Impression Of Specific Vitamins And Minerals On Haematology Of Young Indian Badminton Players

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Abstract
Haematology is an essential biochemical parameter to evaluate health, fitness and performance status of badminton players in response to intense and prolong training for successive performance. Sound nutrition with proper intake of specific vitamins and minerals is essentially required to maintain normal haematological components that include haemoglobin (Hb), red blood cells (RBC), white blood cells (WBC) and platelet count, functioning primarily in transportation, fortification and regulation of the various body systems. Present study had evaluated the intake of players (400 nos. 10-15 years junior male and female badminton players from Nagpur, Maharashtra) for certain vitamins such as pyridoxine (B_6), Folate (B_9), vitamin C and carotene and minerals like iron, copper, zinc through 24 hour's dietary recall method, tested haematological components and assessed the effects of micro nutrient intake on haematology. Except carotene, intake of other vitamins and minerals for all age groups far exceeded the Indian RDAs (recommended dietary allowances), also corroborated by adequate (100%) to extra NAR (nutrient adequacy ratio) (>100%) to RDAs recorded over majority of the subjects from all age groups. Except female pre-eminence in carotene intake among younger age group, male ascendency were obviously recorded in other vitamins and minerals among all age groups. Haematological tests showed that majority of the players were non anaemic with normal RBC, WBC and platelet counts. Positive correlations (0.0209, $p>0.05$ to 0.8401, $p<0.01$) were established between vitamins-minerals intake and haematology. Considering the status of haematology, dietary assessment and their interrelationship depicted from the present study, scientifically planned balanced diets by expert nutritionists are recommended for competitive badminton players right from young age for successful performance.

Keywords: Badminton, Haematology, Minerals, Vitamins

Introduction

Biochemical analysis for various parameters has an important role for the evaluation of training of the athletes as it gives a clear picture of any deficiencies or excesses which could hamper the performance. By daily training and the proper structure of nutrition, athletes can maintain their biochemical and nutritional parameters within limits considered healthy[1]. Biochemical parameters are widely used to the health, fitness and performance status of badminton players as the responses to exercise stress are largely depend on the haematology and biochemistry of the body[2]. Biochemical profile can also affect explosive power and endurance during aerobic and anaerobic activities. Haematology may help the players in identifying the degree of anemia, immunity and thrombosis.

Blood is an intracellular liquid (plasma) within which the red blood cells, white blood cells and platelets are suspended[3]. This intracellular liquid has a key role to maintain homeostasis[3]. Quality health care entails a comprehensive evaluation of each athlete's health condition. This includes a detailed biochemical case history, thorough physical examination and suitable laboratory and diagnostic testing from authentic pathological and radiological laboratories. Laboratory tests are usually carried out for periodic appraisal of the healthy athlete[4]. Haematological components (CBC-complete blood count) such as haemoglobin (Hb), red blood cells (RBC), white blood cells (WBC) and platelet count majorly involve in in transportation, fortification and regulation of the various systems of body. The haematological parameters can change, depending on the type, intensity and duration of the exercise[5,6]. Haemoglobin analysis indicates that if there is any iron deficiency which can directly affect the stamina of players to perform continuously for long time without any tiredness. Haematocrit test analyses the proportion of red blood cells (RBC) in blood, indicates the anemic tendency of the player which can also directly effect on stamina of long term play. RBC count is important to know the amount of oxygen carrying capacity of haemoglobin. The red blood cells production rate and their survival rate are highly prejudiced by exercise and sports participation[7]. Likewise, intense physical stress from sports increases the number of leukocytes in the body[8]. WBCs which include eosinophil, basophil, neutrophil, lymphocyte and monocyte cells indicate the tendency of allergy and infection among the players. As injury is very common in sports, so the platelet count is important for observing external and internal bleeding tendency from injured body part. It is commonly seen that due to improper fluid intake players often suffer from dehydration. Continuous involvement in physical trainings in terms of sports and exercise may causes increment of Platelets and platelet related parameters[9]. So, biochemical tests are used

extensively to assess health and fitness of the intensively training badminton athletes. All these parameters if not monitored periodically, any abnormalities may lead to poor physical fitness which affects the performance.
Appropriate nutrition make ensure the adequate supply of specific vitamins and minerals which are essential for substantial blood cell production. Vitamins B_6 and B_9 are pivotal in making of haemoglobin. The minerals iron and copper contribute to the production of vigorous red blood cells. Vitamin A helps support red blood cell development[10]. Vitamins B_6 and B_9 also help to produce white blood cells in the body[11]. Zinc can help the body produce more WBCs and makes existing WBCs more aggressive[11]. Platelet counts largely dependent on Iron, Vitamin B_9 and Vitamin-C[12].

Materials and Methods
For the present study, 400 junior badminton players of 10-12 years (100 nos. males and 100 nos. females) and 13-15 years of age (100 nos. males and 100 nos. females) from Nagpur regularly playing in different club, school, city, district, and national level tournaments were purposively selected through purposive sampling method.
Micronutrients assessment was done by 24 hour's dietary recall method for consecutive three days[13] along with general dietary history. Nutritive values for certain vitamins such as pyridoxine (B_6), Folate (B_9) and vitamin C (water soluble) and carotene (precursor to vitamin A) (fat soluble) and minerals like iron, copper, zinc, (micro elements) were computed by standard food composition tables [14,15]. The average micronutrient (vitamin and mineral) intake of players was compared with the RDAs for Indians[16]. Nutrient Adequacy Ratio (NAR) was figured to understand the adequacy of the specific vitamins and minerals intake of the 10-12 and 13-15 years old badminton players[17]. The formula used to estimate the NAR of a particular nutrient is given below:

$$\text{NAR} = \frac{\text{Actual intake of nutrient by subject}}{\text{RDA for that nutrient}}$$

The adequacy/inadequacy of a particular nutrient intakeby the badminton players was classified as follows [18]:
1. Inadequate intake: NAR <0.66 (intake being less than 66% of the RDA)
2. Fairly adequate intake: NAR = 0.66 < 1.00 (intake of 66% to <100% of RDA)
3. Adequate intake: NAR =1.00 (intake being =100% of the RDA)
4. Extra intake: NAR= >1.00 (intake being ≥100% of the RDA)

Total RBC, WBC and platelet along with haemoglobin level were recorded from available recent pre tournament routine blood reports of the players. The reported haematological values of the players were compared with reference standards for age[19, 20].

Results
Baseline characteristics of the players indicates that in the present study, among 10-12 years girls (avg. 11.02 ± 0.85 years) and boys (avg. 11.01 ± 0.87 years), 35% and 37% are of 10 years, 28% and 25% are of 11 years and 37% and 38% are of 12 years of age. Whereas, among 13-15 years girls (avg. 13.94 ± 0.84 years) and boys (avg. 14.03 ± 0.83 years), 38%, 30% and 32% are 13, 14 and 15 years girls and 33%, 31% and 36% are 13, 14 and 15 years boys.
Micronutrients assessment indicates that in terms of vitamin components (Table-1), mean value of pyridoxine consumption by younger and elder players substantially exceeded the RDA[16] of pyridoxine by 32.65% (z= 4.84), 45.76% (z= 7.82), 13.47% (z=6.61); p<0.01 and 16.66% (z= 6.54); p<0.01, respectively, significant at 5% and 1% levels. With progressive age, significant increment (0.02 mg/ day; z= 0.18, p>0.05) and 0.12 mg/ day (z= 0.88, p>0.05) were obtained among female and male players. Difference in pyridoxine consumption between male and female players was comparatively greater in elder group (0.53 mg/day) than younger group (0.39 mg/ day).

The folate content in the diet of players of all age groups extensively surpassed recommended folate value[16] by 45.24% (z= 14.79), 55.31% (z= 16.05), 39.49% (z= 16.83) and 35.47% (z= 12.39) respectively, p<0.01. Between elder and younger group, significant difference (both at 5% and 1% levels of significance) (44.40 µg/day; z= 3.99, p<0.01) was recorded among male players and insignificant difference (14.96 µg/day; z= 1.67, p>0.05) was obtained among female players. Male predominance in folate intake observed among both younger (14.89 µg/day) and elder (44.32 µg/day) groups.

Mean vitamin C intake of the players noticeably exceeded the recommended vitamin-C intake[16] by 131.94% (z= 18.51), 146.78% (z= 23.24), 101.15% (z= 15.45) and 128.23% (z= 20.23) respectively, p<0.01. Both the group showing significant increment in vitamin C intake (Girls: 32.26 mg/day; z= 5.20 and Boys: 31.06 mg/day; z= 5.45, p<0.01) with progression in age. Like other vitamin components, male players were found to have higher intake of vitamin C (Younger: 12.65 mg/day and Older: 11.45 mg/day) than female players.

Mean carotene intake of the players were found famine pre-eminence (279.36 µg/day) among younger group and mannish among elder group (165.10 µg/day). Although, all the age groups from both the gender were unable to meet the RDAs[16] (Younger: Girls- 47.88%; z= 15.11, Boys- 53.70%; z= 18.85 and Elder: Girls- 37.31%; z= 11.31, Boys- 33.88; z= 8.42, p<0.01). As per age group comparison, difference between older and younger group among male players (951.41 µg/day; z= 4.02, p<0.01) was significant both at 5% and 1% significant levels whereas among female players although the difference (506.95 µg/day; z= 2.31, 0.05>p>0.01) was significant at 5% level but insignificant at 1% level.

Table -1 Data on vitamin intake of the subjects

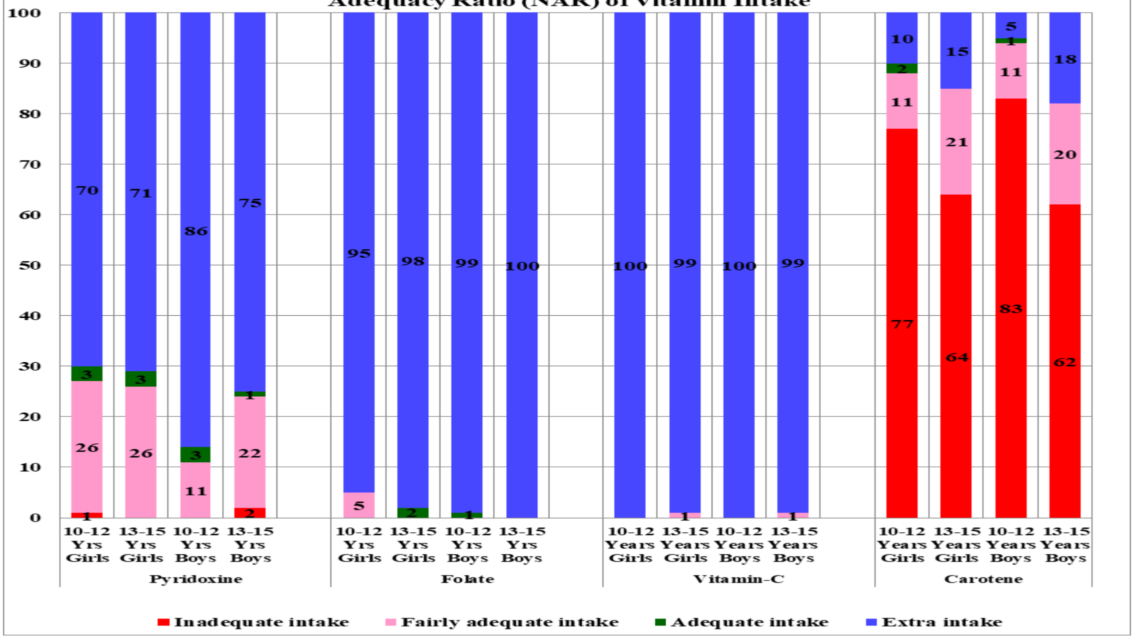
S. No.	Parameters	Girls (N=200)			Boys (N=200)		
		10-12 years (n=100)	13-15 years (n=100)	z values #	10-12 years (n=100)	13-15 years (n=100)	z values #
1.	**Pyridoxine (mg)**						
i.	**Mean±SD**	2.52±1.28	2.50±0.45		2.92±1.17	3.03±0.66	
ii.	**Range**	1.06-8.81	1.66-4.61		1.48-8.96	1.64-5.11	
iii.	**Standard**	1.90	2.20	0.18	2	2.60	0.88
iv.	**z values§**	4.84*	6.61*		7.82*	6.54*	
v	**% Excess**	+32.65	+13.47		+45.76	+16.66	
2.	**Folate (µg)**						
i.	**Mean±SD**	326.79±68.82	341.76±57.51		341.68±75.81	386.08±81.57	
ii.	**Range**	196.55-615.63	241.42-483.15		222.07-623.74	256.80-740.70	
iii.	**Standard**	225	245	1.67	220	285	3.99*
iv.	**z values§**	14.79*	16.83*		16.05*	12.39*	
v	**% Excess**	+45.24	+39.49		+55.31	+35.47	
3.	**Vitamin C (mg)**						
i.	**Mean±SD**	120.61±37.06	152.87±49.77		133.26±34.11	164.32±45.63	
ii.	**Range**	55.52-252.43	69.13-294.78		74.90-244.23	66.71-298.53	
iii.	**Standard**	52.00	76.00	5.20*	54.00	72.00	5.45*
iv.	**z values§**	18.51*	15.45*		23.24*	20.23*	
v	**% Excess**	+131.94	+101.15		+146.78	+128.23	
4.	**Carotene (µg)**						
i.	**Mean±SD**	2501.93±1521.25	3008.88±1583.25		2222.57±1367.58	3173.98±1930.92	
ii.	**Range**	448.98-8412.01	524.71-7964.04		322.73-7994.55	439.48-8757.69	
iii.	**Standard**	4800.00	4800.00	2.31**	4800.00	4800.00	4.02*
iv.	**z values§**	15.11*	11.31*		18.85*	8.42*	
v	**% Deficit**	-47.88	-37.31		-53.70	-33.88	

*- Significant at both 5 % and 1% levels ($p<0.01$); **- Significant at 5 % level but insignificant at 1 % level ($0.01<p<0.05$); Values without any mark indicate insignificant difference at both 5% and 1% levels ($p>0.05$).

As per as NAR of vitamins concerned (Fig. 1), majority of the badminton players from all age groups had extra NAR for Pyridoxine (B_6) (Girls: Younger- 70%, Older- 71% and Boys: Younger- 86%, Older- 77%). Extra NAR was also recorded for folate (B_9) and vitamin C for about 95% badminton players of all age groups. However, inadequate intake of carotene was largely observed among all the age groups (Girls: Younger- 77%, Older- 64% and Boys: Younger- 83%, Older- 62%).

Among micro elements intake (Table-2), mean iron intake of both younger and elder players found deficient by 19.48% (z= 13.02) and by 23.02% (z= 20.21); p<0.01 for female players and excess by 46.30% (z= 25.50) and 12.20% (z= 7.89); p<0.01 for male players respectively, as compared to RDAs of iron[16]. Age group comparison revealed insignificant difference of iron intake (0.55 mg/day; z= 1.02, p>0.05) for female players and significant difference for male players (1.28 mg/day; z= 2.85, p<0.01) at 5% and 1% levels. For both the ages, male players had higher iron intake (Younger: 0.86 mg/day and Older: 1.60 mg/day) than female players.

Figure 1: Percenage Wise Distribution of Players on the Basis of Nutrition Adequacy Ratio (NAR) of Vitamin Intake



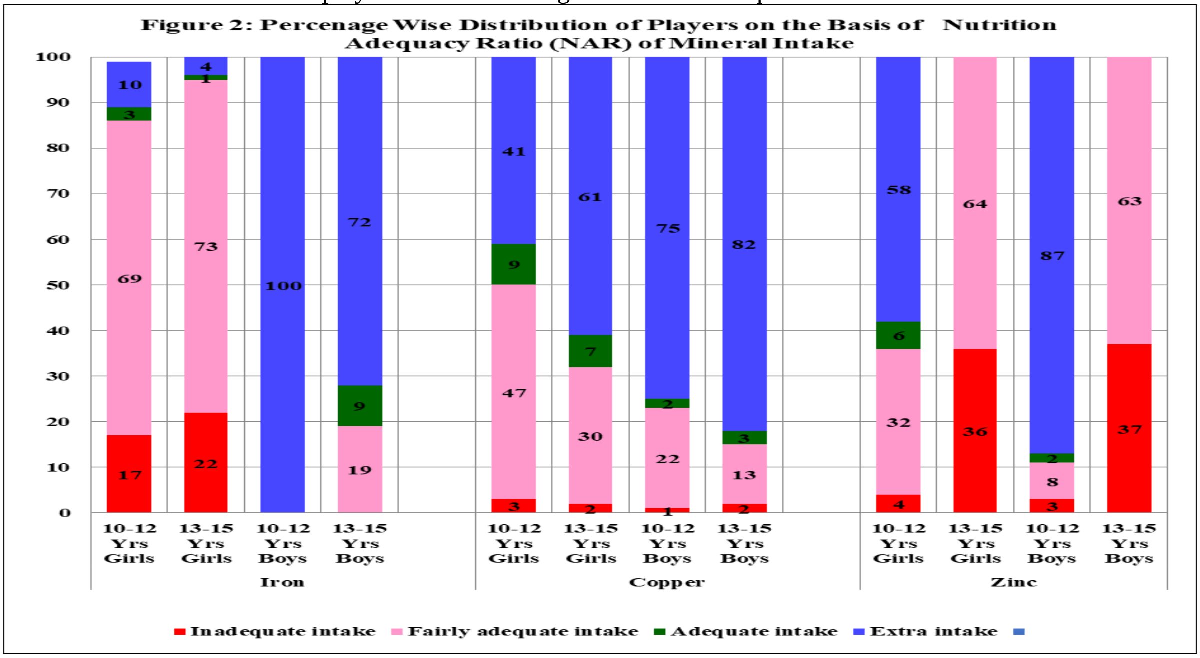
Mean copper intake of the players ascertained that except younger girls with copper deficiency of 2.32% (z= 1.45, p>0.05), all other groups had reasonably excess intake by 10.27% (z= 5.94) and 5.48% (z= 2.85), 18.16% (z= 9.06) respectively, p<0.01 as per recommended copper intake[16]. For both the genders, significant increment (Girls: 0.16 mg/day; z= 3.12 and Boys: 0.16 mg/day; z= 2.98, p<0.01) in copper intake was recorded with progression in age. Both the age groups demonstrated male pre-eminence (Younger: 0.26 mg/day and Older: 0.25 mg/day) in copper intake.
The zinc content in the diet of the younger and elder players depicted surplus amount for younger groups by 2.96% (z= 1.48, p>0.05) and 16.05% (z= 9.38, p<0.01) respectively and deficit amount for elder groups by 31.46% (z= 19.52, p<0.01) and 31.54% (z= 22.69, p<0.01), as compared to RDAs of zinc content[16]. Minimal increment (0.02 mg/day; z= 0.08, p>0.05) of zinc intake among female players and decrement (0.07 mg/day; z= 0.30, p>0.05) among male players recorded as age progresses. Although, irrespective of age groups, significant difference of zinc intake (Younger: 1.11 mg/day and Older: 1.02 mg/day) obtained between male and female players.

Table -2 Data on minerals intake of the subjects

		Girls (N=200)			Boys (N=200)		
S. No.	**Parameters**	**10-12 years (n=100)**	**13-15 years (n=100)**	**z values #**	**10-12 years (n=100)**	**13-15 years (n=100)**	**z values #**
1.	**Iron (mg)**						
i.	**Mean±SD**	22.55±4.19	23.09±3.42	1.02	23.41±2.91	24.69±3.41	2.85*
ii.	**Range**	12.60-32.62	17.61-33.64		16.70-32.17	16.87-34.37	
iii.	**Standard**	28.00	30.00		16.00	22.00	
iv.	**z values§**	13.02*	20.21*		25.50*	7.89*	
v	**% Deficit/ Excess**	-19.48	-23.02		+46.30	+12.20	
2.	**Copper (mg)**						
i.	**Mean±SD**	1.95±0.32	2.11±0.38	3.12*	2.21±0.35	2.36±0.40	2.98*
ii.	**Range**	0.82-2.64	1.11-3.10		1.14-2.96	1.18-3.32	
iii.	**Standard**	2.00	2.00		2.00	2.00	
iv.	**z values§**	1.45	2.85*		5.94*	9.06*	
v	**% Deficit/ Excess**	-2.32	+5.48		+10.27	+18.16	
3.	**Zinc (mg)**						
i.	**Mean±SD**	8.75±1.71	8.77±2.06	0.08	9.86±1.45	9.79±1.99	0.30
ii.	**Range**	4.17-12.25	4.38-12.45		5.15-13.25	4.20-12.79	
iii.	**Standard**	8.50	12.80		8.50	14.30	
iv.	**z values§**	1.48	19.52*		9.38*	22.69*	
v	**% Excess/ Deficit**	+2.96	-31.46		+16.05	-31.54	

*- Significant at both 5 % and 1% levels (p<0.01); **- Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); Values without any mark indicate insignificant difference at both 5% and 1% levels (p>0.05).

NAR of the mineral intake (Fig. 2) demonstrates that 100% of younger male badminton players had extra intake of iron. Among 9% younger and 72% older male players, adequate to extra NAR were noted. On contrary, 69% and 73% younger and older female subjects depicted fairly adequate intake of iron. NAR for copper showed most of the male players had extra NAR beyond 100% of RDA (Boys: Younger- 75%, Older- 82%) whereas among female category, 50% younger and 68% older age groups exhibited adequate to extra NAR. Zinc intake indicates that 87% of younger male players had more than adequate intake of zinc whereas only 6% and 58% younger female players falls in adequate and extra NAR category. For older groups from both the genders no one had sufficient copper intake to reach 100% of RDA. Over one third of the older players from both the genders had inadequate intake of zinc.



Among biochemical parameters (Table- 3), testified from the existing routine blood reports, haemoglobin level of the players was able to exceed the non-anaemic limit[20] by 3.13% (z= 4.74), 15.04% (z= 12.54), 4% (z= 4.85) and 16.17% (z= 17.80) respectively, p<0.01. With increasing age, significant differences in haemoglobin levels (Girls: 0.62 g/ dL; z= 4.97 and Boys: 0.71 g/ dL; z= 4.04, p<0.01) were recorded among both the genders. Mannish superiority were clearly visible among both the age groups (Younger: 1.37 g/ dL and Older: 1.46 g/ dL).

Both the gender displayed significant augmentation in RBC count (Girls: 0.62 million/cu.mm; z= 5.64 and Boys: 0.65 million/ cu.mm; z= 6.32, p<0.01) with age progression. Gender comparison depicted mannish superiority in RBC count (Younger: 0.11 million/ cu.mm and Older: 0.14 million/ cu.mm) at both the age levels. Like RBC count, WBC count also resulted mannish superiority (Younger: 356/ cu.mm and Older: 556/ cu.mm) among both ages. However, age group comparison revealed increment among female players (744/ cu.mm; z= 3.87, p<0.01) and male players (944/ cu.mm; z= 4.72, p<0.01). As age progresses, female players depicted inconsequential decrement (8788 cu.mm; z= 1.59, p>0.05) while male players exhibited noteworthy increment (16028 cu.mm; z= 2.60, p<0.01) in platelet count. Gender comparison exposed feminine preponderance (4080 cu.mm) at younger age and male prevalence (20736 cu.mm) at elder age.

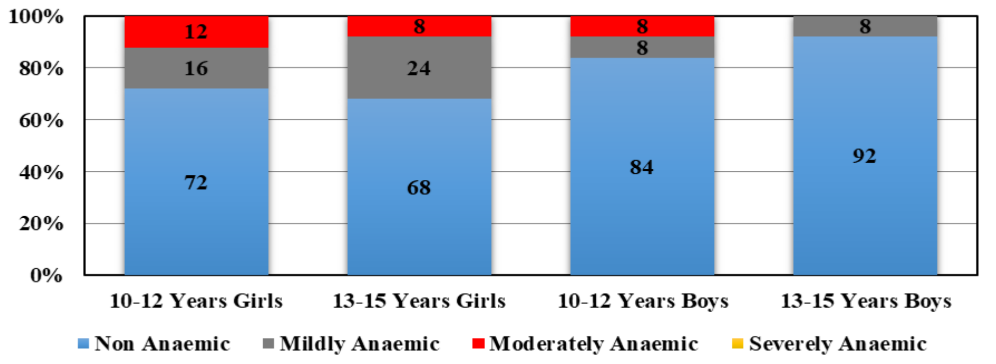
Table -3 Data on Haematology of the subjects

		Girls (N=200)			**Boys (N=200)**		
S. No.	**Parameters**	**10-12 years (n=100)**	**13-15 years (n=100)**	**z values #**	**10-12 years (n=100)**	**13-15 years (n=100)**	**z values #**
1.	**Haemoglobin (g/dL)**						
i.	**Mean±SD**	11.86±0.76	12.48±0.99		13.23±1.38	13.94±1.09	
ii.	**Range**	10.20-13.70	10.60-14.60		10.70-15.50	11.50-15.30	
iii.	**Standard**	11.50	12.00	4.97*	11.50	12.00	4.04*
iv.	**z values§**	4.74*	4.85*		12.54*	17.80*	
v	**% Excess**	+3.13	+4.00		+15.04	+16.17	
2.	**RBC (million/cu.mm)**						
i.	**Mean±SD**	4.50±0.84	5.12±0.71		4.61±0.67	5.26±0.78	
ii.	**Range**	2.90-5.80	3.20-6.00		3.50-5.80	3.90-6.60	
iii.	**Standard**	3.50		5.64*	4.30		6.32*
iv.	**z values§**	11.90*	22.82*		4.63*	12.31*	
v	**% Excess**	+28.57	+46.29		+7.21	+22.33	
3.	**WBC (/cu.mm)**						
i.	**Mean±SD**	6216±1061	6960±1604		6572±1514	7516±1309	
ii.	**Range**	4200-8700	4200-9700		4100-9000	5500-9800	
iii.	**Standard**	4500		3.87*	4500		4.72*
iv.	**z values§**	16.17*	15.34*		13.69*	24.05*	
v	**% Excess**	+38.13	+54.67		+46.04	+67.02	
4.	**Platelets (cu.mm)**						
i.	**Mean±SD**	277544±39395	268756±44063		273464±48524	289492±37875	
ii.	**Range**	200100-355900	211200-354200		199000-352600	221900-353300	
iii.	**Standard**	150000		1.49	150000		2.60*
iv.	**z values§**	32.38*	26.95*		25.44*	36.83*	
v	**% Deficit**	+85.03	+79.17		+82.31	+92.99	

*- Significant at both 5 % and 1% levels (p<0.01); **- Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); Values without any mark indicate insignificant difference at both 5% and 1% levels (p>0.05).

From blood analysis, haemoglobin content of the players (Fig. 3) showed majority of the players from all the age groups (Girls: Younger- 72%, Older- 68% and Boys: Younger- 84%, Older- 92%) were fallen within non-anaemic range[20]. Among female players, 16% younger one and 24% older one depicted mild anaemic condition whereas 12% and 8% respectively from both the age groups diagnosed with moderate anaemia. Among male players, 8% each from younger group were fallen within mild and moderate anaemic conditions. Also, 8% from older boys showed mild anaemia. None of the players were found to be severely anaemic.

Figure 3: Percentage Wise Distribution of Subjects Categorized on the Basis of Haemoglobin Level



It was also noted that among female and male players, 76% each from younger group and 60% and 68% from older group exhibited RBC well within range. 20% girls and 24% boys from younger group had RBC below the range whereas 36% girls and 24% boys from older age group crossed the upper threshold level of RBC normal range. WBC count revealed more than 85% of the players from all groups had WBC within the range. Only 8% older male players and 4% each from younger and older female players had WBC at slightly below the lower threshold of normal range. Platelet count demonstrated that except 4% each and 8% from younger female, older male and female players with lower than normal range, all players were reported within normal range.

Discussion

To validate the results of present study, Indian and Global eminent literatures on badminton players and other athletes as well as standard data of adolescents of particular age group are discussed and compared with present study.

From the present study, it was obvious that due to diversified food habits and food patterns of the players, wide ranges were noted for each and every assessed nutrient intake and hence, there observed noteworthy differences with RDAs.

Among micronutrient assessment, it was observed that there were significant differences between pyridoxine intake of the Indian players from elder age groups and national middle school players from badminton playing countries like South Korea[21]. Fish intake of some of the non-vegetarian subjects under the present study might had increased the overall mean pyridoxine intake of subjects. However, significant high mean intake were observed between the observation of the present study and the national level male sprinters[22].

It was well understood that invariably of gender and age group, the mean folate intake of the elder subjects of present study were prominently higher than the senior university and state level badminton players[23] and the players from Physical Education Institution of Vidarbha, Maharashtra[24] which show good iron intake of the badminton players under this study. Significantly higher differences were postulated between players from present study and professional hockey players[25] as well as trained swimmers of Nagpur city[26] for folic acid intake. The badminton players under present study remarkably exceeded the Korean badminton players[21] for daily folate consumption (females by 457.52% ($z= 48.77$, $p<0.01$ and males by 529.82% ($z= 39.81$, $p<0.01$). Regular and disciplined meal pattern over 80% percentage of subjects with intake of green leafy vegetables and fruits are cumulatively responsible for higher folate intake. Regular intake of supplementary health foods also enhanced the folate intake.

As for vitamin C, the elder subjects of the present study had lesser intake than the badminton players from Vidarbha[24] but higher intake than the university badminton players[23]. This disparity pointed towards variation in the daily intakes of citrus food and cruciferous vegetables. Comparing with Korean players[21], the consumption of vitamin C of the female and male badminton players from both the age groups of 10-12 years and 13-15 years was out rightly higher as non-veg food items were mostly reported to be incorporated in Korean player’s diet as compared to citrus foods which were mostly consumed by the players in this study. For other games, substantial higher differences were clearly perceived between the players of present study and trained swimmers[26].

Comparing the mean daily carotene intake, due to variation in individual’s dietary food choices, badminton players of the present study were found with considerably lesser intake of carotene than the badminton players[23,24] but unusually higher than the estimations for trained swimmers[26]. Regular intake of carrot in the form of salad and consumption of pulpy fruits like papaya and mango might have increased the carotene intake. However, the intakes were not sufficient to meet RDAs[16].

The iron ingestion of the elder badminton players from the present study was poorer than other Indian badminton players[23] but astoundingly higher than Korean players[21]. The iron intake of the badminton players from the present study was found to be superior over other Indian players from the same age groups engaged in other sports such as sprinting[22] but inferior as compared to gymnasts[27] and swimmers[26]. Despite of lower intake of iron than RDAs[16], the haemoglobin status of the badminton players were better than recommended level[20].

Mean copper intake of the female badminton players of both the groups (10-12 years and 13-15 years) was found to be sufficiently on higher than the Spanish[28] and American[29] female players of multidisciplinary sports (karate, handball, basketball, running, tennis, swimming, soccer and gymnastics). For both the groups of male badminton players under this study, it was noted that they were well behind the intake of physically active Indian male youths[30].

Mean daily zinc intake of badminton players under the present study were portentously higher than Korean middle school badminton players[21]. Zinc intake of the players under present study was found to be substantially higher than the intake in Turkish football players[31]. But strangely in Indian context, the zinc intake by the male players of the present study resulted considerably lower than the sprinters[22] and hockey players[25] but higher than male swimmers[26]. On contrary, the female badminton players under present study showed reasonably lower mean daily zinc intake than Indian female swimmers[26] but significantly higher than female hockey players[25]. Not only dietary variations but also consumption of nutraceutical supplements were the causative factors for wide disparity of zinc intake of the badminton players under the present study.

Analysis of blood parameters disclosed that the younger badminton players had lower haemoglobin level than Chinese[32], Iraqi[33] and Spanish[34] racket players. However, present study found that the mean haemoglobin level of badminton players was well above than not only the normal cut off level[20] but also higher than that of university players[24] and state female players[35]. Also, the present study resulted higher mean haemoglobin level of badminton players than Indian hockey players[25], female basketball players[36] and female gymnasts[27]. Normal haemoglobin level (Females: 12.00-16.00 g/dL and Males: 13.50-17.50 g/dL)[19] is the indicative of proper blood oxygen carrying capacity which can even sustain in strenuous physical exercise.

RBC analysis of the female badminton subjects of present study confirmed their preeminence over state level female badminton[35]. Comparing with other games such as football[37] and handball[38], the elder male players of the present study exhibited enhanced RBC, whereas, younger one unveiled deficit RBC than male players from Ghana[37] and Turkey[38]. RBC within recommended range (Females: 3.5-5.5 million/cu.mm and Males: 4.3-5.9 million/cu.mm)[19] advocated the non haemo dilution condition even during arduous training.

Dean[19] in 2005 stated that WBC analysis of the players within normal range (4500-11000/ cu. mm) represents player's immunity against infections and allergies. Al-Yasary and Al Harbi (2014)[33] analysed extraordinarily higher WBC among Iraqi national badminton players as compared to the results of the present study. Platelet counts of the players also found to be within normal range (150,000-400,000/cu. mm). It plays a fundamental role in thrombosis and haemostasis at the time of injury. Male players of the present study recorded higher platelet counts than Spanish players[33]. Comparing with other games, significant differences were existed between WBC count of the elder male players of the present study and Ghanaian male football players studied by[37] and Turkish male handball players[38]. Also, platelet count of male badminton players under the present research from both the age groups had noteworthy differences with Ghanaian male football players and Turkish male handball players.

The correlation studies of examined vitamins and minerals with blood parameters had firmly established their positive relationship. The correlation study admitted that haemoglobin and RBC both had conspicuous moderate to strong positive relationships with the intake of vitamin-B complex such as pyridoxine (B_6) (Girls: Younger: 0.4562, 0.4772; $p<0.01$ and Elder: 0.2291, 0.1964; $0.05>p>0.01$ and Boys: Younger: 0.3476, 0.3490; $p<0.01$ and Elder: 0.2022; $0.05>p>0.01$, 0.3999; $p<0.01$); folate (B_9) (Girls: Younger: 0.3442; $0.05>p>0.01$, 0.3731; $p<0.01$ and Elder: 0.4773, 0.6426; $p<0.01$ and Boys: Younger: 0.3695; $0.05>p>0.01$, 0.3947; $p<0.01$ and Elder: 0.1605, 0.2011; $p>0.05$) and moderate to strong affirmative relationships with micro minerals such as iron (Girls: Younger: 0.3667; $0.05>p>0.01$, 0.5445; $p<0.01$ and Elder: 0.8112, 0.6186; $p<0.01$ and Boys: Younger: 0.8401, 0.7881; $p<0.01$ and Elder: 0.4322, 0.4939; $p<0.01$) and copper (Girls: Younger: 0.3493; $0.05>p>0.01$, 0.3626; $0.05>p>0.01$ and Elder: 0.2952, 0.3578; $0.05>p>0.01$ and Boys: Younger: 0.2245; $p>0.05$, 0.2883; $0.05>p>0.01$ and Elder: 0.3900; $p<0.01$, 0.3571; $0.05>p>0.01$). Moderate to strong affirmative relationships (0.2089; $0.05>p>0.01$ to 0.3584; $p<0.01$) of vitamin C and iron were the indicative of boosting iron absorption by vitamin C. Optimistic relationship of haemoglobin with copper intake advocated the significance of proper copper intake for maintaining haemoglobin level which is important for oxygen supply to each organ for proper function and for aerobic work capacity which is very important among players. All the age groups of both the genders had weak to moderate relationship haemoglobin and RBC with carotene intake (Girls: Younger: 0.1435, 0.1671; $p>0.05$ and Elder: 0.1192, 0.0832; $p>0.05$ and Boys: Younger: 0.0493; $p>0.05$, 0.0209; $p>0.05$ and Elder: 0.3644; $0.05>p>0.01$, 0.2464; $p>0.05$).

Similarly WBC had moderate positive relation with pyridoxine (B_6) intake among badminton players (Girls: Younger: 0.3851; $p<0.01$ and Elder: 0.3323; $p<0.01$ and Boys: Younger: 0.4603; $p<0.01$ and Elder: 0.2148; $0.05>p>0.01$); strong assenting relation with folate (B_9) (Girls: Younger: 0.6190 and Elder: 0.5340; $p<0.01$ and Boys: Younger: 0.5009 and Elder: 0.4734; $p<0.01$) as well as weak to strong positive relation with zinc (Girls: Younger: 0.1356; $p>0.05$ and Elder: 0.6940; $p<0.01$ and Boys: Younger: 0.2322; $p>0.05$ and Elder: 0.4682; $p<0.01$).

Significantly resilient affirmative relationship was also witnessed between blood platelets and folate (B_9) intake (Girls: Younger: 0.7384 and Elder: 0.7272; $p<0.01$ and Boys: Younger: 0.5182 and Elder: 0.7214; $p<0.01$), vitamin C (Girls: Younger: 0.4067; $p<0.01$ and Elder: 0.7073; $p<0.01$ and Boys: Younger: 0.4269 and Elder: 0.4993; $p<0.01$) as well as iron (Girls: Younger: 0.4996 and Elder: 0.5907; $p<0.01$ and Boys: Younger: 0.6721 and Elder: 0.4212; $p<0.01$) intake.

Conclusion

From the assessed data, it was perceived that with the exception of carotene intake (all age groups), iron intake for male players (both the age groups), copper intake of younger female players and zinc intake of elder players (both the genders), the consumption of all other vitamins and minerals of female and male badminton players from age groups of 10-12 years and 13-15 years far exceeded the Indian RDAs, also corroborated by adequate to extra NAR recorded for majority of the subjects from both the age groups. Except female superiority for carotene intake (younger age group), male pre-eminence was evidently recorded among all the assessed consumption of vitamins and minerals. The iron intake of male players found to be satisfactory but female players showed iron deficiency which need to be overcome by consuming iron rich foods. Poor zinc intake among elder players likely to impact on player's immune system and metabolic system, which may directly effect on performance in badminton. Blood parameters showed majority of players fell well within the non-anaemic group with RBC, WBC and platelet well within the range. Positive correlation between vitamins such as pyridoxine, folate, carotene and minerals such as iron and copper with haemoglobin and RBC were noted. So with adequate intake of vitamins and minerals, haemoglobin and RBC can be maintained in normal range that can increase the oxygen transport capacity which ultimately helps player's aerobic endurance for intense and prolonged practice of game. Also proper vitamins and minerals also restrict the haemo dilution as intense training may increase blood plasma volume. But less intake of carotene may indirectly affect RBC production which may tend to cause low RBC and haemoglobin in future. WBC also had affirmative relation with pyridoxine, folate as well as zinc. WBCs increase the immune system of the body which can help the players to acclimatize at any altitude, any climate, and any season with diverse food intake and prowess to do rigorous and intense practice. Positive relationship between folate, vitamin C and iron with platelet indicated that with proper intake of these specific vitamins and minerals by the players, platelets count can be maintained in the range that helps to protect themselves from injury and also speedy recovery from any injury.

The idea that nutrients might boost up players performance is not new and well known to all but for optimum and successive performances, the competitive athletes need scientifically planned balanced diets by expert nutritionists considering the status of blood parameters, player's dietary assessment and the finding their interrelationship that came out from the present study. Hence, the diet must include the optimal amalgamation of these specific vitamins and minerals in recommended quantities to fuel their exclusive needs for performance enhancement.

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