Original Article

Effect of training on anthropometric, physiological and biochemical variables of U-19 volleyball players

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ABSTRACT

Manna I, Lal-Khanna GL, Chandra-Dhara PC. Effect of training on anthropometric, physiological and biochemical variables of U-19 volleyball players. *J. Hum. Sport Exerc.* Vol. 7, No. 1, pp. 263-274, 2012. The effect of training on anthropometric, physiological and biochemical variables of U-19 volleyball players was aimed in the present study. A total of 30 Indian under 19 years (U-19) male volleyball players (age: 17.7 ± 0.5 yr; height: 185.1 ± 4.9 cm; body mass: 67.2 ± 4.0 kg) regularly playing competitive volleyball volunteered for this study. The training sessions were divided into 2 phases (i) Preparatory Phase (PP, 8 wk) and (ii) Competitive Phase (CP, 4 wk). The training programme consist of aerobic, anaerobic and skill development, and were completed 4 hr/d; 5 d/wk. Selected variables were measured at zero level (baseline data, BD) and at the end of preparatory and competitive phases of training. A significant increase ($P<0.05$) in anaerobic power, back and grip strength, serum urea and high density lipoprotein-cholesterol (HDL-C) was observed after training. On the other hand, a significant decrease ($P<0.05$) in body fat, 1st min recovery heart rate, hemoglobin, triglyceride and low density lipoprotein-cholesterol (LDL-C) was noted after the conclusion of training. However, no significant change was reported in lean body mass (LBM), maximal heart rate (HR_{max}), maximal aerobic capacity (VO_{2max}), uric acid and total cholesterol level of the players following the training. The training programme is effective for improving selected anthropometric, physiological and biochemical parameters for volleyball. **Key words**: BODY FAT, HEART RATE, VO2MAX, ANAEROBIC POWER, STRENGTH, LIPID PROFILE.

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INTRODUCTION

Volleyball is very popular game world wide. There is a need of high level of physical and physiological fitness to participate at the elite level (Marques et al., 2009). Training can improve the performance of the players (Bompa, 1997). 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 anthropometric, physiological and biochemical variables can be attributed to appropriate load dynamics. Physique and body composition have an important role for playing volleyball (Lidor & Ziv, 2010; Sheppard et al., 2009). The elite volleyball players do not possess VO_{2max} values as high as typical endurance trained athletes, but an optimum level of aerobic capacity is required for playing volleyball since the game may continue for longer time (Lidor & Ziv, 2010; Sheppard et al., 2009). Performance of the volleyball players during longer match play depends on the aerobic component; so the players need to maintain an optimum level of haemoglobin to optimise performance (Ostojic & Ahmetovic, 2008). Heart rate response during exercise and recovery can be very useful parameters in monitoring training (Sheppard et al., 2009). Volleyball involves repeated jumping, blocking, spiking, power hitting, and setting which require a high level of strength and power (Lidor & Ziv, 2010; Popadic Gacesa et al., 2009). Moreover, the serum level of urea and uric acid may be used as indicates of over training (Urhausen & Kindermann, 2002). In addition, regular monitoring of lipid profile of volleyball players can provide valuable information about their health, metabolic and cardiovascular status (Kelley & Kelley, 2009; Popichev et al., 1997).

This study was focused on the volleyball players as the game is popular and played through out the world. Studies observing the effect of training on anthropometric, physiological and biochemical variables of professional volleyball players are lacking in India. In view of the above, a study was undertaken to investigate the effect training on anthropometric, physiological and biochemical variables of U-19 volleyball players.

MATERIAL AND METHODS

Subjects and Training

A total of 30 Indian male volleyball players (age: 17.7 ± 0.5 yr; height: 185.1 ± 4.9 cm; body mass: 67.2 ± 4.0 kg) regularly playing competitive volleyball (playing for last 4-7 years) volunteered for this study. The sportsmen represented India in different International competitions including Junior World Championship, Sate Level Competitions. The players under went a training programme comprises of two phases (i) Preparatory Phase (PP) for 8 weeks, and (ii) Competitive Phase (CP) for 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. 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 volleyball, match practice and competition 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, the players spent 2 hours in the evening sessions for technical and tactical training, which include jumping, blocking, spiking, power hitting, setting 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. The training programme, tests and measurements were conducted according to the standard procedures, having established reliability and validity, adopted by various researchers. Thus the training programme, tests and measurements used were valid. The selected anthropometric, physiological and biochemical variables were measured in the laboratory at the beginning of the training (baseline data, BD) and at the end of Preparatory 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 (SAI), New Delhi and was approved by the Ethical Committee of the Institute.

Table 1. *General training schedule for the U-19 volleyball players.*

					Training objectives											
Athletes name	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			
	Skill Acquisition			-		Foundation			Advanced				Stimulation			
Periodization	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		-		10%					10%		35%		35%	
	Psych prep	40		-							10%		20%		30-35%	
		30	Peaking													
		20														
		10														

PC = Pre Competition, AA= Anatomical Adaptation.

Measurement of Anthropometric Variables

Body mass was measured with an accurately calibrated electronic scale (Seca Alpha 770, UK) to the nearest 0.1 kg, and the stature with a stadiometer (Seca 220, UK) recorded to the nearest 0.5 cm (Jonson & Nelson, 1996). Body density (BD) was estimated from the sum of the skin-folds based on the standard procedure (Durnin & Womersley, 1974). The skin fold measurement was taken from four different sides of the body (biceps, triceps, sub-scapular and suprailiac) using the skin fold calliper on the right side of the body. The 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 (Siri, 1956).

BD = 1.1620-0.0630 log (biceps + triceps + subscapular + suprailliac)
Body fat (%) = (495 / Body density) – 450
Fat mass (kg) = [Body mass (kg) × Body fat (%)] / 100
LBM (kg) = Body mass – Fat mass

Measurement of Physiological Variables

Determination of maximum oxygen consumption (VO_{2max}) and heart rate

The direct assessment of maximal aerobic capacity (VO_{2max}) was achieved using a metabolic analyzer (Oxycon Champion, Jaeger, Germany) and a treadmill (Jaeger LE 500; Jaeger, Germany). The treadmill was attached to a computerized metabolic analyzer. Subjects were fitted with a face mask which was connected to an automated gas analyzer. This analyzer sampled the expired air containing oxygen and carbon dioxide, and through a series of calculations, oxygen consumption was determined (Astrand & Rodhal, 1986). The subject was instructed to avoid heavy food intake and exercise at least 2 hrs before the treadmill test. The detailed procedure of the test was explained to the subjects and the demonstration of the test was shown to them. Subjects were given a trial run on a treadmill at 0% gradient and at 4km · h-1, 5km · h-1, 6km · h-1, and 8km · h-1 for 2 minutes at each speed, with the face mask attached to the mouth-piece. Then the subject was asked to stand on the treadmill with the face mask attached to the mouth-piece, while the treadmill was stationary. Expired gases were sampled breath-by-breath and measured from a mixing chamber using a computerized metabolic analyzer. The heart rate, oxygen consumption, carbon dioxide production, pulmonary ventilation and respiratory quotient (RQ) were recorded while the subject was standing on the treadmill. The initial speed and the inclination of the treadmill were 8km · h-1 and 2% respectively. The speed was increased by 2km · h-1 every 2 minutes, until volitional exhaustion (RQ>1.0). Oxygen consumption, heart rate, respiratory quotient (RQ) was monitored every 30 seconds. When the subject's heart rate leveled off, prior to the final exercise intensity at the value of at least 95% of the predicted maximum heart rate and his respiratory exchange ratio was greater than 1.0, the observed VO_2 was considered as VO_{2max}. During recovery the treadmill speed was gradually slowed down and stopped, and all the above physiological variables were monitored.

Measurement of Anaerobic Power

The Wingate Anaerobic Test (WANT) was performed using a cycle ergometer (Jaeger LE 900; Jaeger, Germany) following a standard methodology (Inbar et al., 1996). The subjdect was instructed to avoid heavy food intake and exercise at least 2 hrs before the test. The detailed procedure of the test was explained to the subjects and the demonstration of the test was shown to them. The subject was asked to follow the instructions of the investigator during the experiment. The subject was given a trial on cycle ergometer. The test requires the subject to pedal a mechanically braked bicycle ergometer for 30 seconds at an "all out" pace. The individual is advised to complete a warm-up for 3-5 minutes followed by a recovery cool down for 1-2 minutes. On commencing the test, the individual pedalled "all out" with no resistance, then within 3 seconds, the predetermined fixed resistance of 0.075 kg per kg body mass was applied to the flywheel and the athlete continued to pedal "all out" for 30 seconds while the load remained through out the test. A computerized counter was used to record revolutions of the flywheel in 5-second intervals, although the actual test was performed for 30 seconds. Anaerobic power was measured using the software supplied by Jaeger, Germany.

Measurement of Back and grip Strength

The back and grip dynamometers (Senoh, Japan) were used to record the strength of the back and grip muscles following a standard method (Jonson & Nelson, 1996). For measurements of back strength, one hand of the subject gripped over and the other under the bar. The hands were spread to the width of shoulders. The trunk was flexed only slightly forward (10°-15°) at the hip joints. The body weight was balanced on the feet, which were placed about 15 cm apart. The knees were kept straight throughout the lift. The lift was performed steadily upwards, without jerking. The subjects were not allowed to lean backwards on the heels. It was ensured that the back was almost straight at the end of the lift. For measurement of grip strength the dryness of the hand and the instrument were ensured. The tester set the pointer to zero and placed the dynamometer in the subject's hand, with the dial against the palm and the larger (concave) pressing edge in the "heel" of the palm. The posture and positioning of the subjects tested were according to the standard method (Jonson & Nelson, 1996). The data was obtained with the elbow at 90° flexion, shoulder at 0° flexion and wrist between 0° and 15° of ulnar and radial deviation. The subject squeezed sharply and steadily as much as possible, making certain that no part of the arm touched the body. For both back and grip strength test three trials were allowed with an interval of two minutes. The test was repeated in case any other deviation from proper procedure was noted. The highest reading of the three trials was recorded in kilograms.

Measurement of Biochemical Variables

A 5 ml of venous blood was drawn from an antecubital vein after a 12 hrs fast and 24 hrs after the last bout of exercise for subsequent determination of hemoglobin (Hb), serum urea, serum uric acid, total cholesterol (TC), triglycerol (TG), high density lipoprotein-cholesterol (HDL-C) and low density lipoprotein-cholesterol (LDL-C). Haemoglobin was measured using Cyanmethaemoglobin method (Mukharjee, 1997). Serum urea (Wybenga et al., 1971) and uric acid (Martinek, 1970) were determined calorimetrically using standard procedure. Serum triglycerol (Schettler & Nussei, 1975), serum total cholesterol (Wybenga, et al., 1970) and HDL-C (Wybenga, et al., 1970) were determined by enzymatic method. LDL-C was indirectly assessed following standard equation (Friedewald et al., 1972).

Statistical analysis

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

RESULTS

Effect of training on body fat and LBM of Indian U-19 volleyball players

A significant (P<0.05) reduction in percent body fat was noted among the volleyball players when comparing base line data with that of the preparatory and competitive phases. However, when comparing body fat of preparatory phase with that of the competitive phase no significant change was noted among the players. Further, no significant difference was observed in body mass and LBM of the volleyball players after the training programme (Table 2).

Table 2. *Effect of Training on Body Fat and Lean Body Mass of Indian U-19 Volleyball Players.*

Parameters	BD	PP	CP
Body Mass (kg)	67.2 ± 4.0	66.9^{NS} ± 4.9	66.7^{NS} ± 4.9
Body Fat (%)	13.8 ± 1.6	12.4* ± 1.5	11.8* ± 1.2
LBM (kg)	57.6 ± 4.2	58.4^{NS} ± 3.6	58.4^{NS} ± 4.7

*Note. Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to BD, BD= base line data, PP= preparatory phase, CP= competitive phase, NS= not significant; LBM= lean body mass.*

Effect of training on physiological variables of Indian U-19 volleyball players

A significant ($P<0.05$) increase in anaerobic power was noted among the volleyball players when comparing the base line data with that of the preparatory and competitive phases. When comparing anaerobic power of preparatory phase with that of the competitive phase no significant change was noted among the players. In addition, significant increase ($P<0.05$) in back strength and grip strength of right hand (GSR) was noted among the volleyball players when comparing the base line data with that of the preparatory and competitive phases. However, significant increase ($P<0.05$) in grip strength of left hand (GSL) was noted among the volleyball players when comparing the base line data with that of the competitive phases. But no significant change was noted when comparing back strength and grip strength of preparatory phase with that of the competitive phase of players. On the other hand, a significant ($P<0.05$) reduction in 1st min recovery heart rate was noted among the volleyball players when comparing the base line data with that of the preparatory and competitive phases. When comparing 1st min recovery heart rate of preparatory phase with that of the competitive phase no significant change was noted among the players. Further, no significant change in maximal aerobic capacity (VO_{2max}) and maximal heart rate (HR_{max}) was observed among the volleyball players following the training programme (Table 3).

Table 3. *Effect of training on physiological variables of Indian U-19 volleyball players.*

Parameters	BD	PP	CP
AP (W kg^{-1})	9.9 ± 0.9	11.4* ± 1.1	11.5* ± 1.2
BST (kg)	122.7 ±2.1	124.2* ± 2.5	124.4* ± 2.3
GSR (kg)	34.4 ± 2.2	35.2* ± 2.1	35.9*± 2.2
GSL (kg)	33.5 ± 2.1	34.5^{NS} ± 2.0	34.9* ± 2.2
VO_{2max} (ml·kg^{-1}·min^{-1})	53.9 ± 4.3	54.2^{NS} ± 3.7	54.2^{NS} ± 5.1
HR_{max} (beats·min^{-1})	192.4 ± 3.0	191.6^{NS} ± 3.5	191.0^{NS} ± 5.1
RHR1 (beats·min^{-1})	157.1 ± 1.5	155.6* ± 2.2	154.6* ± 2.5

*Note. Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to BD, BD= base line data, PP= preparatory phase, CP= competitive phase, NS= not significant; AP= anaerobic power, BST= back strength, GSR= grip strength of right hand, GSL= grip strength of left hand, VO_{2max}= maximal aerobic capacity, HR_{max}= maximal heart rate, RHR1= recovery heart rate in 1st min.*

Effect of training on biochemical variables of Indian U-19 volleyball players

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

Table 4. *Effect of training on biochemical variables of Indian U-19 volleyball players*.

Parameters	BD	PP	CP
Hb (gm dl^{-1})	14.7 ± 0.5	14.2* ± 0.5	14.2* ± 0.3
Urea (mg dl^{-1})	30.8 ± 1.1	32.8* ± 2.0	33.6* ± 2.2
Uric Acid (mg dl^{-1})	3.7 ± 0.3	3.7^{NS} ± 0.4	3.8^{NS} ± 0.4
TC (mg dl^{-1})	154.4 ± 4.6	152.9^{NS} ± 4.5	152.1^{NS} ± 4.8
TG (mg dl^{-1})	98.7 ± 4.2	97.4^{NS} ± 4.2	96.1* ± 4.7
HDL-C (mg dl^{-1})	39.4 ± 3.2	41.7* ± 4.7	42.0* ± 4.1
LDL-C (mg dl^{-1})	93.2 ± 4.4	91.4^{NS} ± 4.1	90.4* ± 4.8

*Note. Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to BD, BD= base line data, PP= preparatory phase, CP= competitive phase, NS= not significant; Hb= hemoglobin, TC= total cholesterol, TG= triglyceride, HDL-C= high density lipoprotein cholesterol, LDL-C= low density lipoprotein cholesterol.*

DISCUSSION

Elite volleyball players, in keeping with many other elite athletes, tend to be lean and muscular (Lidor & Ziv, 2010; Portal et al., 2010; Sheppard et al., 2009). In the present study, a significant ($P<0.05$) reduction in percent body fat was noted among the volleyball players when comparing base line data with that of the preparatory and competitive phases. The reduction in body fat might be due to the fact that the sportsmen underwent high intensity and volume of training over a period of time, which resulted in lowering of body fat percentage. The possible reason of reduction of body fat was endurance training which increased greater utilization of fat for energetic (Carbuhn et al., 2010; Malousaris et al., 2008). Therefore, it can be stated that volleyball players can lose body fat more during preparatory phase and competitive phase of training. This might be due to intensive training and competition schedule. Before and after the season, during the interval most players have their fat content increased, presumably owing to reduced aerobic activity along with nutritional and behavioral changes (Carbuhn et al., 2010; González-Ravé et al., 2011). Similar findings were reported by other researchers (Carbuhn et al., 2010; González-Ravé et al., 2011). On the other hand, no significant difference was observed in body mass and LBM of the volleyball players after the training programme. This might be due to improper optimization of the training load and/or short duration of the training. It has been reported that short duration of training has no significant effect of body mass and LBM (Reilly, 1990). Since volleyball players, even at the highest levels, tend to have depots of body fat higher than optimal, it seems rational to advise the volleyball players to keep their activity profile relatively high especially during the off-season with the aim to stay fit and to prevent increased body adiposity.

Maximal oxygen uptake (VO_{2max}) is regarded as the best determinant of aerobic capacity (Lidor & Ziv, 2010; Rankovic et al., 2010). An improvement in VO_{2max} improves running economy, increased both the distance covered in a game and the average exercise game intensity after the training. Thus, aerobic capacity certainly plays an important role in volleyball and has a major influence on technical performance and tactical choices. In the present study, no significant change was observed in VO_{2max} of the volleyball players following the training programme. This might be due to improper optimization of the training load and/or short duration of the training. Earlier studies showed that VO_{2max} improved after training particularly in the younger age group (Häkkinen, 1993; Lidor & Ziv, 2010; Okazaki et al., 2011; Reilly, 1990). It has been reported that during adolescence the male elite players showed a more promising development in VO_{2max} after a training program (Lidor & Ziv, 2010; Okazaki et al., 2011; Reilly, 1990).

Hemoglobin concentration is related to VO_{2max} of the athletes (Ostojic & Ahmetovic, 2008; Radjen et al., 2011). In the present study, a significant reduction ($P<0.05$) in hemoglobin level was noted in preparatory and competitive phases when compared to base line data of the volleyball players. This might be due to the effect of training. The training load was gradually increased from base line to the preparatory phase therefore, reduction in hemoglobin level was observed in this phase. Further, during the competitive phase, training load along with the stress of competition was responsible for the declined in hemoglobin level. It can be suggested that the decline in hemoglobin level might be due to haemolysis (Fujitsuka et al., 2005). In addition, exercise training induced reduction in hemoglobin concentration also might 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 (Neumayr et al., 2005). Similar observations were reported by many researchers. Studies on professional athletes showed that hemoglobin values were higher at the beginning of the competition season, and then declined in well-trained athletes (Ostojic & Ahmetovic, 2008; Radjen et al., 2011).

The influence of endurance training on heart rate monitoring is one of the most commonly-used and easily understood standards for measuring the intensity and effort of physical exercise. In this study, a significant ($P<0.05$) reduction in 1st min recovery heart rate was noted among the volleyball players when comparing the base line data with that of the preparatory and competitive phases. This might be due to the effect of training. The changes in volume and intensity of various training modules have shown significant improvement in recovery heart rate of the players. During preparatory phase the volume of training was high, and an increase in aerobic training stimulus might be the reason behind the reduction of recovery heart rate after training. Quick recovery from strenuous exercise is important in volleyball which involves intermittent efforts interspersed with short rests. It can be stated that highly trained players are able to sustain, and more quickly recover from high intensity intermittent exercise. However, no significant change was observed in maximal heart rate (HR_{max}) of the volleyball players following the training programme. It might be due to short duration of the training programme or improper optimization of the training. It was reported that short term exercise has no significant effect on maximal heart rate (Reilly, 1990). The maximal heart rates of volleyball players are close to the rates expected for non-athletic populations of similar age and race (Kneffel, 2008; Reilly, 1990). The results of the present study suggest that the strain on the circulatory system during play is relatively high. Exercising at this intensity should provide a good training stimulus, provided such participation is frequent enough.

Anaerobic power and strength are the central component of a volleyball training program (Marques et al., 2008, 2009; Sheppard et al., 2009). As vertical jumping and rapid movements are part of the game, therefore, high anaerobic power and strength are essential for match play (Kasbalis et al., 2005; Marques et al., 2008; Popadic Gacesa et al., 2009). A significant ($P<0.05$) increase in anaerobic power, back strength and grip strength of right hand (GSR) were noted among the volleyball players when comparing the base line data with that of the preparatory and competitive phases. In addition, significant increase ($P<0.05$) in grip strength of left hand (GSL) was noted among the volleyball players when comparing the base line data with that of the competitive phases. This might be due to the effect of training. The changes in volume and intensity of training modules have shown significant improvement in anaerobic power and strength of the players. During preparatory phase the volume of training was high, and an increase in strength and power training stimulus might be the reason behind the improvement in anaerobic power and strength after training. Similar findings were noted by many researchers (Kasabalis et al., 2005; Häkkinen, 1993; Marques et al., 2008; Newton et al., 2006). It has been seen that the application of the training programs using strength and power exercises would be particularly effective in improving performance (Burnham et al., 2010; Gabbett, 2008).

The serum urea and uric acid level has been considered as an indicator of overtraining and protein catabolism (Kargotich et al., 2007; Urhausen & Kindermann, 2002). In this study, significant increase (P<0.05) in serum urea level was noted in preparatory and competitive phases when compared to base line data of the volleyball players. The highest level of urea was noted in the competitive phase when the training load and stress of competition was highest. The possible reason for the increased urea level might be due to increase in training stimulus and increase breakdown of proteins. It is believed that a pronounced increase in the urea concentration indicates strong influence of a training session, whereas normalization of the urea level in blood is an index of time to perform subsequent strenuous training sessions (Urhausen & Kindermann, 2002). Similar observations have been reported by many researchers (Kargotich et al., 2007; Neumayr et al., 2005). However, no significant change was noted in serum uric acid levels of the players after the training. This might be due to improper optimization of the training load.

Lipids and lipoprotein profile indicate the cardiovascular and the metabolic status of the athlete (Kelley & Kelley, 2009; Popichev et al., 1997). In the present study, a significant increase (P<0.05) in HDL-C level was noted in preparatory and competitive phases when compared to base line data of the volleyball players. On the other hand, significant reduction (P<0.05) in triglyceride and LDL-C levels were noted in the competitive phase when compared to base line data of the volleyball players. As the training load and stress of competition increased from pre-training period to preparatory phase and competitive phase, the level of triglyceride and LDL-C were decreased where as the level of HDL-C increased gradually. These changes might be due to training. The possible reason for the reduction in triglyceride and LDL-C; and elevation in HDL-C was that exercise especially, endurance exercise which increased metabolism and utilization of blood lipids and lipoprotein for energy production (Altena et al., 2006; Kelley & Kelley, 2009; Popichev et al., 1997). However, no significant change was noted in total cholesterol level of the players after the training programme. This might be due to improper optimization of the training load. 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 & 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).

CONCLUSIONS

These changes are due to training as well as due to participating in an increasing number of competitions. A specific volleyball training programme with the structure and loads described in this study is effective of improving body composition, aerobic capacity and anaerobic power, heart rate recovery and strength parameters. The training induced changes in anthropometric and physiological variables have indirect effect on biochemical variables such as hemoglobin, serum urea and uric acid, lipids and lipoproteins profiles of the volleyball players. Regular monitoring of the biochemical variables of the volleyball players is essential to optimize their general health, metabolic and cardiovascular status which has direct relation with their performance. The unique profile should be taken into consideration while administering training to the volleyball players. It was recommended that a careful selection of anthropometric, physiological and biochemical variable should be made when assessing the abilities of adolescent volleyball players.

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