e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.8, 2022
 UGC CARE Listed (Group -I) Journal

Determinants Of Body Composition And Nutritional Profile Of Elite Male National Level Runners From Manipur, India: Can They Meet The Recommendation?

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ABSTRACT:

Aims: The study aims to determine young male runners' body composition and dietary habits in Manipur, India.
Methods and Material: 20 young Manipuri elite male athletes who competed at the national level (aged 19.9 ± 2.4 yrs) volunteered to the study to measure fat percentage (BF%), body fat mass (F.M.), body mass index (BMI), fat-free mass (FFM), total body water (TBW) using Tanita TBF-300 A, Japan. The nutritional profile was recorded using the standardized cups and spoons method according to the procedure described by Gopalan et al. in 1989.
Statistical analysis: Descriptive analysis was used to analyze data using SPSS 14 for mean and standard deviation. One way sample t-test was employed to test the statistical difference between the mean of dietary intake and Recommended Daily Allowances (RDA) for athletes given by the Indian National Institute of Nutrition (NIN) classification of specific sports and games according to energy expenditure and the Indian Council of Medical Research; ICMR. The critical level of $p<0.05$ was considered significant.
Results: Manipuri male runners are characterized by low body fat percent (mean ± S.D.; 7.9±3.2 %), light body mass (mean ± S.D.; 55±12.2 kg), average height (165.3± 2.3 cm), and body mass index; BMI within the normal range (18.5-24.9 kg/m2). The mean energy intake is 3118.5± 56.7 kcal/day during training. Carbohydrates, fat, and protein contributed to 68.5%:17.9%:13.6% of total energy intake.
Conclusions: The dietary intake was imbalanced, which might be at risk of nutritional deficiencies, one reason for not excelling in their athletic performance. Manipuri male runners consumed hypo-caloric food and a hypolipidic diet.

Key-words: Manipuri; hypocaloric; hypolipidic; indigenous

INTRODUCTION:

An optimum sport-specific body physique, body composition, and nutrition are required to maximize athletic performance [1]. Manipuris are an ethnic group of people from Manipur, a northeastern state of India. Hudson[2] explained that the body physique of these indigenous people of Manipur is distinct. Manipuri men are usually not heavy, averaging about five feet seven inches tall with good chests and well-formed limbs [3], which are advantages of long-distance running [4]. Despite their suitable physique to become good runners, they cannot excel in international running events, except for a few won medals in the national arena. Brown[5] also stated that the general facial characteristics of the Munniporie (Manipuri) are of Mongolian type and are decidedly a muscular race and fat people are rare. However, it is often difficult to measure the body composition of athletes since every technique has its limitations[6,7], and the results obtained in other studies are difficult to compare because of methodological differences. Bodyweight (mass) and body fat distribution are elements of body composition that have implications for health and fitness[8]. In this study, we have tried to observe how close the body composition parameters of Manipuri male runners are to the values suggested by American Council on Exercise (ACE) guidelines and World Health Organization (WHO). American Council on Exercise (ACE) classification for Body Fat Percentage expressed the desirable BF% for an athlete is 6-13%.

As we all know, adequate nutrition is critically important for achieving the athlete's optimal. A healthy diet adapted to specific demands imposed upon the individual athletic training and competition is required to allow optimal performance[9]. Burke[10] stated that carbohydrates are the primary source of energy in sports; however, the dietary habits of athletes differ from event to event. A carbohydrate-rich diet spares protein from being used as fuel[11]. A high-carbohydrate diet (7-10 g/kg body mass (B.M.)) was recommended for a cross country skier[12] and endurance runners[13]. Recently, the Indian National Institute of Nutrition proposed 11.9 g/kg/B.M., 2.9 g/kg/B.M., and 2.5 g/kg/B.M. for carbohydrate, protein, and fat, respectively, in elite distance runners[10]. Proteins have a low contribution to energy production. Generally, 1.2- 1.7g/kg of B.M. has been proposed as good recommendations, and regarding the consumption of fat, it suggests an intake of 20-35% of the total energy intake for active Indian people[14]. However, a general recommendation for all athletes is to consume 60–70% of total energy intake from carbohydrates (CHO), 12–15% from proteins, and 25–30% from fats[15]. In this study, we recorded the dietary habits of these indigenous male runners to know whether they meet the recommended daily allowance (RDA) suggested by the Indian National Institute of Nutrition (NIN) and Indian Medical Council Research (ICMR) based on their sports event.

Subjects and Methods:

Participants

Initially, thirty-four (34) male athletes volunteered for the study; however, only twenty (20) male subjects (aged 19.9 ± 2.4 yrs) participated in the study. All the participants are healthy elite runners who represented the state and are undergoing regular training at Athletic Training Center at Khuman Lampak, Manipur, India.

All subjects provided their informed consent for participating in this study. The study received approval from the Institutional Human Ethics Committee, Manipur University, and adhered to local ethics guidelines.

The study got registered under the Clinical Trials Registry, India, with CTRI number: CTRI/2014/07/004745 [Registered on: 16/07/2014]. The link to the trail is given below: http://ctri.nic.in/Clinicaltrials/pdf_generate.php?trialid=7877&EncHid=&modid=&compid=%27,%277877det%27

Body composition assessment

Height was measured according to standard procedures using a stadiometer (Charder's HM230 'Wall Mounted Manual Stadiometer, USA). Height was measured to the nearest 0.2 cm without wearing the shoes. Weight was measured to the nearest 0.1 kg using a calibrated electronic scale (Tanita, Tokyo, Japan) with minimum clothing.

Body fat percentage (BF%), body fat mass (F.M.), body mass index (BMI), fat-free mass (FFM), and total body water (TBW) were measured using Tanita, Tokyo, Japan, following the standard protocol:

a) All measurements were conducted in the morning under fasting conditions and at least 12 h after exercise. This foot-to-foot body composition analyzer measures their body composition across both lower extremities and incorporates impedance into a single frequency (50 kHz). The system's four electrodes are in the form of stainless steel foot pads divided in half so that the anterior and posteriors form two separate electrodes. Bodyweight is simultaneously measured as the subject's bare feet make pressure contact with the electrodes and digital scale (which uses weight, height, and age) when tested in athletic mode.

b) The age of an athlete was recorded from the identity card issued by their training centers.

Dietary Assessment

A standard procedure described by Gopalan et al., 198916 was followed to collect food and nutrient intake information. The participants were asked to consume their food/beverage using the standardized cups and spoons for 7 days and recorded on the paper. They recall all the food items consumed and the quantity of each food item consumed. The researcher recorded the intake of foods consumed by an individual per day, and each food item's raw equivalents were computed.

The daily food and nutrient intakes were calculated using tables of food composition (ICMR 2010), and the nutritional value of Indian Foods have given by Gopalan et al., 2012[17]. The

food and nutrient intakes were compared with Recommended Dietary Allowances (RDA) for nutrients of the corresponding age groups suggested by ICMR (2010)[14].

The calculated energy and macronutrient intake were compared with the recommended intake levels for the Group III (middle-distance and long-distance) category for the nature of sports as recommended by the Indian National Institute of Nutrition (NIN) [11] pp: Appendices: IV. Excess and deficit percentage of food intake was calculated using the following formula: Excess/Deficit (%): AFI-RDA/RDA x 100; where, AFI; Actual Food Intake, RDA; Recommended Daily Allowance.

Statistical analysis

All data are presented as means and standard deviations (s). SPSS 14.0 for Windows Evaluation Version, Software was used in analyzing the data. A one-way sample t-test was employed to test the statistical difference between the mean of dietary intake and RDA. The critical level of $p<0.05$ was considered significant.

Results:

Body composition

Table 1 summarizes the physical characteristics and body composition of the subjects. The mean body mass index (BMI, kg/m2) of the runners was 21.3 ± 1.4 kg/m2, which indicates that the athletes were within the normal BMI category (18.5-24.9 kg/m2) compared with the norm given by the WHO expert consultation group[18]. The mean fat mass (F.M., kg) of the athletes was 4.6 ± 1.9 kg with mean fat-free mass (FFM, kg) 53.9 ± 4.1 kg; total body water (TBW, kg) 39.4 ± 3.1 kg, and body fat percentage (BF%, kg) 7.9±3.2 kg respectively. However, though the mean BMI is within the desirable range, as recommended by American Council on Exercise (ACE)[19] guidelines for body fat percent classification, 40 % of the runners in this study were exceptionally lean body type, i.e., B.F. % < 6 % and 60% of the runners are in the optimal range (Athletic lean body types) with B.F. % between 6-13 %, and none of the runners B.F. % lies above the optimal range, i.e.,> 13%. This result shows that the Manipuri elite runners in the present study had low body fat percentages. A recent survey by SK Krishna[20] reported that active young, healthy Indian males between 18 to 30 (yrs) who exercise regularly and B.F. % between 6-13% have good cardiorespiratory fitness.

Dietary intake

The mean food intake of the runners was compared with the recommended dietary allowances suggested by ICMR (2010)[14]. Data on the daily intake of different food groups showed that the mean intake of milk, eggs, fruits, and pulses considered essential for athletes was inadequate and deficient, reflected in their low nutritional profiles (Table 2), except for leafy vegetables, which meet recommendation allowance show slight excess of 3.3%. This result is also observed in the team sports athletes of Brazil (Basketball, Indoor Soccer, Handball, and Volleyball) [21]. Fruits, vegetables, milk, and dairy product are low in Young Manipuri runners in this study

Hypocaloric (low-caloric) diet pattern is observed with a mean energy of 3118.5± 56.7 kcal/day during their training period. It was recommended to consume a more balanced diet

during their competition period as it will need more energy intake during the peak performance.

These values are significantly below those recommended energy allowances (80 kcal/kg/body mass) given by the Indian National Institute of Nutrition (NIN) for Group III events based on their nature of sports. However, the actual mean energy intake (56 kcal/kg/body mass) by the present runners in this study almost meets the recommended allowance for Indian given by the Indian Council of Medical Research (ICMR) for the heavy worker, i.e., 58kcal/kg/day, albeit significant at $p<0.05$. The energy intake during the competition period could not be obtained in our study, which is one of the limitations of this study.

Table 3 reveals the macronutrient intake of Manipuri runners. All the athletes were consuming an imbalance intake of nutrients compared to the recommended value suggested by the Indian National Institute of Nutrition (NIN) for the specific event and the Indian Council of Medical Research (ICMR) [22]. Athletes from the present study had a marginal intake of carbohydrates, protein, and energy but a poor intake of fat. Carbohydrates, fat, and protein contributed 68.5%:17.5%:13.3 % of the total energy intake, respectively.

The mean (%) deficit of carotene, riboflavin, and thiamine is shown in Table 3. Calcium, Iron, and vitamin C intake were in excess of 17.8%, 1.2%, and 12.5%, respectively. The surplus in calcium is mainly from the consumption of snails and meat, which plays a vital role in hematopoiesis by increasing the absorption of iron[23]. However, we recommended that calcium and iron intake should be at different meals since calcium can interfere with iron absorption[24].

Discussion:

Body physique and Body Composition

Many researchers expressed the advantages of studying the body composition of athletes in sports, like height, body weight, and body mass index are essential anthropometric parameters for sprinters[25] and as in a tall runner's longer limbs which enable longer step length[26]. The athletes must be underweight for distance running events with good lean body weight and lesser body fats[27]. This study hypothesized that a good physique, optimum body composition, and nutrition are necessary to become good runners. Dawkins[28,] in his book, expressed that sport is considered a selective system by its competitive nature, and the essential characteristic for the selection of sports is the physique. A strong association is found between body physique and performance in track and field events [29], supported by the study of Sedeaud et al., 2012 [30]. They said that all Rugby World Cups teams, the highest performing teams, have the tallest backs and heaviest forwards with the most elevated collective experience. Bejan and Marden in 2006[31] expressed that speed increases with larger physiques in different species, including mammals and humans. Lucia et al., 2006[32] reported that Kenyan runners dominated long-distance running events and observed that they are attributable primarily to their low body mass index (BMI), which allows them to run with minimal energy used for swing limbs. Recently, Marc et al. in 2014[33] suggested the optimal BMI (men) value was 19.8 kg.m−2 for a distance runner, and for the ten best performers of all time, BMI ranged between 17.5 and 20.7 kg.m−2. In our study, the mean BMI of Manipuri runners was 21.3± 1.4 kg.m−2, which is slightly above the optimum range given by

the Marc et al. This result indicates that the present runners need proper nutrition to bring the BMI to the optimum state as BMI is a helpful indicator in the categorization of elite athletes[34]. The BMI distribution of all athletes by running events, according to their study, is 24 kg.m−2 for the 100 m, 23 kg.m−2 for the 200 m, 23–22 kg.m−2 for the 400 m, 21 kg.m−2 for 800 m and 1500 m and 20 kg.m−2 for the 3000 m, 10 000 m and marathon. A study on Kenyan male elite distance runners reported by Kong and Heer35 has an optimum body mass index (BMI, kg/m2) of 20.1± kg/m2. Ethiopian and Caucasian elite male runners also have optimum mean BMI; of kg/m2, 19.4±1.5 kg/m2, and 20.6±2.0 kg/m2, respectively, as reported by R. Rafael Wishnizer et al., in 2013[36]. Another study by Nikolaidis in 2013[37] also shows an inverse relationship between BMI and physical fitness in young female volleyball players. However, Torstveit M. et al., 2005[38] expressed that body mass index (BMI) is not a good predictor of body composition in elite female athletes.

Height is another important factor that significantly influences sports. Sedeaud et al., 2014[34] reported that shorter athletes run long and middle distances, with a progressive increase in mean height from marathon to sprint events (marathon: 171.9±6.28 cm, 10,000 m: 172.37±6.44 cm, 3000 m: 175.02±6.55 cm, 400 m: 182.75±6.24 cm, 200 m:180.99±6.17 cm, and 100 m: 179.20±5.94 cm). However, Connor et al., 2007 [29] reported that 400m runners are the tallest. Sleivert and Rowlands supported the study in 1996 [39] that taller athletes may confer benefits like improvement in stride length. In the present study, the Manipuri runners are of average height, with a mean height of 165.3± 2.3 cm compared to the height given by Sedeaud et al., 2014[34]. However, this value is close to male Ethiopian 10 km runners studied by R. Rafael Wishnizer et al., 2013[36,] with a mean height of 167.4 ± 7.4 cm. Based on the literature available, if height and running performance are associated, then long and middle-distance events will be suitable for Manipuri male runners.

Bodyweight (mass) and body fat distribution are elements of body composition that have implications for health and fitness. Many studies reported body mass and speed-running association in running events. Weyand and Davis 2005[40] expressed that sprint specialists are relatively massive and muscular, while endurance specialists are conspicuously limited in body and muscle mass. Sedeaud et al., 2014[34] reported that runners gradually become heavier as the distance progressively decreases from marathon to 100 m. However, Kong and Heer 2008[35] reported that the superior running economy of Kenyan runners is primarily due to their slender limbs with lower masses requiring less muscular effort in leg swing. Manipuri runners in the present study are lightweight with a mean body mass; of kg (55±12.2 kg), which might be advantageous for middle and long-distance runners according to the literature of Connor et al., 200729 Knechtle 2007[41], Berg K. 2003[42], and Larsen 2003[43]. R. Rafael Wishnizer et al.[36] also reported that Ethiopian distance runners are also lightweight (mean; 54.3±4.3 kg), dominating distance running in the world running events[44].

Body fat is one of the essential variables of body composition in athletes. Tanda and Knechtle 2013[45] found BF% to have an association with marathon performance time. Though BMI is a helpful indicator for sportspeople, our study suggested that BMI measurement alone cannot always accurately determine the body fat status of a person. Torstveit M. et al., 2005[38] reported that body fat percent (B.F. %) should be preferentially used over BMI to classify

body composition in young female athletes validly. In the present study on this indigenous group of Manipuri runners, one athlete had a high BMI value (26.3 kg/m2). Still, the body fat percentage (10.4 %) was within the normal range for an athlete given to American Council on Exercise, 200919. Spartali et al., 2014[46] also recommended using more than one anthropometric component to classify the male cadets and not depend solely on BMI values. They also supported B.F. % as a more accurate predictor than BMI, which helps Cadets' performance enhancement. Recently, a study on active young Indian healthy gym clients by S.A. Krishna et al. in 2016[20] also suggested body fat percentage is a convenient predictor of cardio-respiratory fitness. They also observed poor cardiorespiratory fitness with an increasing body fat percentage. Heer and Kong[35] reported the elite male Kenyan distance runners, to have a very low BF% of 5.1%, but another study by Underhey C. et al.[47] reported world-class African male distance runners with a mean BF% of 7.3% ± 2.62. In our study, the mean BF% was 7.9±3.3 % which is within the ideal body fat percentage for athletes given by ACE, 2009[19]. Thus, in terms of BMI, Manipuri runners are slightly above the desirable range; however, body fat percentage is within a desirable state. Therefore, the study supports the statement that measuring only BMI cannot predict the overall body fat status of an individual[36;48;49;50].

Hydration is beneficial not only to exercise and athletic performance but also to physiologic functions[51]. Total Body Water Percentage (TBW %) is the total amount of fluid in the body expressed as a percentage of total weight[52]. Intracellular water (ICW) and extracellular water (ECW) are the two compartments that makeup all the body's fluids, known as total body water (TBW) [53]. As dehydration increases, there is a gradual reduction in physical and mental performance[54; 55]. Prentice et al.[56] reviewed that only a few countries include water on the list of nutrients. According to Popkin et al.[57,] at present, only the United States and Germany provide Adequate Intake (A.I.) values, but no other country does that. Currently, no reference values are available as a determinant of "ideal" body water levels[44; 58]. However, as per TANITA[59], the average TBW% ranges for a healthy person are 45-60 % (female) and 50-65% (male), respectively. And for the highly active person and athletes, the normal value of TBW% are female (55-60%) and male (65-70%)[43]. Regarding TBW of Manipuri male runners in this group, they are well hydrated with a mean TBW% of 71.6 % (range; 66-77.3%).

Dietary intake

Differences exist in dietary patterns and food choices between countries and regions[60]. Therefore, it is often difficult to compare the results of studies even within countries because of methodological differences. It is even more complex to compare the results of one country with those from other countries. There was a significantly lower energy intake of 3118.5± 56.7 kcal/day versus 4400 kcal/day (with a deficit of -29.1%, $p<0.01$) based on the recommendation by the Indian National Institute of Nutrition (NIN), which may be the cause for light body mass in Manipuri runners. The intake of carbohydrates does not meet the daily Recommended Dietary Allowance; RDA (9.5 versus 11.9 g/kg body mass, -20.1 % deficit; $p<0.01$). The consumption of carbohydrates food should be higher during training for

competition [61;62]. The percentage of carbohydrate in energy contribution was 67.1% of actual food intake, with an average carbohydrate energy intake of 2090 (kcal/day) versus 2616 (kcal/day) which will be beneficial in storing muscle glycogen[63]. The source of carbohydrate diet is mainly the consumption of boiled rice as the primary food in Manipur. However, the intake of carbohydrates (9.5 g/kg/day) by the Manipuri male runners in our study meets the recommendation (7-10 g/kg/day) for endurance runners[12].

As regards fat, consumption by the Manipuri runners significantly does not meet the Recommended Dietary Allowance (RDA), i.e., 1.9 versus 2.5 g/kg body mass; -56% deficit; $p<0.01$). The percentage of fat in energy contribution was 17.5 % of actual food intake, with an energy intake of 544.5 (kcal/day) versus 1237.5 kcal/day RDA, which is essential for runners in energy production acting against cell disruption[21]. Manipuri runners in this study consumed a hypolipidic diet due to the very low inclusion of ghee, butter, margarine, etc., in their diet.

For protein, there was a deficit of -34.5%; 1.9 versus 2.9 g/kg body mass significant at $p<0.01$, which could delay the cells to adapt to the exercise stimulus[17]. The ratio of protein in energy contribution was 13.4% of actual food intake with an energy intake of 418 (kcal/day) versus 638 (kcal/day) of RDA. However, the protein intake by the present runners in the present study meets the RDA value recommendation (1.2 to 1.7 g/day) in previous studies for athletes [64;65;66], which is equivocal for us what would be the actual RDA for protein for athletes.

The mean food adequacy of the runners is presented in Table 2. Iron (17.2 mg/day), calcium (707 mg/day), and vitamin C (45 mg/day) meet recommended dietary allowance and are found to be adequate, which will help the athletes for a robust immune system and to combat free radicals. Still, the poor intake of anti-oxidant vitamins like carotene (53.10% deficit), thiamine (52.9% deficit), and riboflavin (23.8% deficit) could result in low protection of athletes from oxidative damage caused by long and strenuous aerobic exercise. The imbalance in dietary habits by the Manipuri runners in the present study may be due to nutritional knowledge[67], financial constraint[68], and about lack of sports nutritionists and coaches who underwent sports nutrition education and specific training[69]. However, Heaney et al. in 2011[70] reviewed nine studies. They found a weak ($r>0.44$) positive association between nutritional knowledge and dietary intake in 5 of 9 studies assessing the relationship between nutritional knowledge and dietary intake. Other factors like training volume[71], gait[31], and biomechanical approaches like stride length[72], running economy[73; 74], leg length, etc., which also contribute to sports performance, are recommended for future research in this indigenous group of runners.

CONCLUSIONS

The dietary intake was imbalanced, which might be at risk of nutritional deficiencies, one reason for not excelling in their athletic performance. Manipuri male runners consumed hypo-caloric food and a hypolipidic diet.

Acknowledgment

The researchers are grateful to all the athletes who devoted their time involved in the test for the study. We acknowledge Dr. Thongam Chanu Anel, Assistant Professor in Home Science, Department of Food and Technology, SK Women's College, Manipur, India, for the help in the nutritional part.

Competing interests

The authors declare no competing interests.

Funding agency:

The present study is supported by a research grant from "University Grant Commission, Bahadur Shah Zafar Marg, New Delhi, INDIA, for Junior Research Fellowship; Award No.: No.F.15-6(DEC.,2012)/2013 (NET).

TABLE 1

PHYSICAL CHARACTERISTICS AND BODY COMPOSITION OF RUNNERS

Parameters	Mean	SD
Age (yrs)	19.9	2.4
Height (cm)	165.3	2.3
weight (kg)	55	12.2
BMI (kg/m2)	21.3	1.4
FM (kg)	4.6	1.9
FFM (kg)	53.9	4.1
Fat (%)	7.9	3.2
TBW (kg)	39.4	3.1

BMI; body mass index, F.M.; fat mass, FFM; fat free mass, TBW; total body water, S.D.; standard deviation

TABLE 2

FOOD INTAKE BY THE MANIPURI RUNNERS

Nutrient	@RDA	Actual Intake	Excess/Deficit (%)	p
Cereals (g/day)	630	550	-12.7	<0.01
pulses (g/day)	40	15	-62.5	<0.01
Leafy Vegetables (g/day)	150	155	3.3	>0.05
Other Vegetables (g/day)	200	80	-60	<0.01
Root and Tubers (g/day)	150	80	-46.6	<0.01
Fruits (g/day)	200	60	-70	<0.01
Milk (ml/day)	750	300	-60	<0.01

Meat (g/day)	250	200	-20	>0.05
Egg (g/day)	150	80	-46.7	<0.01
Sugar (g/day)	80	40	-50	<0.05
Oils (g/day)	50	40	-20	<0.05

Source: @ National Institute of Nutrition, India (2007)[11]

TABLE 3
MACRO AND MICRO NUTRIENT INTAKE (N= 20)

Nutrient	RDA	Actual Intake	Excess /deficit (%)	p
CHO (g/kg/day)	654 (11.9)*	522.5 (9.5)	-20.1	<0.01
Protein (g/kg/day)	159.5 (2.9)*	104.5(1.9)	-34.5	<0.01
Fat (g/kg/day)	137.5 (2.5)*	60.5(1.1)	-56	<0.01
Energy (kcal/day)	4400 (80)*	3118.5(56.7)	-29.1	<0.01
Calcium (mg/day)	#600	707	17.8	<0.01
Iron (mg/day)	#17	17.2	1.2	>0.05
Carotene (µg/day)	#4800	2251	-53.10	<0.01
Riboflavin (mg/day)	#2.1	1.6	-23.8	<0.01
Thiamine (mg/day)	#1.7	0.8	-52.9	<0.01
Vitamin C (mg/day)	#40	45	12.5	<0.01

Food energy conversion factors (kcal/g) : Fat= 9, protein= 4 and carbohydrate = 4
*values in parenthesis for RDA are according to Indian National Institute of Nutrition[14]
#ICMR, India (2010)[22]

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