Anthropometric measurements and nutritional adequacy of elite Sri Lankan volleyball players

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Abstract— *Previous research has shown that nutrition plays a significant role in successful performance in sports. The objective of this study was to assess anthropometric measurements and nutrient adequacy in competitive volleyball players.*

The sample consisted of 48 national and international level volleyball players. Data were collected 3 months prior to the 10th South Asian Games held in Colombo. Dietary history was obtained by 24 hour dietary recall method using an interviewer-administered questionnaire. Nutrient intake was calculated using diet analysis software. BMI and percentage body fat were calculated using height, weight and skin fold thickness.

All volleyball players were in the recommended BMI range (21±1.708 kg/m^2) though slightly higher than their counterparts in the region. Mean percentage of body fat 15.35±4.34 in males and 16.75±6.01 in females was not comparable with the players in the continent. Only a minority (10%) of players had daily calorie adequacy; approximately 60% of players had 50-75.9% of daily calorie adequacy. None of the volleyball players have consumed proteins to meet recommended daily requirement. The dietary intake of calcium, riboflavin and thiamin were more than the Recommended Daily Adequacy (RDA) in over 75% of volleyball players but iron and ascorbic acid intakes were below the RDA in the majority of players.

The analysis of nutritional profile has shown that the volleyball players have not received the required amounts of both macro and micronutrients though the anthropometric parameters are almost comparable with their counterparts in the region. The findings suggest the need for sport authorities to plan and recommend optimum dietary schedules along with appropriate nutritional counseling.

Keywords— **Anthropometric, Nutrient intake, Volleyball**

I. INTRODUCTION

Volleyball is a sport which requires an athlete not only to jump high and hit the ball hard but also to perform for 1 to 3 hours; though mainly an anaerobic sport, the aerobic capacity of players is of crucial importance in view of longer play time (Scates, 1993). Thus the athletes require optimum height, muscular strength and both aerobic and anaerobic energy for satisfactory performance. Appropriate nutrition is of crucial importance to enable volleyball players to reach their peak performance and replace lost energy (Carey, 1987).

Anthropometric profiles are an indicator of suitability for the competition at the highest level in a specific sport as reported by Classens et al (2005) and will in turn become sensitive indicators of physical growth and nutritional status of sport personnel required for optimal performance (Wilmore & Costill, 1999; Chatterjee & Bandhyopadhyay, 2006). Proper evaluation of these parameters will help quantify the predicted performance of sport personnel (McArdle & Katch, 2001).

II. LITERATURE REVIEW

Few are the studies (Thompson, 1998; Chapman and et al, 1997; Elmadfa, 1994; Morrow and et al, 1979; Viviani & Baldin, 1993; Bernadot, 1996) done globally and none in Sri Lanka that assess nutritional profile with anthropometric features in players of volleyball and compared with recommended guidelines.

Balance nutrition is an essential factor for optimum performance of sports personnel. The diet of an athlete should be planned to provide the nutritional requirements required during training for competition for optimal health and performance.

In general recommendation for all athletes is to consume 60-70% of total energy intake from carbohydrates, 12-15% from protein and 25-30% from fats (Katch & Mc Ardle, 1993).

There is limited information on the direct impact of low intake of vitamins and minerals on the physical performance of humans (Lukaski, 2004).

According to Lukasaki et al, (2004) vitamin deficiencies do not impair performance in contrast to mineral deficiencies. Although micronutrients do not have a direct relationship with the sports performance, they are known to be important in cellular metabolism with an indirect influence on performance.

Although vitamin deficiency does not impair sports performance significantly some studies (Lukaski et al, 2004; Fry et al, 2006) have suggested the beneficial effects of supplemental vitamins in sports personnel in states of deficiency states.

Proper nutrition is critical in order to enable the volleyball player to reach his or her peak performance and replace the lost energy (Carey, 1994).

Findings of studies have shown certain anthropometric characteristics to be beneficial in volleyball players, including greater height (Gladden & Colacino, 1978; Spence et al, 1980), greater mass (Kovaleski et al, 1980; Spence et al, 1980) lower body fat percentage (Morrow et al, 1979; Fleck et al, 1985).

The purpose of this study was therefore to assess nutritional and anthropometric profiles of elite Sri Lankan volleyball players in Sri Lanka.

III. METHODOLOGY

Forty eight national and international level volleyball players were studied after having obtained their informed consent in writing. The data was collected during the competitive season, 3 months prior to the 10th South Asian Games held in Colombo.

A. Dietary assessment

Dietary intake was assessed by the 24 hours dietary recall method using an interviewer-administrated questionnaire. Each sport personnel was asked to record the quantities of food and beverages taken on three non-consecutive days (two days during the week and one day over the weekend). The recording of food and beverages was done according to standard household units introduced to players prior to the activity. The collected dietary recalls were analyzed by a nutrition support software 2000 designed by the Institute of Brain Chemistry, London and updated with food composition of Sri Lankan food to determine the daily intake of energy and nutrients. The athletes' dietary adequacy for the ingested macro and micronutrients was determined by comparing with the recommended dietary values for Sri Lankan players. Percentage calorie adequacy of players' diet was calculated parallel to the dietary recall by considering the intake and expenditure of energy on a daily basis.

Energy expenditure of players was assessed by considering all activities from the time of waking up and going to sleep in the night. Equation by Judy & Wolinsky in the year 2000 was used in determining the energy expenditure in relation to different activities.

Energy Expenditure (Kcal) equals to

Metabolic equivalent (MET) × Body weight (kg) × Hours of activity

Percentage calorie adequacy of the daily diet was then calculated by comparing the average energy intake with the energy expenditure of the sports personnel in a 24 hours period.

Percentage Calorie adequacy equals to

$$\frac{\text{Energy intake of the subject} \times 100\%}{\text{Energy expenditure}}$$

Adequacy of protein intake was calculated on the recommendations made by Wickramanayake (2007) for Sri Lankan players (1.2g/kg/day).

Percentage Protein adequacy equals to

$$\frac{\text{Protein intake} \times 100}{\text{Recommended protein intake}}$$

Adequacy of micronutrient intake was determined by comparing to Recommended Dietary Allowance (RDA) values for Sri Lanka.

% Micro nutrient adequacy equals to

$$\frac{\text{Micronutrient intake of the subject} \times 100\ \%}{\text{Recommended micronutrient intake (RDA)}}$$

B. Anthropometric assessment

Anthropometric data (age, sex, height, weight, percentage of body fat) were assessed. Height was measured to the nearest centimeter without shoes using a MIZUNO stadiometer and weight was recorded to the nearest 0.1kg with a digital scale (Seca 835). Body mass index (BMI) was calculated for all athletes. Skinfold measurement was taken from four different sites (triceps, abdomen, supra illiac and thigh) using a Harpenden skinfold caliper. Percent body fat was calculated using formula suggested by Robert & David (1996).

IV. RESULTS

Standard descriptive statistics (mean±SD) were determined for directly measured and derived variables.

The volleyball players' mean height was 1.82 ± 0.07 m in males and 1.66 ± 0.069 m in females; mean weight was 71.54 ± 8.005 kg in males and 55.99 ± 13.48 kg in females. Measures of BMI and % body fat are presented in Table 1.

BMI of all players were comparable to others while % body fat was relatively higher than in comparable groups.

Parameter	Male Mean ±SD	Female Mean ±SD
Age	15.35±4.34	16.75±6.01
Height (m)	1.82 ±0.07	1.66 ±0.069
Weight (kg)	71.54 ±8.005	55.99 ±13.48
BMI	21.37 ±1.521	20.07 ±2.06
Body fat %)	15.35 ±4.34	16.75 ±6.01

Table 1. Anthropometric characteristics

In the majority of players, daily calorie adequacy was suboptimal in the competitive period. Only in about 10% of male and female players had an adequate daily calorie adequacy of ≥ 100%. Calorie adequacy was below 50% in 10 % of males & 20% of females; approximately 70% of males and 60% of females had their calorie adequacy ranging between > 50% and < 100%.

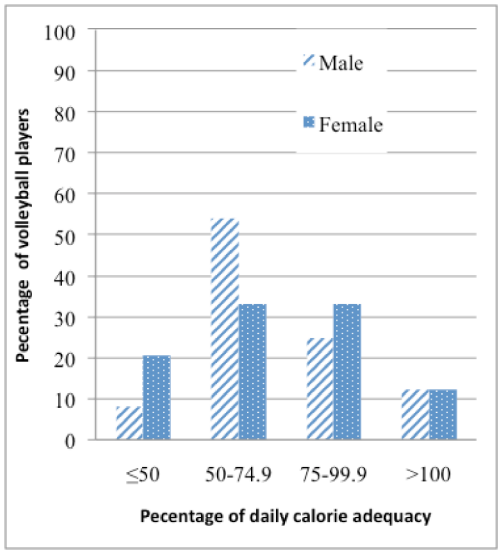

Table 2: Calorie adequacy of volleyball players

None of the players had optimal level of protein intake during the competitive period though all had an intake of over 50% as shown on Table 3.

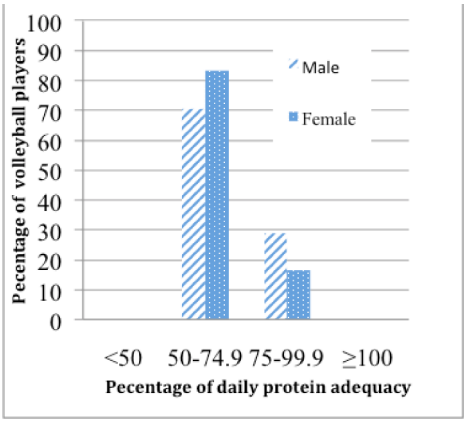

Table 3. Pecentage Protein adequacy of volleyball players

Over 97% of volleyball players have consumed more than RDA of calcium during the competitive season. However the intake of iron and ascorbic acid has been insufficient in approximately 60% and 70% of players respectively. Under consumption of Thiamin (23%) and Riboflavin (6%) has been noted only in a minority of players as per Table 4.

Micro nutrient	< RDA*		> RDA*	
	N	%	N	%
Ca^{2+}	1	2.08	47	97.9
Fe^{2+}	28	58.3	20	41.6
Thiamin	11	22.9	37	77
Riboflavin	3	6.25	45	93.75
Ascobic acid	32	66.6	16	33.3

Table 4. Micro nutrient adequacy of volleyball players

V. DISCUSSION

In the present study, the anthropometric measurements and nutritional adequacy of elite Sri Lankan volleyball players were assessed. The results have revealed some of physical and dietary profiles in unfavourable range with a likelihood of negative impact on the performance of players.

The influence of anthropometric parameters on the performance have been studied by the previous researchers. One of the most specific physical attributes highlighted in favour of volleyball players is the optimal height (Lidor & Ziv, 2010) as the game requires handling the ball above the head. Although the mean height of our male players was comparable with counterparts in West Bengal, India (173.10±4.19) reported by Bandyopdhyay (2007) and in Punjab (181.93±6.37) obtained by Koley and et al (2010). The values were much lower than their English counterparts (1.91±0.05m) reported by Duncal et al (2006). The mean height of female players was greater than the players in Punjab (159.67±5.85) reported by Koley and et al and lower than the American players (176.70±4.60) as reported by Ferris and et al (1995).

In the present study, the mean body weights and BMI of male and female players were comparatively higher than the values reported by Koley and et al (2010). Greater body weight in volleyball players might be a disadvantage in attaining a good jump height in lifting a greater weight as suggested by Koley et al (2010).

Volleyball players of the study group had a percentage body fat (15.35±4.34) in male players and (16.75±6.01) in female players. The values of female players were lower compared to values of Fleck (1983) and Tania & Elaine (2003), 19% and 20.5 % respectively. However the values reported by Koley and et al (2010) for male players were comparatively lower (mean: 13.48%) with significantly

higher values for the female players (mean: 20.4%). An increased fat weight may be detrimental in volleyball in lifting the body against gravity. Lower proportion of body fat was identified in favour of enhanced performance by Schutz (1999) and Morrow et al (1979).

A number of previous studies have pointed to the unbalanced diet resulting in negative energy balance (Leydon & Wall, 2002) along with marginal intake of several important micronutrients in athletes (Beals, 2002; Kim et al, 2002; Leydon & Will, 2002; Clark et al, 2003).

Intense physical activity of volleyball players requires an adequate intake of energy to be expended on aerobic and anaerobic needs of energy during the game to maximize the performance. Approximately 10% of exercise energy needs are met by proteins in an endurance sport like volleyball (Brotherhood, 1984; Lemon et al, 1981); Consumption of proteins in excess has the potential for increased excretion of calcium with detrimental effects (Butterfield, 1991). In the present study, the majority of players have not received the required amounts of proteins and calories to optimize their performance.

The study by Sauzana et al (2002) on Greek volleyball players using a 3 day food record found that protein intake was satisfactory whereas fat consumption was above recommended values at the expense of carbohydrate intake.

Unbalanced nutrition appears to be a major determinant of underperformance (Schokman et al, 1999; Sugiura et al, 1999).

Improving macro and micronutrient intakes could ensure adequate energy for performance and minimize fatigue in players.

According to Gimmston et al, (1997) volleyball is a sport of impact which produces a reaction power by hitting the ground 3 to 6 times the body mass power and therefore has a higher bone density particularly hips and lumbar spine than the non players of same age. Based on the observation, calcium requirements of volleyball players are assumed to be greater to keep up with the nature of the game. The players of studied group had an intake of calcium (> RDA in over 97%) favouring the rise in bone density as per observations of Gimmston et al.

Being the carrier of oxygen in the haemoglobin molecules, iron has an indirect impact on the aerobic synthesis of energy and thereby the level of performance of players.

The majority (58%) of players of study group had an intake of iron below the recommended levels with likely negative impact on the performance. A study by Ainsworth et al (1992) recommends female athletes for additional intake of iron in view of menstrual losses.

As per recommendations of ADA (American Dietetic Association) and CDA (Canadian Dietetic Association) in J Am Diet Assoc (1993) vitamins and minerals play an important role in metabolism of macronutrients.

An adequate intake of antioxidant vitamins is essential to protect athletes against oxidative damage (Maughan, 1999) and for the optimum function of immune system.

B-complex vitamins riboflavin (B_2) and thiamin (B_1) have been linked to the intake of energy as reported by Armstrong, Meresh (1996) and Rokitzki et al (1994).

Ascorbic acid (Vitamin C) being an effective anti-oxidant is required in metabolic reactions involving synthesis of collagen, immunologic functions and enhancing absorption of non-heme iron preventing iron deficiency anaemia. The intake was suboptimal in the majority of players in the study group.

In this study group of players, the intake of ca^{+2} and riboflavin has been satisfactory in the majority. Over 50% of players in the study group have underconsumed iron and ascorbic acid during the competitive season.

Though the players had a lower intake of iron and ascorbic acid compared to NRC/ RDA (1989) and Monsen's guidelines (2000), it may not be possible to conclude dietary deficiency in view of inherent limitations in a 3-day food-intake record such as changes in nutritional behavior, cooperation of players and the estimation of quantities.

The overall results show that the volleyball players have not received the required amounts of both macro and micronutrients during the competitive season. These findings suggest the need for closer supervision of dietary schedules of players along with appropriate nutritional counseling to maximize performance.

VI. CONCLUSIONS

The anthropometric results of players though revealed favourable values for BMI, the body fat % are in excess of recommended values for comparable players of volleyball with a possible negative impact on the performance.

Further, the suboptimal intake of some of vital macro and micronutrients could have had detrimental influence on performance as a result of insufficient energy needs during competition.

The importance of a balanced diet in improving physical fitness and thereby the performance should have been stressed during the training period.

The findings should be an eye opener for sports authorities to plan and recommend optimum dietary schedules along with appropriate nutritional counseling by sport nutritionists especially during the competitive period.

The education of players on the importance of dietary adequacy for health and enhanced performance could not be underestimated in promoting fitness and physical wellbeing of players.

Further studies are recommended to evaluate the performance of players against their anthropometric and nutritional profiles to recommend ideal parameters to guide the players in Sri Lanka.

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