ORIGINAL ARTICLE *Al Ameen J Med Sci (2010)3(2):128-139*
ISSN 0974-1143

Variation in Age and Training on Selected Biochemical Variables of Indian Hockey Players

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Abstract

The present study was aimed to find out the variation of age and training on biochemical variables of Indian elite hockey players. A total of 120 hockey players who volunteered for the present study, were equally divided (n=30) into 4 groups: under 16 years (14-15 yrs); under 19 years (16-18 yrs); under 23 years (19-22 yrs); and senior (23-30 yrs). The training sessions were divided into 3 phases: Transition Phase (TP), Preparatory Phase (PP), and Competitive Phase (CP). The training programme consisted of aerobic, anaerobic and skill training; and completed 4 hours in morning and evening sessions, 5 days/week. Selected biochemical parameters were measured and data were analyzed by applying Two-way ANOVA and Post hoc test. The mean values of haemoglobin (Hb), total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) have been increased significantly ($P<0.05$) with the advancement of age of players. A significant increase ($P<0.05$) in serum urea, uric acid and HDL-C and a significant decrease ($P<0.05$) in Hb, TC, TG and LDL-C have been noted in PP and CP when compared to that of TP. The present study would provide useful information for biochemical monitoring of training of hockey players.

Key words: haemoglobin, urea, uric acid, lipid profile, training

Introduction

Field hockey is a sport with a long history that has undergone quite rapid and radical change within the past decade. To achieve the best possible performance the training has to be formulated according to the principles of periodization [1]. The training induced changes observed in various biochemical variables can be attributed to incremental training load. 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 [1]. Biochemical parameters like haemoglobin, urea, uric acid and lipid profiles are of advantage in regulating the training load [2-4]. Haemoglobin represents the iron status of the body [2, 5]. Oxygen is transported to muscle primarily by haemoglobin (Hb). Therefore, the athlete needs to maintain normal haemoglobin level to optimise performance. The serum level of urea and uric acid indicates the training load imposed on the athletes. In addition, the urea and uric acid accumulation is most frequently used as a measure of protein catabolism and degradation of adenonucleotides [3, 6-7]. 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 [4, 8]. Elevated plasma cholesterol concentrations have been implicated in the development of coronary artery disease (CAD) [4, 9]. The primary function of high density lipoprotein cholesterol (HDL-C) is to serve as the cholesterol acceptor in the reverse transport and excretion of cholesterol [10, 11]. On the other hand low density lipoprotein cholesterol (LDL-C) is directly associated with cholesterol [10-11]. It has been reported that LDL-C has the greatest correlation to severity of coronary atherosclerosis [10-11]. Therefore, monitoring of lipid profile in athletes can provide valuable information about their metabolic and cardiovascular status. The present study has been focused on the field hockey players as the game is played through out the world, but limited studies are available on the field hockey players. Although some of the studies concentrate on the physiological characteristics and the training aspect of the players at the international level [12-14], however limited studies have been reported on the biochemical parameters of Indian field hockey players particularly in relation to growth and development [15]. Therefore, the purpose of the present investigation was to conduct a study of biochemical variables among Indian male field hockey players with reference to age and training.

Materials and Methods

Subjects : One hundred and twenty (N=120) male field hockey players, regularly playing competitive field hockey, volunteered for the present study. They were selected from the National training camps at Sports Authority of India. The players were equally divided (n=30) into 4 groups: under 16 years (U16, age: 14.00-15.99 yr; 14.7 ± 0.5 yr); under 19 years (U19, age: 16.00-18.99 yr; 17.7 ± 0.5 yr); under 23 years (U23, age: 19.00-22.99 yr; 20.9 ± 1.0 yr) and senior (SR, age: 23.00-30.00 yr; 26.3±2.0 yr). The baseline physical and physiological parameters are given in table 1.

Table 1: Physical and physiological characteristics of hockey players

Parameters	Age group			
	U16	**U19**	**U23**	**SR**
Height (cm)	163.5 ± 2.4	170.3^{*} ± 3.4	$172.7^{*\#}$ ± 3.3	$173.3^{*\#}$ ± 3.2
Body mass (kg)	53.9 ± 3.9	60.7^{*} ± 3.7	$63.8^{*\#}$ ± 3.4	$64.9^{*\#}$ ± 4.4
Body fat (%)	18.7 ± 1.96	15.5^{*} ± 1.4	$13.9^{*\#}$ ± 1.2	$12.0^{*\#¥}$ ± 0.5
LBM (kg)	40.0 ± 4.4	46.2^{*} ± 4.1	$50.0^{*\#}$ ± 4.9	$52.1^{*\#}$ ± 3.6
VO_{2max} (ml $kg^{-1}min^{-1}$)	54.6 ± 2.8	57.0^{*} ± 3.9	$56.0^{\#}$ ± 3.7	$54.1^{\#}$ ± 4.0
MHR (bpm)	195.3 ± 2.7	190.5^{*} ± 2.5	$185.5^{*\#}$ ± 3.4	$183.1^{*\#}$ ± 4.6
AP (W kg^{-1})	8.2 ± 0.6	11.3^{*} ± 0.9	$13.8^{*\#}$ ± 0.9	$14.7^{*\#}$ ± 1.1
BST (kg)	106.4 ± 4.0	113.3^{*} ± 3.9	$123.6^{*\#}$ ± 3.5	$125.0^{*\#}$ ± 2.9
GSTR (kg)	28.0 ± 2.5	32.1^{*} ± 1.5	$35.2^{*\#}$ ± 1.9	$37.2^{*\#}$ ± 0.9
GSTL (kg)	26.5 ± 1.8	28.4^{*} ± 1.9	$32.4^{*\#}$ ± 1.7	$33.6^{*\#}$ ± 1.9

Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to U16, # when compared to U19, ¥ when compared to U23, U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; LBM= lean body mass., VO_{2max} = maximal aerobic capacity, MHR= maximal hear rate, AP= anaerobic power, BST= back strength, GSTR= grip strength of right hand, GSTL= grip strength of left hand.

Training: The training sessions were divided into 3 phases: [Transition Phase (TP), 4 weeks], [Preparatory Phase (PP), 8 weeks], and [Competitive Phase (CP), 4 weeks]. The players generally completed an average of 2 hours of training in morning sessions. The training involved continuous training, interval training, strength training, power training, speed training, flexibility training etc. In the evening sessions 2 hours of technical training, which included dribbling, tackle, set up movements, penalty and penalty corner shootout, free hit, match practice etc were followed 5 days/week. The details of the training schedule are given in table 2 and 3.

Table 2: General training schedule for all the hockey players

Training	Transition phase	Preparatory phase	Competitive phase
Continuous training	Low	High	Low
Interval training	Low	High	Maintenance
Strength training	Low	High	Low
Power training	Low	High	Maintenance
Speed training	Low	High	Maintenance
Flexibility training	Low	High	High
Skill training	Low	High	Maintenance

Table 3: Training schedule of the hockey players during the competitive phase

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Interval training	Team training, plyometrics and Sprint work	Weight session and flexibility	Team training, interval training	Rest	Match	Recovery run and flexibility

Testing: The selected physiological and biochemical variables were measured in the laboratory. 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 the consents were taken from them. The study was conducted at Sports Authority of India and was approved by the institute.

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 [16]. Serum urea [17] and uric acid [18] were determined calorimetrically. Serum triglycerides [19], serum total cholesterol (TC) [20] and high-density lipoprotein cholesterol (HDL-C) [20] were determined by enzymatic method. Low-density lipoprotein cholesterol (LDL-C) was indirectly assessed following standard equation [21].

Statistical Analysis: All the values of biochemical parameters were expressed as Mean and Standard Deviation. Two-way Analysis of Variance (ANOVA) followed by multiple comparison (Post Hoc) tests were performed, to find out the significant difference in selected biochemical parameters among the selected age categories (under 16 yrs, under 19 yrs, under 23 yrs and seniors); and within the different training phases (transition phase, preparatory phase and competitive phase). Pearson's correlation coefficient was performed to find out the relationship between the different parameters among the players of all age groups. In each case the significant level was chosen at 0.05 levels. Accordingly, a statistical software package (SPSS) was used.

Results

Age wise changes in different physiological variables: In the present study significant increase ($p<0.05$) in mean height and body mass has been observed among the hockey players with the advancement of age. On the other hand, a decrease ($p<0.05$) in body fat has been noted with the advancement of age among the players of the present study. However, LBM significantly increased ($p<0.05$) with the advancement of age of the players. In the present study VO_{2max} values of hockey players exhibit variation in different age categories, and it has been seen that during adolescence (under 19 yrs) aerobic capacity elevates ($P<0.05$) and then declines ($P<0.05$) further in the senior age group players. When VO_{2max} values has been expressed in absolute terms, it has been noted that VO_{2max} increases with growth and development of the players, as the age advances from junior to senior elite level. It has been found that the junior players possess similar mean relative VO_{2max} values as the senior players. Maximal heart rate and recovery heart rate have been reduced significantly ($P<0.05$) with the advancement of age of the players of the present study. It has also been seen that anaerobic power, and strength (back and grip) increased ($P<0.05$) with the advancement of age of the players of the present study (Table 1).

Variation of age and training on hemoglobin, urea and uric acid of the hockey players: A significant increase ($P<0.05$) in hemoglobin level has been noted as the age of the hockey player increases. However, a significant reduction ($P<0.05$) in hemoglobin level has been observed after training among all the players of the present study. On the other hand, a significant increase ($P<0.05$) in serum urea and uric acid has been noted with the advancement of age of the players of the present study. In addition, a significant increase ($P<0.05$) in serum urea and uric acid level has been noted after training among the players.

Table 4: Variation of age and training on haemoglobin, urea and uric acid levels of hockey players

Parameters	Training phase	Age group			
		U16	U19	U23	SR
Haemoglobin (gm dl $^{-1}$)	TP	13.6 ± 0.4	13.7 ± 0.6	$14.5^{*\#} \pm 0.3$	$14.9^{*\#\yen} \pm 0.3$
	PP	13.4 ± 0.5	13.5 ± 0.5	$14.3^{*\#} \pm 0.5$	$14.8^{*\#\yen\ddagger} \pm 0.4$
	CP	$13.2^{\ddagger} \pm 0.6$	$13.4^{\ddagger} \pm 0.7$	$14.1^{*\#\ddagger} \pm 0.6$	$14.7^{*\#\yen\ddagger} \pm 0.4$
Urea (mg dl $^{-1}$)	TP	24.9 ± 2.0	$26.5^{*} \pm 1.7$	$30.5^{*\#} \pm 2.6$	$32.7^{*\#\yen} \pm 1.0$
	PP	$25.9^{\ddagger} \pm 2.7$	$27.7^{*\ddagger} \pm 1.9$	$31.3^{*\#\ddagger} \pm 2.1$	$33.9^{*\#\yen\ddagger} \pm 1.9$
	CP	$26.6^{\ddagger} \pm 2.1$	$28.7^{*\ddagger\dagger} \pm 2.7$	$33.7^{*\#\ddagger\dagger} \pm 2.4$	$34.4^{*\#\yen\ddagger} \pm 2.1$
Uric acid (mg dl $^{-1}$)	TP	3.4 ± 0.3	3.6 ± 0.5	$4.7^{*\#} \pm 0.3$	$4.6^{*\#} \pm 0.3$
	PP	3.6 ± 0.5	3.8 ± 0.6	$4.7^{*\#} \pm 0.5$	$4.7^{*\#} \pm 0.2$
	CP	3.7 ± 0.7	$3.9^{\ddagger} \pm 0.6$	$4.9^{*\#\ddagger} \pm 0.5$	$4.8^{*\#\ddagger} \pm 0.3$

Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to U16, # when compared to U19, ¥ when compared to U23, ‡ when compared to TP, † when compared to PP; U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; TP= transition phase, PP= preparatory phase, CP= competitive phase.

Variation of age and training on lipids and lipoprotein profiles of the hockey players: In the present study significant increase (P<0.05) in total cholesterol, triglyceride, HDL-C and LDL-C level have been observed as the age of the players increases. However, a significant decrease (P<0.05) in total cholesterol, triglyceride and LDL-C have been noted among the field hockey players after the training programme. On the contrary, significant increase (P<0.05) in HDL-C has been noted among the players after the training programme.

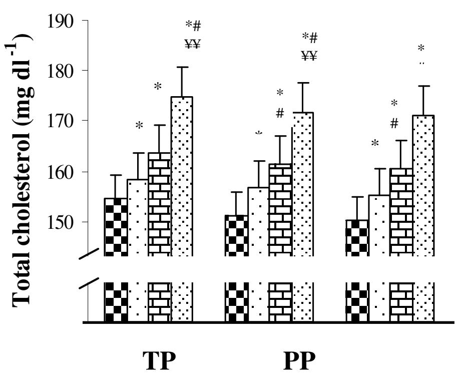

Figure 1a: Variation of age on total cholesterol level of hockey players

Data presented as mean and SD, n=30; Two-way ANOVA followed by multiple comparison test was applied. Data were significantly different from each other when compared to (U16 *P<0.050, U19 #P<0.050, U23 ¥P<0.050); U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; TP= transition phase, PP= preparatory phase, CP= competitive phase.

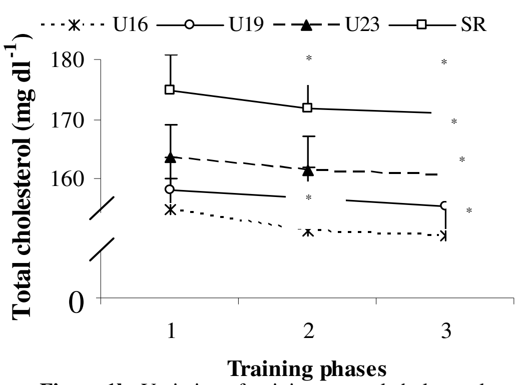

Figure 1b: Variation of training on total cholesterol level of hockey players

Data presented as mean and SD, n=30; Two-way ANOVA followed by multiple comparison test was applied. Data were significantly different from each other when compared to (1 *P<0.050), 2 #P<0.050); U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; 1= transition phase, 2= preparatory phase, 3= competitive phase.

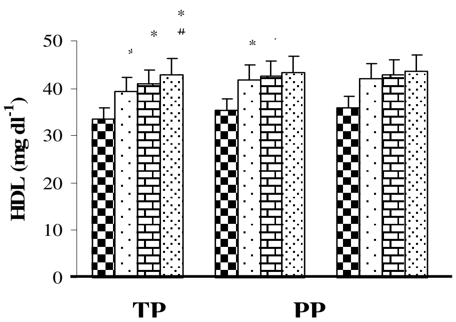

Figure 2a: Variation of age on HDL level of hockey players

Data presented as mean and SD, n=30; Two-way ANOVA followed by multiple comparison test was applied. Data were significantly different from each other when compared to (U16 *P<0.050, U19 #P<0.050, U23 ¥P<0.050); U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; TP= transition phase, PP= preparatory phase, CP= competitive phase; HDL= high density lipoprotein.

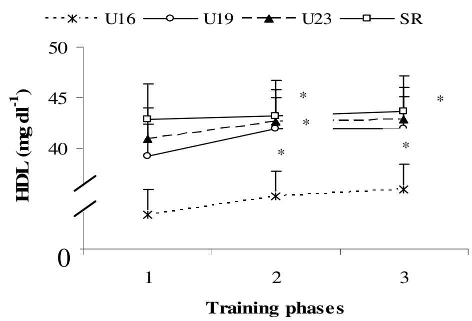

Figure 2b: Variation of training on HDL level of hockey players

Data presented as mean and SD, n=30; Two-way ANOVA followed by multiple comparison test was applied. Data were significantly different from each other when compared to (1 *P<0.050), 2 #P<0.050); U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; 1= transition phase, 2= preparatory phase, 3= competitive phase; HDL= high density lipoprotein.

Table 5: Variation of age and training on triglyceride and LDL-C levels of hockey players

Parameters	Training phase	Age group			
		U16	U19	U23	SR
Triglyceride (mg dl $^{-1}$)	TP	90.5 ± 4.6	89.6 ± 5.9	97.6*# ± 4.4	103.6*#¥ ± 5.1
	PP	89.6 ± 4.2	88.5 ± 4.7	94.3*#‡ ± 4.1	101.9*#¥ ± 5.3
	CP	88.4 ± 4.6	87.7 ± 4.9	93.2*#‡ ± 4.3	99.4*#¥‡ ± 5.6
LDL (mg dl $^{-1}$)	TP	103.2 ± 5.9	101.1* ± 4.9	102.0*# ± 4.0	109.3*#¥ ± 4.9
	PP	100.7 ± 5.5	98.0*‡ ± 4.2	100.8*# ± 5.5	108.1*#¥ ± 4.6
	CP	100.6 ± 5.9	97.3*‡ ± 5.5	99.8*# ± 4.9	107.4*#¥ ± 4.7

Data presented as mean ± SD; n=30; Computed using alpha = 0.05; * when compared to U16, # when compared to U19, ¥ when compared to U23, ‡ when compared to TP, † when compared to PP; U16= under 16 yrs, U19= under 19 yrs, U23= under 23 yrs, SR= senior age groups; TP= transition phase, PP= preparatory phase, CP= competitive phase; LDL= low density lipoprotein.

Correlation studies: In the present study, hemoglobin showed ($p<0.05$) a significant positive correlation with body mass and VO_{2max} of the field hockey players. Further, a significant positive correlation has been found between age and serum urea ($p<0.05$); and between serum uric acid and strength ($p<0.05$) of the players. In addition, total cholesterol has significant positive association with age ($p<0.05$), anaerobic power ($p<0.05$), triglyceride ($p<0.05$), and LDL-C ($p<0.05$) of the players. On the other hand, HDL-C has significant positive correlation with age ($p<0.05$), body mass ($p<0.05$), VO_{2max} ($p<0.05$), anaerobic power ($p<0.05$), strength ($p<0.05$), serum urea ($p<0.05$), and serum uric acid ($p<0.05$) of the field hockey players. In addition, HDL-C showed significant negative correlation with triglyceride ($p<0.05$) and LDL-C ($p<0.05$) of the players. Further, triglyceride showed significant negative correlation with serum urea ($p<0.05$). Similarly, significant negative correlation has also been observed between LDL-C and serum uric acid ($p<0.05$) among the players.

Table 6: Correlation coefficient of different variables of Indian hockey players

Pair of variables	R-Value	Pair of Variables	R-Value
Hb vs BM	0.41	Hb vs VO_{2max}	0.40
SU vs age	0.20	SUA vs strength	0.20
TC vs age	0.21	TC vs AP	0.20
TC vs TG	0.40	TC vs LDL-C	0.84
HDL-C vs age	0.44	HDL-C vs BM	0.20
HDL-C vs VO_{2max}	0.30	HDL-C vs AP	0.24
HDL-C vs strength	0.30	HDL-C vs SU	0.20
HDL-C vs SUA	0.20	HDL-C vs TG	- 0.20
HDL-C vs LDL-C	- 0.20	TG vs SU	- 0.20
LDL-C vs SUA	- 0.20		

Correlation coefficient Values (r- values) were significant at $P< 0.05$; Hb= haemoglobin, BM= body mass, VO2max= maximal aerobic capacity, SU= serum urea, SUA= serum uric acid, TC= total cholesterol, TG= triglyceride, HDL-C= high density lipoprotein cholesterol, LDL-C= low density lipoprotein cholesterol.

Discussion

Hemoglobin represents the iron status of the body [2, 5]. The present study shows that the hemoglobin level increases as the field hockey players get matured. This might be due to the higher body mass of the senior players than the juniors. It is also supported by the fact that the body mass of the players is significantly correlated with hemoglobin level. Further, oxidative potentiality of an athlete is dependent on his hemoglobin level. In hockey players the hemoglobin level and VO_{2max} are significantly correlated. It can be stated that body mass and VO_{2max} increases as the age of the players' increases. Therefore, the increase in VO_{2max} ensures higher rate of oxygen supply. Oxygen is transported to muscle primarily by hemoglobin (Hb), and it is suggested that hemoglobin mass and / or concentration is related to VO_{2max}. Similar findings have been reported by many researchers. Recent studies have reported that the adults have a higher hemoglobin mass than children and therefore, most of the variability is due to body mass differences [7, 22-23]. The demand in endurance sports is mainly aerobic and the athlete needs to maintain hemoglobin level more than 15 g dl^{-1} to optimise performance. This is the reason that the players engaged in endurance sports have got high hemoglobin level. Another finding of the present study showed that hemoglobin level decreases after training programme among all the players. During transition phase the training load is lesser than preparatory phase and competitive phase; therefore, reduced hemoglobin level has been observed in the latter two phases. Moreover, as the training load increases in the competitive phase, the decline in haemoglobin level is more prominent when compared with the transition phase. Similar observations have been noted by many researchers in their recent studies. Studies on professional athletes showed that haemoglobin values were higher at the beginning of the competition season, and then declined in well-trained athletes [2, 5, 7]. It can be suggested that the decline in hemoglobin level may be due to haemolysis [2, 24-25]. Intravascular haemolysis is one of the most emphasized mechanisms for destruction of erythrocytes during and after physical activity [26-27]. Further, exercise-induced oxidative stress has been proposed among the different factors for explaining exercise-induced haemolysis [28]. The serum urea and uric acid level has been considered as an indicator of overtraining. In the present study, significant increase in serum urea and uric acid has been observed with the advancement of age of the field hockey players. In the senior players the higher level of serum urea and uric acid has been noted when compared with junior players. A significant positive correlation has been found between age and serum urea of players. Therefore, it can be stated that the serum urea and uric acid level increases as the players get matured. This higher urea and uric acid level may be due to increased training load or high amount of protein intake in the senior players compared with the junior players. The strength component increases with the maturation of the players. However, in all the age groups the urea and uric acid level has been found to be in normal range. Studies on urea and uric acid levels on athletes reported that the urea and uric acid accumulation is most frequently used as a measure of protein catabolism and degradation of adenonucleotides [3,6-7]. Although increased level of serum urea and uric acid has been observed after training, the urea and uric acid level is found to be within the normal range. In addition to that a significant positive correlation is noted between serum uric acid and the strength of the players. This indicates that as the training load is increased the strength is also increased, which may elevate the serum uric acid level among the players. The highest level of urea and uric acid has been noted in the competitive phase when the training load is the 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 [6]. The possible reason for the increased urea level is the breakdown of proteins. Similar observations have been reported by many researchers [3, 7]. It has been reported that prolonged exercises have been shown to cause increased urea concentration in the blood, liver, skeletal muscles, urine, and sweat [3, 7, 29]. This considered as an augmented urea production. The increased uric acid level is also attributed the degradation of adenonucleotides [3, 6-7]. Uric acid has been found in sweat and urine collected during exercise [6]. 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 [30]. Lipids and lipoprotein profile indicate the cardiovascular and the metabolic status of the athlete [4, 9, 31]. In the present study changes in lipid profile with the changes of age have been noticed. It is possible to influence the lipoprotein profile, independent of alterations in confounding variables such as body composition, cardio-respiratory fitness and habitual physical activity. Correlation studies have shown that age has significant positive association with total cholesterol of the players. Similarly, significant positive correlations have also been derived between anaerobic power and total cholesterol among the players (Table 1). On the other hand, HDL-C has significant positive correlation with age, body mass, VO_{2max}, anaerobic power, and strength of the players. This shows that lipids and lipoproteins level increases as the age, body mass, and strength components of the players are increased. Therefore, it indicates that maturation process has positive relationship with the lipids and lipoproteins levels of the athletes. Other investigators [32-33] also reported similar observations that lipids and lipoproteins levels were increased with the advancement of age of the athletes. Young athletes have been reported to have low triglycerides concentration, which differs during developmental periods [34]. Cross-sectional analysis of age wise variation in lipids and lipoproteins of Indian players has indicated that the levels of plasma lipids and lipoproteins are in the normal range. Low density lipoprotein cholesterol (LDL-C) is directly associated with cholesterol [4, 8, 35]. In the present study, it has been seen that total cholesterol has significant positive correlation with triglyceride, and LDL-C. On the other hand HDL shows significant negative correlation with triglyceride and LDL-C. Similar opinion has also been put forwarded by other researchers [6, 7, 36]. It has been reported that LDL-C has the greatest correlation to severity of coronary atherosclerosis [6-7, 31, 35]. Therefore, monitoring of lipid profile in athletes can provide valuable information about their metabolic and cardiovascular status. Activity levels have significant impact on the lipids and lipoprotein levels of the athletes. As the training load increases from transition to preparatory phase and further to competitive phase the level of total cholesterol, triglyceride and LDL-C decreases, and the level of HDL-C increase gradually. It has already been observed that the serum urea and uric acid level increases as the training load increases. The present study also shows negative correlation between triglyceride and serum urea, LDL-C and serum uric acid; and positive correlation between HDL-C and urea, HDL-C and uric acid. Therefore, it can be stated that the training load has a significant negative association with triglyceride and LDL-C and a positive association with HDL-C level of the athletes. It indicates that as the training load increases the total cholesterol, triglyceride and LDL-C decrease gradually with an increase in HDL-C level. The possible reason for the exercise induced reduction in total cholesterol, triglyceride and LDL-C, and elevation in HDL-C is that exercise especially, aerobic exercise increases metabolism and utilization of blood lipids and lipoprotein for energy production. 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 and decrease in triglyceride level after exercise [4, 8, 35-36]. Another study showed significant increase in HDL-C and decrease in LDL-C, with no change in triglyceride after 9 weeks of training [6]. It has been reported that 4 weeks of aerobic exercise training significantly decreased the levels of total cholesterol, LDL-C, and increased HDL-C [9]. Therefore, regular monitoring of lipids and lipoproteins profiles of the field hockey players is essential to optimize their performance. In the present study an attempt was made to identify biochemical demand of hockey at different age categories. The training and age wise changes were reflected on various parameters like haemoglobin, urea, uric acid, and lipid profile. The unique profile of age related changes should be taken into consideration while administering training to the players. As the studies on 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 hockey players of different age groups.

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