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Comparison of dietary intake, energy adequacy and anthropometric parameters between Indian junior male and female hockey players

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ABSTRACT

Introduction: Athletes' performance is highly depended on their nutritional status for optimising performance. This study is aimed at assessing and comparing adequacy intake of nutrients and energy between male and female Indian hockey players. **Methods:** A total of 40 Indian junior national hockey players with an equal number of males and females were selected randomly by the Sports Authority of India, Kolkata. Mean age of males was 18.2±2.3 years while that of females was 17.1±2.2 years. Dietary intake was assessed based on a 3-consecutive-day, 24-hour dietary recall and frequency intake questionnaire. Dietary intake adequacy was determined according to the Recommended Dietary Allowance for India (2010). Energy requirement was estimated by the basal metabolic rate based on the Harris-Benedict formula and multiplied by an index of physical activity. Various anthropometric parameters were assessed using standard procedures. **Results:** Total energy intake was significantly lower in both male (2622±450 kcal) and female (1848±236 kcal) when compared with their total energy expenditure (male: 3621±127 kcal, female: 3049±115 kcal; $p<0.00$). Dietary intake consisted of low fat (male: 53.5±14.01g; female: 34.0±8.33 g) and high carbohydrate (male: 431.7±85.90 g; female: 317.5±45.69 g). Insufficient intake of iron, folic acid, zinc, B-vitamins and vitamin-C were found among female participants, but not in the males. Significant differences were observed in muscle mass and haemoglobin level between the sexes. **Conclusion:** The study revealed inadequate dietary intake among hockey players, especially among the females. Individualised nutritional orientation, nutrition education and dietary interventions are recommended for Indian hockey players towards improving their performance.

Keywords: Hockey players, India, total energy expenditure, vitamins, minerals, nutrition

INTRODUCTION

The importance of nutrition in endurance sports is well established. Athletes' performance is highly depended on their nutritional status; hence, adequate nutrition is necessary to optimise their performance. Hockey is characterised by high intensity passages of play, mixed with low intensity activities, including standing, walking, jogging. Players must perform continuously for 70 minutes with just one 5-10 mins interval. Good aerobic endurance is required to support repetitive bouts of high intensity exercise

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(Bishop *et al.,* 2015). The intermittent high intensity pattern of activity during matches requires a high function of both aerobic and anaerobic energy delivery pathways (Manna *et al., 2010*). Performance during intermittent sports is dependent upon a combination of anaerobic and aerobic energy systems, both of which rely on muscle glycogen and/or blood glucose as an important substrate for energy production (Baker *et al.,* 2015).

The role of a balanced diet is well recognised for helping to maximise the physical efficiency of bodily function and hence improve the effectiveness of training. All the macro, micro nutrients, fluids and electrolytes play a decisive role in body composition of athletes (Thomas *et al.*, 2013). High intensity training demands a higher nutritional need. Moreover, because of the heightened requirement for micro- and macro-nutrients, during training, athletes are often much more vulnerable to any deficiencies, compared to the general population (Nowacka *et al.,* 2010). Recent studies describe that an athlete's diet is not fulfilling the energy (Coutinho *et al.,* 2016; Sangeetha *et al.,* 2014), carbohydrates requirements (Wardenaar *et al.* 2017) and also deficit in intake of vitamins and minerals (Wardenaar *et al.*, 2017, Raizel *et al.*, 2017).

In India, there are limited published data on the nutritional assessment and dietary intake of elite Indian hockey players. Hence, the aim of the present study was to compare dietary intake, energy intake versus energy expenditure, and anthropometric parameters between Indian male and female junior players, in Kolkata.

MATRERIALS AND METHODS

Forty young hockey players (20 male and 20 female) with an age range of 13-22 years representing India were selected randomly by the Sports Authority of India (SAI) in Kolkata. These players were at least state level performers with minimum of 3-4 years of formal training history. They belonged to almost the same socio-economic status and have similar dietary intake during training. Participants signed an informed consent form before the verbal interview and testing. Inclusion criteria included being medically fit with no history of hereditary and cardio respiratory diseases. All participants were clinically examined by the SAI physicians, who specialised in Sports Medicine (Debnath *et al.*, 2016). Various anthropometric parameters were assessed in the Human Performance Laboratory at Sports Authority of India, Kolkata.

Training regimen

The training programme applied to the present subjects consisted of aerobic and anaerobic training, scrimmaging, and different resistance training along with flexibility exercises. By and large, all the players underwent training on an average duration of 4-5 hours a day. One-hour training session both in the morning and afternoon was fixed for all the players to improve the physical fitness component while the rest of the sessions were fixed for skill/technical and tactical training. Total training period was about 30 hours in a week excluding Sunday. Players had also undergone mental training sessions in addition to the physical and skill/technical training programmes.

Dietary assessment

The dietary assessment was based on three consecutive 24-hours dietary recall method. This is the most commonly used dietary assessment method to estimate dietary intake (Shim *et al.,* 2014; Wierniuk & Włodarek, 2013). The serving sizes of the meals consumed by athletes were recorded according to home-based

measurements followed by conversion into grams and milligrams. The 'Diet soft' Software package (Invincible Ideas, Delhi) was used to determine calorie and the nutritive values of foods consumed based on Indian standards (Narasinga & Sivakumar, 2010).

Energy expenditure

Basal metabolic rate (BMR) was calculated using modified Haris-Benedict equation (Wierniuk & Włodarek, 2013) followed by multiplying an index of physical activity, assumed here as 2.3, for individuals performing heavy physical activity (Narasinga & Sivakumar, 2010).

Anthropometric measurements

Height (cm) and body weight (kg) were measured by anthropometric rod and digital weighing instruments respectively, using standard procedures (Debnath *et al.*, 2016). Body Mass Index (BMI) was calculated from body height and weight measurements.

Body composition including lean body mass (LBM), fat free mass (FFM), fat mass (%) were measured by using a multi-frequency bioelectrical impedance analyser (Maltron Bioscan 920- 2, Made in UK) (Bolanowski & Nilsson, 2001). Total body electrical impedance to an alternate current (0.2 mA) with four different frequencies (5, 50, 100 and 200 KHz) was measured. Measurements were taken using the standard testing manual of Maltron International. The laboratory tests were performed at a room temperature varying from 23-25°C with the relative humidity varying between 50-60%.

Statistical analysis

Data were analysed using the SPSS software version 16.0 for Windows (IBM Corp., USA). All values expressed as means±standard deviation (SD). A confidence level at 95% (p<0.05) was considered as significant. Parametric test one-way ANOVA was done for normally distributed data. As the nutrient consumption data was not normally distributed, non-parametric Mann–Whitney test was used to study the differences between male and female hockey players.

RESULTS

Table 1 represents descriptive statistics of all the anthropometric and nutritional parameters of both the male and female Indian hockey players respectively. There is no significant difference in the mean age between the sexes, while a significant difference was shown in the height and weight, but not in their mean body mass index (BMI) status (Table 2). Similarly, fat free mass was also found to be higher in male players (87.6±5.82%) than the female (83.0±7.77%), but the difference was statistically insignificant. Haemoglobin (Hb) level was significantly higher in male players as compared to their female counterparts.

Table 3 represents the intake of macronutrients of male and female hockey players. The total energy consumption was significantly higher in the males (2622±450 kcal) than female athletes (1848±236 kcal). The protein intake of the male players was significantly higher (110.9±15.20 g and 77.4±9.74 g, respectively). The average protein intake was adequate among both groups (>1.5 g/kg body weight). A significant difference was also observed in total fat and carbohydrate consumption between the sexes. Carbohydrates provide 65% of total calorie intake, while fat and protein provide 18% and 17% respectively among the male players. On the other hand, carbohydrates, fat and protein contributed 67%, 16% and 17% of total calories, respectively for the female players.

Table 1. Anthropometric and nutritional parameters of Indian junior male and female hockey players

Parameters	*Male*					*Female*				
	Range	*Minimum*	*Maximum*	*Mean±SD*	*Std. Error*	*Range*	*Minimum*	*Maximum*	*Mean±SD*	*Std. Error*
Age (yrs)	7.4	12.8	20.2	17.1±2.21	0.50	7.9	14.0	21.9	18.2±2.27	0.51
Height (cm)	21.0	156.0	177.0	168.4±1.24	5.54	10.0	153.0	163.0	158.3±3.48	0.78
Weight (kg)	17.0	53.0	70.0	58.4±0.91	4.07	17.0	37.0	54.0	48.6±4.86	1.09
BMI	4.1	18.7	22.8	20.6±0.28	1.26	6.2	15.8	22.0	19.5±1.77	0.40
Muscle mass (kg)	23.1	70.0	93.1	87.6±1.30	5.82	32.5	64.0	96.5	83.0±7.77	1.74
Fat mass (%)	23.0	6.9	30.0	12.4±1.29	5.78	35.5	3.5	39.0	17.3±8.50	1.90
Haemoglobin (g/dl)	2.0	11.4	13.4	12.3±0.13	0.57	2.6	9.4	12.0	10.6±0.69	0.15
Energy (kcal)	1285	2013	3298	2622±450	101	908	1428	2336	1848±236	53
Protein (g)	50.5	83.7	134.2	110.9±15.20	3.40	36.0	56.9	92.9	77.4±9.74	2.18
Fat (g)	47.1	37.4	84.6	53.5±14.01	3.13	31.2	18.6	49.8	34.0±8.33	1.86
Carbohydrate (g)	283.2	293.0	576.2	431.7±85.90	19.21	163.2	235.9	399.1	317.5±45.69	10.22
Dietary fibre (DF) (g)	8.6	9.5	18.0	13.6±2.31	0.52	5.0	7.6	12.6	11.1±1.97	0.44
Insoluble DF (g)	6.6	6.9	13.5	10.8±1.99	0.44	4.3	6.1	10.5	9.0±1.83	0.41
Soluble DF (g)	2.4	2.2	4.6	2.8±0.67	0.15	0.6	1.5	2.1	1.9±0.22	0.05
Calcium (mg)	900.2	500.7	1400.8	845.5±358.86	80.24	386.3	490.6	876.9	678.0±81.32	18.18
Phosphorous (mg)	1188.3	1720.1	2908.3	2364.0±384.97	86.08	779.9	1221.7	2001.6	1594.6±237.91	53.20
Iron (mg)	18.4	10.8	29.2	20.0±4.92	1.10	16.2	1.2	17.4	11.2±3.78	0.85
Zinc (mg)	7.2	6.5	13.7	10.1±2.49	0.56	3.7	5.2	9.0	6.9±1.19	0.27
Beta carotene (µg)	2756.0	652.6	3408.6	1674.6±779.02	174.19	718.5	391.7	1110.3	683.5±210.32	47.03
Retinol (µg)	457.0	426.0	883.0	620.0±165.68	37.05	84.0	378.0	462.0	415.2±27.23	6.09
Thiamine (mg)	2.0	0.5	2.6	1.7±0.53	0.12	1.0	0.4	1.4	0.8±0.36	0.08
Riboflavin (mg)	1.3	0.5	1.7	1.2±0.27	0.06	1.0	0.0	1.0	0.7±0.26	0.06
Niacin (mg)	17.4	3.4	20.8	12.6±4.49	1.00	7.9	4.1	12.0	8.5±1.74	0.39
Pyridoxine (mg)	0.7	0.9	1.6	1.1±0.20	0.04	0.5	0.4	0.9	0.6±0.11	0.03
Folic acid (µg)	190.1	207.8	398.0	281.2±51.75	11.57	83.3	139.6	222.8	180.0±27.88	6.24
Vitamin C (mg)	108.5	26.4	134.9	60.1±32.79	7.33	22.1	18.2	40.3	27.2±7.70	1.72
Vitamin B_{12} (mg)	1.9	1.4	3.2	2.3±0.74	0.17	0.0	1.6	1.6	1.6±0.00	0.00

Table 2. Mean, SD and level of significance of various anthropometric parameters and haemoglobin level of Indian junior male and female hockey players

Parameters	*Male (n=20)*	*Female (n=20)*	*F-value*
Age (yrs)	17.1±2.21	18.2±2.27	0.10
Height (cm)	168.4±1.24	158.3±3.48	47.7**
Weight (kg)	58.4±0.91	48.6±4.86	47.8**
BMI	20.6±0.28	19.5±1.77	5.1
Muscle Mass (kg)	87.6±1.30	83.0±7.77	148.4**
Fat free Mass (%)	87.6±5.82	83.0±7.77	4.6
Fat mass (%)	12.4±1.29	17.3±8.50	4.5
Haemoglobin(g/dl)	12.3±0.13	10.6±0.69	96.0**

**$p<0.01$

Table 3. Mean, SD and level of significance of macronutrients and dietary fibres consumption of elite Indian male and female hockey players

Nutrient	*Male (n=20)*	*Female (n=20)*	*U-value*
Total Energy Intake (kcal)	2621.9±450.31	1847.5±235.53	16.0**
Total Energy Expenditure (kcal)	3621.4±126.49	3048.5±114.81	0.0**
Protein(g)	110.9±15.20	77.4±9.74	11.0**
Fat(g)	53.5±14.01	34.0±8.33	34.0**
Carbohydrates(g)	431.7±85.90	317.5±45.69	48.0**
Total Dietary Fibre (g)	13.6±2.31	11.1±1.97	70.0**
Insoluble Dietary Fibre(g)	10.8±1.99	9.0±1.83	82.0*
Soluble Dietary Fibre(g)	2.8±0.67	1.9±0.22	78.0*

*$p<0.05$; **$p<0.01$

Table 4. Comparison of Mean, SD and level of significance of minerals and vitamins intake of elite Indian male and female hockey players

Minerals	*Male (n=20)*	*Female (n=20)*	*U value and level of significance*	*% below of RDA†*	
				Male	*Female*
Zinc(mg)	10.1±2.49	6.9±1.19	50.0**	65	100
Iron(mg)	20.0±4.92	11.2±3.78	34.0**	30	100
Phosphorous(mg)	2364.0±384.97	1594.6±237.91	18.0**	-	-
Calcium(mg)	845.6±358.86	678.0±81.32	186.0	35	10
B-carotene (µg)	1674.6±779.02	683.5±210.32	5.0**	100	100
Retinol (µg)	620.0±165.68	415.2±27.23	26.0**	11	100
Pyridoxine (mg)	1.1±0.20	0.6±0.11	22.0**	100	100
Thiamine (mg)	1.7±0.53	0.8±0.36	40.0**	40	90
Folic Acid (µg)	281.2±51.75	180.0±27.88	8.0**	-	65
Vitamin-C (mg)	60.1±32.79	27.2±7.70	36.0**	50	100
Vitamin-B12 (µg)	2.3±0.74	1.6±0.00	30.5**	-	-
Vitamin-B2 (mg)	1.2±0.27	0.7±0.26	10.0**	100	100
Niacin (mg)	12.6±4.49	8.5±1.74	102.0*	100	100

*$p<0.05$; **$p<0.01$

†RDA source: Narasinga & Sivakumar (2010). Nutrients Requirements & Recommended Dietary Allowances for Indians. (1990, Reprinted 2008) 2nd Edition – 2010.

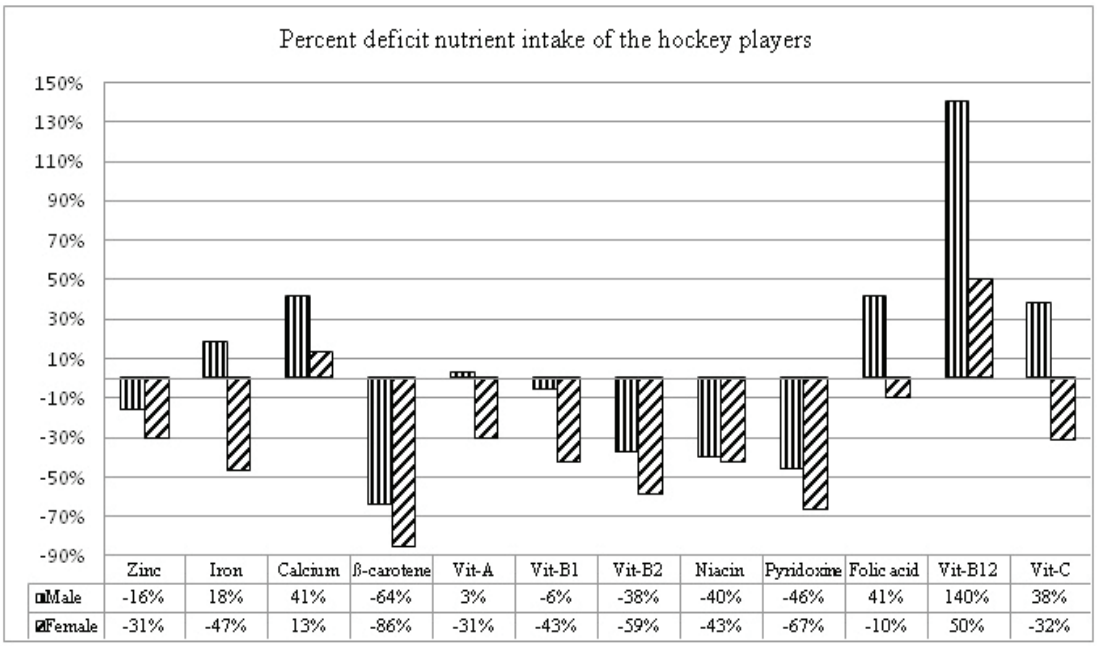
Total energy intake and total energy expenditure

Total energy intake (TEI) and total energy expenditure (TEE) among male and female athletes are was also described in Table 3. In male and female athletes average daily calorie intake was found to be 2622±450 kcal and 1848±236 kcal respectively whereas their total energy expenditure was 3621±126 kcal and 3049±115 kcal.

Micronutrient intake

Average intake of minerals and vitamins of the present subjects and adequacy of micronutrient intakes, that were computed based on Indian RDA, 2010 (Narasinga & Sivakumar, 2010) reference values, are presented in Table 4. Adequate intake of calcium and phosphorous was found in both groups whereas intake of iron and zinc was inadequate among male (65%) and female (100%) players. A higher proportion of female players showed deficit in intake of retinol (100%), vitamin C (100%) and folic acid (65%) when compared to their male counterparts. Table 4 revealed that male players met the RDA for these minerals. Intake of B-vitamins (thiamine, niacin, pyridoxine & riboflavin) was inadequate in males and females, except for vitamin B_{12}. Intakes of vitamins and minerals were significantly higher among male players, except for calcium.

Comparison of the average percent deficit intake of vitamins and minerals as compared to the RDA for both male and female hockey players. Zinc and iron intake were deficient in 31% and 47% respectively among the female players, whereas in male players, zinc deficiency wasat16% while iron intake exceeded the RDA by 18%. Calcium intake exceeded the RDA (male: 41%; female: 13%). Female players showed deficient intake



	Zinc	Iron	Calcium	ß-carotene	Vit-A	Vit-B1	Vit-B2	Niacin	Pyridoxine	Folic acid	Vit-B12	Vit-C
Male	-16%	18%	41%	-64%	3%	-6%	-38%	-40%	-46%	41%	140%	38%
Female	-31%	-47%	13%	-86%	-31%	-43%	-59%	-43%	-67%	-10%	50%	-32%

Figure 1. Percent deficit of various nutrient intakes of the hockey players as compared to RDA†.

†RDA source: Narasinga & Sivakumar (2010). Nutrients Requirements & Recommended Dietary Allowances for Indians. (1990, Reprinted 2008) 2nd Edition – 2010.

in all B-vitamins i.e., B_1 (43%), B_2 (59%), niacin (43%), pyridoxine (67%), folic acid (10%) along with vitamin C (32%) and vitamin A (31%). In male players, vitamin B_1, vitamin B_2, niacin and pyridoxine intake were deficient by 6%, 38%, 40%, 46% respectively. Vitamin B_{12} intake was found to exceed RDA in males (140%) and females (50%).

DISCUSSION

For optimal performance in sports, adequate nutrition and physical training are essential. Athletes have poor understanding of nutrition which may directly affect their nutritional status (Coutinho *et al.,* 2016). In India there are very few studies available on individual athletes' needs for energy and nutrients.

The present study showed that both males and females had normal BMI. The average muscle mass of male and female players were 25.4 kg and 16.4 kg respectively. It is known that the lower the fat mass proportion, the greater the musculature, and more active mass is required in most sports disciplines (Coutinho *et al.,* 2016).

The study revealed that female players had greater fat mass than male players though was not statistically different. According to the American College of Sports Medicine, the average body fat percentage for male soccer should be within 7-12%. This study recorded the body fat of the players in the "good" category (Thompson *et al.,* 2010). Singh *et al.* (2010) found that the average BMI of Indian hockey players was 22.3±1.75 and body fat percentage was 7.8±3.86. Another study (Sharma & Kailashiya, 2017) revealed that body fat percent of male hockey players was 18.7±5.16 and female hockey players was 24.9±3.91. These findings are closely related with current findings.

Hb level indicates the iron status of the human body (Damodar *et al.,* 2013). Hb_{mass} is often regarded as a key limiting factor to maximum O_2 uptake (VO_2max), which in turn is a strong predictor of endurance performance. Endurance training likely impacts other haematological variables: blood volume (BV) changes generally outpace Hb_{mass} increase, mainly due to an exercise-induced plasma volume (PV) expansion, resulting in lower haemoglobin concentration ([Hb]) and haematocrit levels (Hct) in endurance athletes (Brocherie *et al.*, 2015).

The present study observed low haemoglobin level in male and female hockey players. In contrast, Manna *et al.* (2011) found normal haemoglobin level among male field hockey players. Previous studies revealed that, in female athletes, intense physical exercise leads to early stages of depletion of Hb and other blood cell parameters (Alam *et al.,* 2014; Martínez *et al.,* 2011). It is estimated that 75% of anaemia cases are related to iron deficiency followed by folic acid and vitamin B_{12} deficiency (Haidar, 2010). The present study also revealed that 30% male and 100% female hockey players were deficient in dietary iron intake.

Various studies (Coutinho *et al.,* 2016; Sangeetha *et al.,* 2014) have found energy inadequacy among male and female players. The present study revealed that calorific value of the diet was inadequate for both males and females. Male and female players were consuming 73% and 61% respectively of their total energy expenditure. Almost similar observations were reported by Sangeetha and her colleagues (2014) and Wierniuk & Włdarek (2013) on volleyball players in Poland. Female athletes were reported to have a tendency to follow a restrictive eating habit or chronic dieting to achieve and maintain a low body weight (Hoogenboom *et al.*, 2009; Sundgot-Borgen *et al.*, 2007).

Protein is essential to maintain athletes' body composition and muscle strength. The Indian Council of Medical Research recommends a daily protein need for Indian sedentary individual of 0.8 g/kg body weight (Narasinga & Sivakumar, 2010) and for endurance athletes and bodybuilders it can be go up to 1.0 to 1.5 grams per kilogram of bodyweight (Nutrition and Hydration Guidelines, 2007). According to the American College of Sports Medicine (ACSM) (Potgieter *et al.,* 2013) recommendation, strength and endurance athletes need 1.2-1.7 g/kg body weight/day and guidelines advice that these requirements should be achieve through diet alone. Additional supplementation is not necessary, especially when the energy intake is optimal (Potgieter *et al.,* 2013, Rodriquez *et al.* 2009). We have found the average intake of protein was >1.5 g/kg body weight/day which is considered as adequate according to the recommendations mentioned above.

Fat requirements of athletes are similar, the amount depends largely on the training status and goals of the athletes (Potgieter *et al.*, 2013). A moderate quantity of dietary fat with a balance between saturated and unsaturated fatty acids are desirable for athletes. Dietary intake of fat should not be more than 30% of total daily caloric intake (Nutrition and Hydration Guidelines, 2007). Subjects of this study consumed inadequate amount of fat which may negatively affect training, nutrient density of the diet and the ability to consistently improve their athletic performance (Nutrition and Hydration Guidelines, 2007; Zapolska *et al.,* 2014). The tendency of restrictive eating and chronic dieting for weight loss may be associated with low fat intake in these players.

Carbohydrates are the primary source of energy, and stored muscle glycogen supply fuel for muscle contraction. Sufficient amount of carbohydrate intake reduces post exercise recovery time and helps to restore carbohydrate store for the next practice/training session. The daily requirement for carbohydrate is highly individualised, depending on gender, type of sports, intensity of training, length of practice, condition of environment etc (Potgieter *et al.*, 2013). According to Nutrition and Hydration Guidelines for Excellence in Sports Performance recommendation, carbohydrate should contribute 55% of total energy intake (Nutrition and Hydration Guidelines, 2007). ACSM recommend 6-10 g of carbohydrate per kg body weight per day for athletes. In this study we have also observed an adequate intake of carbohydrate (male: 65%; female: 67%) in both the groups (Potgieter *et al.*, 2013). But low scores were noted in female footballers in Greece (Papadopoulou *et al.,* 2010), India (Jain *et al.,* 2008) and the USA (Papandreou *et al.,* 2006).

Vitamins and minerals are essential for metabolic functions as they are act as cofactors for various enzymes involved in metabolism. Additional supplementation of micronutrients is not recommended for athletes if they are consuming adequate amounts of energy and on a healthy and balance diet. Athletes who restrict their energy intake or restrict certain types of food, especially for a long period to meet weight loss goals, may need supplementation (IOC, 2011, Potgieter *et al.*, 2013, Rodriquez *et al.,* 2009). Previous research reported that calcium, vitamin D, iron, and some antioxidants deficiency are common among athletes (Wardenaar *et al.*, 2017, Raizel*et al.*, 2017).

Intake of calcium and phosphorous was adequate in this study, whereas intake of iron and zinc was inadequate among male (65%) and female (100%) players. Martínez *et al.* (2011) observed

that carotenes, vitamin A, vitamin E, vitamin D, and folic acid deficiency in both boys and girls; girls also had inadequate intake of iron and calcium. In the present study, we have also observed that female athletes were found to be deficit in retinol (100%), vitamin C (100%) and folic acid (65%).

It is generally assumed that athletes with a poor thiamin and riboflavin status have a reduced ability to perform physical activity, especially performing maximal work (Wardenaar *et al.*, 2017).This study found intakes of B-vitamins except vitamin B_{12} in the daily diet were below the RDA levels. Energy intake inadequacy negatively reflects intake of vitamins and minerals (Wardenaar *et al.*, 2017). Athletes should be encouraged to select foods rich in B-vitamins like fruits, vegetables, legumes and milk to meet the dietary requirements for specific B vitamins.

CONCLUSION

The hockey players of the present study were shown to consume inadequate energy, fat, vitamins and minerals. The female players were found to be deficient in intake of several B-vitamins and iron.

The results of the present study may assist sports nutritionists, coaches and trainers to prepare individualised nutrition education programmes, and dietary interventions for Indian hockey players to improve their performance.

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Authors' contributions

Roy M, manuscript preparation, statistical process, data collection and analysis; Chatterjee S, review of literature, Data collection and analysis; Dey SK, study design, manuscript preparation and correction.

Conflict of interest

There is no conflict of interests among the authors.

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