Anthropometric Measurements, Energy and Micronutrient Intake: Effect on Physical Fitness Among Female Players Engaged in Different Sports Disciplines

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Abstract:

This research was undertaken to assess micronutrient status of female players engaged in volleyball, basketball & badminton. For this purpose, total 60 university &/state level female players (18-22 yrs) were selected. Height & weight of players were measured. Nutrient intake of players was calculated based on 24 hour's dietary recall method. Hemoglobin level was estimated. VO_2max of players was calculated. Players were found shorter & lighter than the standards for height & weight. Irrespective of sports, mean daily intake of players for energy, thiamine, riboflavin, iron & calcium was found to be less than recommended dietary allowances (RDAs). In contrast, mean daily intake of players for carotene, vitamin C & phosphorus was found to be more than RDAs ($p<0.01$). Mean hemoglobin level of players ranged between 11.10±1.96 to 11.50±1.50 g/dL. Aerobic work capacity of players was rated as 'superior' with mean VO_2max values ranged between 43.49±4.89 to 46.62±4.98 ml/kg/min. Poor micro nutrient intake of players could possibly be attributed to the skipping of meals as well as training/college schedule of players.

***Key* words**:

Micronutrient status, Energy, Calcium, Iron, VO_2max.

Introduction:

Vitamins and minerals do not provide energy, but they are very important in sports as they participate in the energy metabolism. Micronutrients play an important role in energy production, hemoglobin synthesis, and maintenance of bone health, adequate immune function, and protection of body against oxidative damage. Micronutrients assist with synthesis and repair of muscle tissue during recovery from exercise and injury. Exercise stresses many of the metabolic pathways where micronutrients are required, and exercise training may result in muscle's biochemical adaptations that increase micronutrient needs. Routine exercise may also increase the turnover and loss of these micronutrients from the body. As a result, greater intakes of micronutrients may be required to cover increased needs for building, repair, and maintenance of lean body mass in athletes (Driskell, 2006).

Vitamins & minerals serve primarily as regulators of metabolic functions, many of which are critical to exercise performance. Depending upon the nature of their sport, e.g. strength, speed, power, endurance, or fine motor control, athletes need mega doses of various vitamins & minerals to increase specific metabolic processes important to improved performance. Research has shown that a vitamin/mineral deficiency impairs physical performance. If this deficiency is corrected, performance usually improves.

The most common vitamins and minerals found to be of concern in athletes' diets are thiamine, riboflavin, folic acid, vitamin C, β-carotene, calcium, iron & electrolytes--sodium & potassium. Athletes at greatest risk for poor micronutrient status are those who restrict energy intake or have severe weight-loss practices, who eliminate one or more of the food groups from their diet, or who consume unbalanced and low micronutrient-dense diets (Woolf & Manore, 2006).

To meet growth needs, athletes require higher intakes of some vitamins & minerals than those for non athletes. The B vitamins are of special interest to athletes and exercisers because they govern the energy producing reactions of metabolism. Need for these vitamins increase proportionally with energy expenditure. It has usually been assumed that if athlete meets requirements for increased energy, the vitamin & mineral requirements will also be satisfied. Deficiency of micronutrients leads to lowering of training efficiency, and may cause training staleness. Minerals such as sodium, potassium, calcium, phosphorus & iron play an important role in achieving the winning edge for athletes (Smolin, 1997; Boyle, 2000).

This work is undertaken to assess the anthropometric indices, energy & micronutrient intake, hemoglobin level & physical fitness of young female players engaged in different sports disciplines.

Material and methods:

Selection of subjects:

A total of 60 female players engaged in regular practice & participated in sport tournaments were purposively selected as a sample. The athletes were young players from three sports disciplines namely ***volleyball (n=20), basketball (n=20) & badminton (n=20)***. The players aged between 18-22 years were taken from well known sports clubs/institutions of Vidarbha, Maharashtra. Players who were participating in regular practice schedules & in many sports events from the past few years (players were in the field from last 6-8 years) were mainly of choice. Table I shows game-wise classification of players. An interview-cum questionnaire schedule was designed to gather information from all players about their body measurements, dietary profile, hemoglobin level & physical fitness.

Anthropometric measurements:

Body measurements like height & weight of players were recorded using standard equipments & procedures. Body mass index (BMI) was calculated. Results were matched with standards for height for age & weight for height (ICMR/NIN, 2009).

Dietary Survey:

Precise information on food consumption pattern of subjects was gathered through 24-hour dietary recall method for three consecutive days. Three day's intake of energy & micronutrients by the players was computed using the standard food values (Gopalan et al, 2012) & means were derived. Nutrient intakes were compared with their respective RDAs (Satyanarayana, 1991).

Biochemical data:

Hemoglobin level of players was estimated. The hemoglobin level was estimated with the help of a trained pathologist using *Sahli's Hemometer.*

Physical Fitness:

A 12 minute's run-walk test was used to know aerobic work capacity of players. Based on the results of the field test, Vo_2max (ml/kg/min) of players was calculated (Nande & Vali, 2010).

Statistical analysis:

Data was collected, tabulated & grouped. Mean & standard deviation, range & percentages were calculated. Comparisons were made with the available standards. 'F' Test was applied to see the differences between the groups. Pearson's product moment coefficient of correlation method was used to derive relationship between various parameters. The difference was tested at both 1% & 5% levels of significance.

Result and discussion:

Volleyball, basketball & badminton players were found shorter & lighter as the group's means for height & weight were found less than the standard values. Volleyball players showed higher deficit for height (3.26%) while basketball players showed higher deficit for weight (18.73%). Between group comparison for height of players did not show significant differences ($F=2.68$, $p>0.05$). In contrast, significant variations were noticed for comparison between three sports disciplines for body weight ($F=3.60$, $0.01<p<0.05$), with volleyball players showed the lowest mean weight. Lesser variations were noticed between sports disciplines for mean BMI values which ranged between 19.32-20.86 kg/m^2. Data on mean height, weight & BMI of players is shown in Table II.

Irrespective of games, none of the players met the RDAs for energy, with energy intake deficit ranged between 40.66-41.41%. Deficient energy intake led to lower body weight of the players. Insignificant differences were seen between players from volleyball, basketball & badminton groups for energy intake ($F=2.16$, $p>0.05$). Energy intake showed direct correlation with body weight ($r=0.8769$, $p<0.01$) & BMI ($r=0.7990$, $p<0.01$). Table III presents mean daily intake of energy of players.

Thiamin & riboflavin are involved in energy production during exercise (Lukaski, 2004). For the present study, it was found out that mean daily intake of thiamine & riboflavin was found to be extremely less as compared to RDAs (% deficit ranged between 30.30-53.13 & 40-57.58, respectively). Greater individual variations were noticed for the intake of these two vitamins, however, between group differences were insignificant (F=1.87 & 1.65 for thiamine & riboflavin, respectively, p>0.05). Some data suggest that exercise may increase the need for thiamine & riboflavin as much as twice the current recommended amount (Woolf & Manore, 2006), however, these increased needs can generally be met with higher energy intakes. Therefore, it is important that athletes consume adequate amounts of all micronutrients to support their efforts for optimal performance and health. Inadequate intake of these two vitamins by the players under this study might be because of deficient intake of energy. Table IV presents mean daily intake of vitamins of players.

Lukaski (2004) postulated that folic acid is frequently low in female athlete's diets, especially those who are vegetarian or have disordered eating patterns. Here, for the present study, with the exception of volleyball group, players from rest of the two groups of sports showed higher mean daily intake of folic acid (% excess of RDAs for basketball-22.5 & badminton-32.5). Volleyball players were unable to meet the RDA of folic acid, with % deficit calculated as 7.5. Severe deficiency of folic acid may result in anemia and reduced endurance performance (Driskell, 2006).

The antioxidant nutrients, vitamins C & carotene play important roles in protecting cell membranes from oxidative damage. Because exercise can increase oxygen consumption by 10- to 15-fold, it has been hypothesized that long-term exercise produces a constant "oxidative stress" on the muscles and other cells (Powers et al., 2004) leading to lipid peroxidation of membranes. Because strenuous and prolonged exercise has been shown to increase the need for vitamin C, physical performance can be compromised with marginal vitamin C status or deficiency. Athletes who participate in habitual prolonged, strenuous exercise should consume 100-1000 mg of vitamin C daily (Lukaski, 2004; Keith, 2006). For the present research, mean daily consumption of vitamin C was found to be excess by 75-82%.

Volleyball group showed highest value for mean daily intake of vitamin C (F=3.22, 0.01<p<0.05).

Iron is required for the formation of oxygen-carrying proteins, hemoglobin and myoglobin, and for enzymes involved in energy production Oxygen-carrying capacity is essential for endurance exercise as well as normal function of the nervous, behavioral, and immune systems (Volpe, 2006). Iron depletion (low iron stores) is one of the most prevalent nutrient deficiencies observed among athletes, especially females. Iron deficiency, with or without anemia, can impair muscle function and limit work capacity (Haymes, 2006). Iron requirements for endurance athletes, especially distance runners, are increased by approximately 70% (Driskell, 2006). For the present study, higher between-group differences were observed for iron intake (F=3.10, 0.01<p<0.05) which could be attributed to higher intake of iron by basketballers as compared to volleyballers & badminton players. The high incidence of iron depletion among athletes is also attributed to inadequate energy intake. Table V presents mean daily intake of minerals of players.

Similar to iron intake, mean calcium intake of players from volleyball, basketball & badminton groups was found to be highly deficient than RDAs. Between group variations were found high (F=3.45, 0.01<p<0.05) Female athletes are at greatest risk for low bone mineral density if energy intakes are low, dairy products and other calcium-rich foods are inadequate or eliminated from the diet, and menstrual dysfunction is present (Nickols-Richardson et al., 2006; Nattiv et al., 2007).

Sodium is a critical electrolyte, particularly for athletes with high sweat losses. Many endurance athletes may require much more than the upper limit for sodium (2-3 g/day)(Kenney, 2004; Palmer & Spriet, 2008). Mean daily intake of sodium by the players under this study ranged between 2679.45-2865.59 mg. During intense exercise, plasma potassium concentrations tend to decline to a lesser degree than sodium (Sawka et al., 2007). Mean daily intake of potassium by the players ranged between 1950.54-2550.0 mg which was found to be less than sodium intake.

Mean hemoglobin level of players from volleyball, basketball & badminton groups did not differ significantly ($F=1.80$, $p>0.05$). Mean hemoglobin level for all three groups of players was below the cut-off-level given by WHO indicating mild degree of anemia. Greater within-group differences were noticed for badminton players followed by volleyball players. Lower hemoglobin level can result in compromised sports performance. One of the important factors in player's low hemoglobin levels may be haemodilution. Strenuous training leads to an increase in plasma volume & absolute quantity of hemoglobin, the increases may not be proportional; plasma volume increases more than does the hemoglobin level (Williams, 1990). Hemoglobin level reflected positive relationship with energy & iron intake ($r=0.3560$ to 0.7821), however, no specific correlations were found out between hemoglobin level & folic acid intake of players from all three groups. Table VI presents data on mean hemoglobin level of players.

Volleyballers, basketballers & badminton players were rated "above average" for the results of 12 minute's run-walk test. Insignificant difference was noticed between the three sports groups for this field test indicating more or less similar aerobic work capacity. Factors like motivation & determination can also lead to improvement in the results of field test. Table VII presents results of 12 minute's run-walk test & VO_2max of players.

An attempt was made to calculate maximum oxygen uptake which reflects the aerobic physical fitness. VO_2max is an important determinant of the endurance capacity of players during prolonged, sub-maximal exercise. Players from all three groups were rated "superior" for their VO_2max as mean values were above 40 ml/kg/min. Aerobic work capacity & VO_2max showed direct relationship with energy intake ($r=0.4788$ to 0.8660), iron intake ($r=0.3219$ to 0.8820) & hemoglobin level ($r=0.6671$ to 0.8590). It can be said that dietary intake is effectively related with performance of players on the field.

Table I: Game-wise classification of players (n=60)

Sports Disciplines	No. of Subjects	Age (yrs) M±SD *(Range)*
Volleyball	20	19.89±0.95 *(18.75-21.08)*
Basketball	20	20.13±1.62 *(18.50-21.75)*
Badminton	20	20.45±1.0 *(18.66-21.41)*

Table II: Data on mean height, weight & BMI of players

Sports Disciplines	Height (cm)			Weight (kg)			BMI (kg/m²)
	M±SD	Std#	% deficit	M±SD	Std#	% deficit	
Volleyball (n=20)	158.65±5.20 *(153.50-*	164	3.26	48.90±6.50 *(43.50-*	59	17.12	19.41±5.20 *(17.50-*
Basketball (n=20)	162.80±2.10 *(159.25-162.30)*		0.73	51.20±3.80 *(48.50-55.20)*	63	18.73	19.32±4.22 *(18,50-21.20)*
Badminton (n=20)	159.68±2.53 *(157.00-162.00)*		3.05	53.20±5.80 *(48.00-61.00)*	60	11.33	20.86±3.10 *(18.50-25.00)*
F Values	2.68			3.60**			2.16

(ICMR/NIN, 2009); Figures in parenthesis indicate range; ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); F values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

Table III: Mean daily energy intake of players

Sports Disciplines	Energy Intake (kcal/day)				F Value
	M±SD	**Range**	**RDA#↕**	**% Deficit**	
Volleyball (n=20)	2018±815	1800-2810	3423	41.05	2.16
Basketball (n=20)	2100±490	1750-2400	3584	41.41	
Badminton (n=20)	2210±921	1800-2550	3724	40.66	

#RDA's referred from **Satyanarayana (1991);** ↕RDAs are based on actual body weight; F value indicates insignificant difference at both 5% & 1% levels (p>0.05).

Table IV: Mean daily intake of vitamins of players

Nutrients		Sports Disciplines Volleyball (n=20)	Basketball (n=20)	Badminton (n=20)	F Values
Thiamine (mg)	M±SD	**1.42**±0.2 *(0.89-1.25)*	**1.56**±0.2 *(0.54-3.70)*	**2.30**±0.4 *(0.76-4.80)*	1.87
	RDA#↕	3.0	3.2	3.3	
	% Deficit	52.67	53.13	30.30	
Riboflavin (mg)	M±SD	**1.8**±0.3 *(0.95-1.80)*	**1.9**±0.08 *(0.8-1.70)*	**1.4**±0.5 *(1.20-1.90)*	1.65
	RDA#↕	3.0	3.2	3.3	
	% Deficit	40	40.63	57.58	
Folic Acid (µg)	M±SD	**185.0**±59.4 *(135.5-265.2)*	**245.0**±65.0 *(158.7-275.0)*	**265.0**±59.O *(149.0-269.5)*	2.10
	RDA#¶	200	200	200	
	% Deficit/Excess	-7.5	+22.5	+32.5	

Nutrients		Volleyball	Basketball	Badminton	F Values
Carotene (µg)	M±SD	**6850.0**±555.6 *(6210-7490)*	**5468.5**±716.1 *(4435-5486)*	**5595.3**±939.0 *(4325-6990)*	3.26**
	RDA#¶	4800	4800	4800	
	% Excess	42.71	13.93	16.56	
Vitamin C (mg)	M±SD	**175.0**±20.00 *(140.0-190.5)*	**145.0**±34.9 *(110.0-185.5)*	**135.6**±45.0 *(124.7-175.5)*	3.22**
	RDA#↕	75	79	82	
	% Excess	133.33	83.54	65.37	

#RDA's referred from **Satyanarayana (1991);** ↕RDAs are based on actual body weight; ¶RDAs from ICMR/NIN (2009); Figures in parenthesis indicate range; ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); F values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

Table V: Mean daily intake of minerals of players

Nutrients		Sports Disciplines			F Values
		Volleyball (n=20)	Basketball (n=20)	Badminton (n=20)	
Iron (mg)	M±SD	**25.50**±3.45 (22.5-28.5)	**35.5**±7.50 (25.5-38.5)	**28.54**±4.5 (23.5-29.80)	3.10**
	RDA#↕	45	47	49	
	% Deficit	43.33	24.47	41.76	
Calcium (mg)	M±SD	**1050.0**±205.9 (835.0-1278.0)	**949.0**±69.5 (685.0-1020.0)	**967.8**±160.0 (600.50-1050.0)	3.45**
	RDA#↕	1505	1575	1637	
	% Deficit	30.23	39.75	40.88	
Phosphorus (µg)	M±SD	**2050.0**±356.6 (1800.5-2300.0)	**2367.0**±220.0 (1850.0-2500.0)	**2150.5**±221.5 (1900.2-2560.0)	1.09
	RDA#↕	1505	1575	1637	
	% Excess	36.21	50.29	31.37	
Sodium (mg)	M±SD	**2679.45**±230.0 (2500.0-2880.0)	**2805.0**±155.78 (2555.0-3100.0)	**2865.59**±230.0 (2550.0-3002.0)	1.32
Potassium (mg)	M±SD	**2035.67**±96.8 (1860.0-2350.4)	**1950.54**±145.0 (1675.5-2030.7)	**2550.0**±156.5 (1990.5-2850.7)	2.89

#RDA's referred from **Satyanarayana (1991);** ↕RDAs are based on actual body weight; Figures in parenthesis indicate range; ** - Significant at 5 % level but insignificant at 1 % level (0.01<p<0.05); F values without any mark indicate insignificant difference at both 5% & 1% levels (p>0.05).

Table VI: Data on mean hemoglobin level of players

Sports Disciplines	Hemoglobin Level (g/dL)			F Value
	M±SD	C.O.L#	Range	
Volleyball (n=20)	11.20±1.89	12	10.20-12.80	1.80
Basketball (n=20)	11.50±1.50	12	11.50-12.50	
Badminton (n=20)	11.10±1.96	12	10.00-13.80	

C.O.L-Cut-off-level by world health organization (WHO)(**Bamji et al., 2005);**
F value indicates insignificant difference at both 5% & 1% levels (p>0.05).

Table VII: Data on 12 minute's run-walk test & VO_2max of players

Sports Disciplines	Distance Covered (meters/12 minutes)			VO_2max (ml/kg/min)		
	M±SD	Range	Performance Assessment	M±SD	Range	Analysis of VO_2max Score
Volleyball (n=20)	**2450**±560	1850-3000	Above Average	**43.49**±4.89	30.07 - 55.78	Superior
Basketball (n=20)	**2345**±860	1900-2800	Above Average	**41.14**±8.66	31.19 - 51.31	Superior
Badminton (n=20)	**2590**±540	2000-3000	Above Average	**46.62**±4.98	33.43 - 55.78	Superior
F Values	1.20			1.35		

F values indicate insignificant difference at both 5% & 1% levels (p>0.05).

Conclusion:

It is concluded that nutrient intake of players is a critical determinant of their performance & ability to compete. Players were accustomed to skipping meals which lead to inadequate intake of energy & vital micronutrients such as thiamine, riboflavin iron & calcium. Varied dietary practices & consumption of imbalanced diets resulted in altered micro nutrient status of players. Hemoglobin level in some players indicates a need for scientifically planned balanced diets by expert nutritionists. There is a need of consumption of well balanced diet specially designed for sports persons engaged in regular practice.

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