANOVA followed by multiple comparison (Post Hoc) tests was performed. Each value represents mean ± SD; N= 30; F.05 (2, 89) = 3.11; Computed using alpha = 0.05; * when compared to BD, df= degree of freedoms, NS= not significant, BD= Base Line Data, PP= Preparatory Phase, CP= Competitive Phase.

3.2. Effect of Training on Physiological Characteristics of Under 23 years Soccer Players

In the present study, a significant increase in VO_{2max} was observed among the soccer players when comparing base line data with that of the preparatory and competitive phases. Heart rate recorded during recovery after maximal exercise decreased significantly (P<0.05) in preparatory and competitive phases of training when compared to base line data of the players. However, no significant change was observed in maximal heart rate (HRmax) of the players following the training programme. On the other hand, when comparing base line data with that of the preparatory and competitive phases, significant (P<0.05) increase in anaerobic power, back strength and grip strengths were noted among the players (Table 3).

Table 3: Effect of Training on Physiological Characteristics of Under 23 years Soccer Players

Parameters	F value (df)	BD	PP	CP
VO_{2max} (ml kg^{-1} min^{-1})	3.15* (2, 89)	56.8 ± 3.5	58.4* ± 2.3	58.0* ± 2.5
HRmax (beats min^{-1})	0.93^{NS} (2, 89)	185.5 ± 3.4	184.4^{NS} ± 5.6	184.0^{NS} ± 5.5
RHR1 (beats min^{-1})	10.96* (2, 89)	154.9 ± 3.6	150.3* ± 4.4	150.6* ± 4.2
AP (W kg^{-1})	10.30* (2, 89)	13.4 ± 1.1	14.9* ± 0.9	15.0* ± 1.3
BST (kg)	23.98* (2, 89)	118.9 ± 3.1	122.5* ± 4.5	123.3* ± 4.9
GSTR (kg)	3.11* (2, 89)	36.2 ± 3.4	39.9* ± 3.5	37.8* ± 4.0
GSTL (kg)	4.13* (2, 89)	33.9 ± 3.6	35.5* ± 3.7	35.9* ± 3.9

ANOVA followed by multiple comparison (Post Hoc) tests was performed. Each value represents mean ± SD; N= 30; F.05 (2, 89) = 3.11; Computed using alpha = 0.05; * when compared to BD, df= degree of freedoms, NS= not significant, BD= Base Line Data, PP= Preparatory Phase, CP= Competitive Phase, VO_{2max} = maximal aerobic capacity, HRmax= maximal heart rate, HRR1= recovery heart rate 1st min, AP= anaerobic power BST= back strength, GSTR= grip strength right hand, GSTL= grip strength left hand.

3.3. Effect of Training on Biochemical Characteristics of Under 23 years Soccer Players

A significant reduction (P<0.05) in hemoglobin level was noted in the competitive phase when compared to base line data of the soccer players. However, when compared to base line data with that of the preparatory phase no significant change was noted in haemoglobin level of the soccer players. On the other hand, significant (P<0.05) increase in serum urea was noted in preparatory and competitive phases when compared to base line data of the players (Table 4). In addition, when comparing preparatory phase with that of the competitive phase significant (P<0.05) increase in serum urea level was noted among the players. Further, when comparing competitive phase with that of the base line data a significant (P<0.05) increase in serum uric acid level was noted among the players. However, no significant change in serum uric acid level was noted in preparatory phase when compared to base line data of the soccer players (Table 4). A significant reduction (P<0.05) in total cholesterol and triglyceride levels was noted in preparatory and competitive phases when compared to base line data of the players. However, when comparing base line data with that of the preparatory and competitive phases no significant change was noted in HDL-C and LDL-C levels of the players (Table 4).

Table 4: Effect of Training on Biochemical Characteristics of Under 23 years Soccer Players

Parameters	F value (df)	BD	PP	CP
Hemoglobin (g dl^{-1})	3.12* (2, 89)	14.4 ± 0.5	14.1 ^{NS} ± 0.8	14.0* ± 0.7
Urea (mg dl^{-1})	8.89* (2, 89)	28.1 ± 2.8	29.2* ± 2.3	32.1*$^{\#}$ ± 2.5
Uric acid (mg dl^{-1})	39.49* (2, 89)	4.2 ± 0.6	4.5 ^{NS} ± 0.6	4.8* ± 0.6
TC (mg dl^{-1})	4.03* (2, 89)	159.3 ± 5.8	155.4* ± 4.2	154.6* ± 5.3
TG (mg dl^{-1})	3.11* (2, 89)	87.9 ± 5.2	85.1* ± 5.7	84.7* ± 5.1
HDL-C (mg dl^{-1})	3.27* (2, 89)	40.3 ± 4.6	41.3 ^{NS} ± 4.0	41.6 ^{NS} ± 4.1
LDL-C (mg dl^{-1})	3.11* (2, 89)	100.4 ± 4.1	99.0 ^{NS} ± 5.4	98.2 ^{NS} ± 5.9

ANOVA followed by multiple comparison (Post Hoc) tests was performed. Each value represents mean ± SD. N= 30. F.05 (2, 89) = 3.11. Computed using alpha = 0.05; * when compared to BD, df= degree of freedoms, NS= not significant, BD= Base Line Data, PP= Preparatory Phase, CP= Competitive Phase, TC= total cholesterol, TG= triglyceride, HDL-C= high density lipoprotein cholesterol, LDL-C= low density lipoprotein cholesterol.

3.4. Correlation results

In the present study percentage of body fat showed significant negative correlations with VO_{2max} (r= -0.57, p<0.01) and anaerobic power (r= -0.32, p<0.01) of the soccer players. The anaerobic power showed significant positive correlations with VO_{2max} (r= 0.52, p<0.01) and back strength (r= 0.49, p<0.01) of the soccer players. In addition, back strength showed significant positive correlations with VO_{2max} (r= 0.60, p<0.01) and anaerobic power (r= 0.49, p<0.01), and a negative correlation with percentage of body fat (r= -0.12) among the soccer players of the present study. The oxidative potentiality of an athlete is dependent on his haemoglobin level. In the present study, a significant (p<0.000) positive correlation in the players was observed between haemoglobin and VO_{2max} (r= 0.40). On the other hand, HDL-C showed a significant positive correlation with VO_{2max} (r= 0.3, p<0.001), anaerobic power (r= 0.24, p<0.01), and strength (r= 0.3, p<0.01) of the players.

4. Discussion

Body size (stature and body mass) has significant impact on soccer teams (Hoff, 2005; Johnson et al., 2009; Silvestre et al., 2006). The tall players are recruited in the goal keepers, defenders and forward positions; however a standard height should be maintained for midfield players. Body mass is a considerable factor in soccer since body contact is essential in this game (Hoff, 2005; Johnson et al., 2009; Tahara et al., 2006). In this study no significant difference has been observed in stature and body mass of the soccer players after the training programme. It may 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 and Costill, 2005).

The percentage of body fat plays an important role for the assessment of physical fitness of the soccer players (Hoff, 2005; Silvestre et al., 2006; Tahara et al., 2006; Ostojic, 2003). A lean body is desirable for sports like soccer (Hoff, 2005; Silvestre et al., 2006; Tahara et al., 2006; Ostojic, 2003). A low-body fat may improve athletic performance by improving the strength-to-weight ratio (Reilly, 2005; Mc Ardle et al., 2006; Wilmore and Costill, 2005). Excess body fat adds to the load without contributing to the body's force-producing capacity (Reilly, 2005; Mc Ardle et al., 2006; Wilmore and Costill, 2005). A reduction (P<0.05) in percent body fat has been noted among the players after the training. The possible reason of reduction of body fat is exercise training which increases greater utilization of fat for energetic (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Similar findings were also noted by other research groups who studied on soccer players and reported that percent body fat decreased significantly during preparatory and competitive phase of training when compared to baseline data (Reilly, 2005; Kutlu et al., 2007). In addition, percentage of body fat showed significant negative correlations with VO_{2max} (r= -0.57, p<0.01) and anaerobic power (r= -0.32, p<0.01) of the soccer players. Therefore, it can be stated that increased body fat can reduce the players' aerobic and anaerobic fitness. Soccer players can accumulate body fat in the off seasons when there is no training and lose body fat more during the preparatory phase and the competitive phase of training (Mc Ardle et al., 2006; Wilmore and Costill, 2005). This might be due to intensive training during the preparatory phase and a high level of performance during the competitive phase (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Before and after the season, during the interval most soccer players have their fat content increased, presumably owing to reduced aerobic activity along with nutritional and behavioural changes (Mc Ardle et al., 2006; Wilmore and Costill, 2005). It is advised to perform low intensity aerobic endurance exercise during the off seasons in order to reduce the excess accumulation of body fat during the off seasons. However, no significant change has been noted in LBM among the players after the training. It may be due to the shorter duration of the training. It has been reported that short term exercise training has no significant effect on LBM of the sports persons (Mc Ardle et al., 2006; Wilmore and Costill, 2005).

The maximal oxygen uptake (VO_{2max}) is the best overall measure of aerobic power (Reilly, 2005; Popadic Gacesa, et al., 2009). Aerobic capacity certainly plays an important role in soccer and has a major influence on technical performance and tactical choices (Reilly, 2005; Mc Ardle et al., 2006; Wilmore and Costill, 2005). An increase ($P<0.05$) in relative VO_{2max} value has been noted among the players in the preparatory phase and competitive phases when compared with that of the baseline data. The increase in VO_{2max} after training may be due to an increase in the systemic a-v O2 difference and stroke volume (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Moreover, these changes may be because of the increase volume of endurance training in preparatory phase (Mc Ardle et al., 2006; Wilmore and Costill, 2005). The aerobic endurance training enhances the activity of the cardiovascular system as well as developed oxidative capacity of the skeletal muscles, and thus oxygen delivery to the working muscle is increased (Mc Ardle et al., 2006; Wilmore and Costill, 2005). This is accepted as the main reason for elevation of VO_{2max} after a training programme (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Similar observation has been noted by other research groups (Hoff, 2005; Reilly, 2005; Miller et al., 2007). The extent by which VO_{2max} can change with training also depends on the starting point (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Other than the tactical and technical aspect of the game monitoring of VO_{2max} is essential during the training phases, which help the coaches for selection of players for competition.

Heart rate increases with an increase in work intensity and shows linear relationship with work rate (Astrand and 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 soccer which involves intermittent efforts interspersed with short rests (Mc Ardle et al., 2006; Wilmore and Costill, 2005, Rampinini et al., 2007). The heart rate recovery curve is an excellent tool for tracking a person’s progress during a training program (Mc Ardle et al., 2006; Wilmore and Costill, 2005). A significant decrease ($P<0.05$) in recovery heart rate has been noted among the players after training. 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 and Costill, 2005). Nevertheless, parasympathetic activation is considered to be the main mechanism underlying exponential cardio deceleration after exercise (Mc Ardle et al., 2006; Wilmore and Costill, 2005). On the other hand, no significant change has been noted in HRmax of the players after the training. This may be due to shorter duration of the training. It has been seen that short term exercise has no significant effect on HRmax (Mc Ardle et al., 2006; Wilmore and Costill, 2005). The results of the present study suggest that the strain on the circulatory system during playing soccer is relatively high. Exercising at this intensity should provide a good training stimulus, provided such participation is frequent enough. Therefore, heart rate monitoring is essential during the training seasons, which also provide a data base to the coaches for selection of players.

The game of soccer demands high anaerobic power as accelerate and decelerate quickly is the part of the game (Hoff, 2005; Reilly, 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 (Hoff, 2005; Reilly, 2005). A high anaerobic power is essential for such activities (Hoff, 2005; Reilly, 2005). Thus a high anaerobic power helps to develop sprint quality of the players (Hoff, 2005; Reilly, 2005). Anaerobic power represents the highest rate of anaerobic energy released (Mc Ardle et al., 2006; Wilmore and Costill, 2005). On the other hand, strength is the central component of a soccer training program (Hoff, 2005; Reilly, 2005). Strength of the back muscles plays a key role of fitness among the soccer players, as kicking, passing, changing pace etc. are part of the game (Hoff, 2005; Reilly, 2005). Therefore, the game demands high level of back strength. Further, strength of grip muscle also has significant impact on the performance of the soccer players, which is needed for throw-in, catching or fisting the ball (goal keeping) (Hoff, 2005; Reilly, 2005). A significant increase ($P<0.05$) in anaerobic power, strength of back and hand grip muscles have been noted after the training among the soccer players. This may be due to training, particularly resistance and strength training increases the gain in anaerobic power and strength of the athletes. Similar observation has been observed by many researchers (Hoff, 2005; Reilly, 2005; Ebben and Blackard, 2001). They studied on soccer players and reported that the strength and power increased after training (Hoff, 2005; Reilly, 2005). The anaerobic power showed significant positive correlations with VO_{2max} (r= 0.52, p<0.01) and back strength (r= 0.49, p<0.01), and a negative correlation with percentage of body fat (r= -0.32, p<0.01) of the soccer players. In addition, back strength showed significant positive correlations with VO_{2max} (r= 0.60, p<0.01) and anaerobic power (r= 0.49, p<0.01), and a negative correlation with percentage of body fat (r= -0.12) among the football players of the present study. Therefore, it is suggested that high aerobic and anaerobic fitness increases the strength parameters and reduces the body fat content of the players. Studies on soccer players reported that the strength and power increased after training (Hoff, 2005; Reilly, 2005). Monitoring power and strength at regular intervals is essential during the training seasons, which help in selection of players for competitions.

Oxidative potentiality of an athlete is dependent on his hemoglobin level (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Increase in VO_{2max} demands higher rate of supply of oxygen (Mc Ardle et al., 2006; Wilmore and Costill, 2005). Oxygen is transported to muscle primarily by hemoglobin, and it is suggested that hemoglobin mass and/or concentration is related to VO_{2max} (Kargotich et al., 2007). During the zero level the training load was zero. When the training load and performance level was increased a reduction (P<0.05) in haemoglobin level has been observed in the competitive phase compared to baseline data. Similar observations have been noted by many researchers in their recent studies (Kargotich et al., 2007). The decline in hemoglobin level may be due to haemolysis (Boning et al., 2007). 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). The oxidative potentiality of an athlete is dependent on his haemoglobin level. In the present study, a significant (p<0.000) positive correlation was observed between haemoglobin and VO_{2max} (r=0.40) in the players. As the haemoglobin level has a relation with VO_{2max}, an optimum level of haemoglobin is required for better performance.

The present study showed that the level of serum urea and uric acid increased (P<0.05) after training among the players. The higher urea and uric acid level has been noted in the competitive phase when the performance level is highest. It may be suggested that increased level of urea and uric acid may be due to increased intensity of training (Urhausen and Kindermann, 2002). Determination of serum urea and uric acid is used as indicators of over training (Urhausen and Kindermann, 2002). A recent study suggested that serum uric acid scavenges OH_2 radicals 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). Regular monitoring of serum urea and uric acid levels can 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. Therefore, these parameters may be used to assess the training load imposed on the players.

Lipids and lipoprotein profile indicate the cardiovascular and the metabolic status of the athlete (Kelley and Kelley, 2009; Altena et al., 2006). Activity levels have significant impact on the lipids and lipoprotein levels of the athletes (Kelley and Kelley, 2009; Altena et al., 2006). In the present study the level of total cholesterol and triglyceride level decreased (P<0.05) in the preparatory and competitive phases when compared to base line data. It indicates that as the training load and performance level increases, the level of total cholesterol and triglyceride level decrease gradually. The possible reason for the reduction in total cholesterol and triglyceride level is exercise training (Kelley and Kelley, 2009; Altena et al., 2006; Wilmore and Costill, 2005). However, no significant change has been noted in HDL-C and LDL-C level after the exercise. This may be due to the short duration of the training or improper optimization of the training load. Our findings are supported by observations of other researchers in their recent studies (Kelley and Kelley, 2009; Altena et al., 2006). Cross-sectional studies also reported an increase in HDL-C level and decrease in triglyceride level after exercise (Kelley and Kelley, 2009). 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). HDL-C showed a significant positive correlation with VO_{2max} (r= 0.3, p<0.001), anaerobic power (r= 0.24, p<0.01), and strength (r= 0.3, p<0.01) of the players of the present study. This indicates that an increase in aerobic and anaerobic fitness increases the HDL-C level of the players. Therefore, regular monitoring of lipids and lipoproteins profiles of the soccer players is essential to optimize their health status which has direct effect on performance of the players.

5. Conclusions

Training effects were reflected on various parameters like body fat, aerobic capacity, anaerobic power, strength, haemoglobin, urea, uric acid, and lipid profile of the soccer players. These profiles should be taken into consideration while administering training to the players. As the studies on soccer 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 soccer players particularly of under 23 age group. 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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