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Association Between Dietary Diversity and Lipid Indices among Kho-Kho Players Belonging to Different Regions of India

Research Article

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Abstract

Dietary diversity is a proxy indicator of nutrient adequacy and has been propagated as a health beneficial component of dietary behaviour. The present study was aimed to understand dietary diversity and its association with lipid indices among Kho-Kho playersbelonging to Different Regions of India. Fifty Indian Kho-Kho players aged between 16-31yrs belonging to different regions of India were recruited. Dietary diversity score (DDS; food groups/day) and food variety score (FVS; number of food items/day) were considered to assess the dietary diversity (DD). The United Nations Food and Agricultural Organization food frequency questionnaire was used as a tool. Serum total cholesterol (TC), triglycerides (TG), LDL, VLDL and HDL were measured using an automatic clinical chemistry analyser following the standard protocols. The total DDS and FVS showed no significant difference among players belonging to different regions of India, but individual food groups and number of variety of green leafy vegetables, nuts and oilseeds, seafood and egg consumption showed a significant difference ($p<0.01$). LDL was positively associated ($p<0.01$) with DDS. TG and VLDL were significantly positively associated with DDS of milk and milk products ($p<0.01$), eggs ($p<0.01$) and FVS of spices and condiments ($p<0.01$) and inversely significantly associated with DDS of meat ($p<0.01$) and nuts ($p<0.01$). An inversely significantly association was observed between DDS of vit-A rich vegetables and LDL and also between DDS of roots and tubers and HDL.Dietary diversity was higher among athletes as compared to non-athletes. Lipid indices other than LDL were not associated with DDS and FVS, but individual DDS were associated with TG, VLDL, LDL and HDL.

Keywords: Kho - Kho; Dietary Diversity; Lipid Indices; Indian Athletes.

Introduction

Kho-Kho is a popular traditional team sport in India, dating back to prehistoric India. The origin of the sport is very difficult to trace, but some of the empirical evidence shows that it is originated from Maharashtra, India [1, 2]. In prehistoric India, it was played on Indian chariots (raths), known as Rathera and emerged in the modified form of 'run-and-chase' tag sport. In India, the Kho-Kho competitions are held at the school, college and university level apart from the national level. It is also played in South Asia and South Africa [2]. Kho-Kho is a vigorous and combative sport, requires the variables of agility, endurance, strength, power, skills of dodging, feinting and bursts of speed at the individual level to chase/pursue and touch the opponent [1].

An optimised sporting performance of athletes strongly relies upon multiple factors such as physical, physiological, nutritional, metabolic and cognitive factors [3]. Athletes, especially elite athletes are encouraged to follow sound sports nutrition strategies to meet the energy demands, macro and micronutrient requirements and, maintain ideal body composition during training and competition, reduce injury risk and optimize physical as well as mental performance [3, 4]. Nutrient adequacy is one of the factors that are crucial in maintaining the optimum level of health and performance among athletes [3] for which, selection of foods is important [4]. Designing nutritional interventions in order to improve the nutrient adequacy of athletes requires an understanding of the habitual dietary intake of athletes [5, 6].

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Diverse diets have shown beneficial health effects, protecting against chronic diseases such as diabetes,[7, 8] cardiovascular diseases, [8-10] cancer [11] and longevity [12]. Dietary diversity can be calculated by Dietary Diversity Scores (DDS) and Food Variety Scores (FVS)[13]. DDS is based on food groups whereas FVS is based on the number of food items consumed which are useful in predicting nutrient adequacy [7]. The dietary diversity indicators are very attractive as they are relatively simple and easy to measure and reflects nutrient adequacy [14]. The perceived importance of dietary diversity for health and nutrition has increased in the recent past [15, 16]. To our knowledge, there are no studies available on dietary diversity and its association with lipid indices in the athletic population in Indian as well in the international setting. The present study aimed to measure dietary diversity through DDS and FVS and their association with lipid indices among Kho-Kho Players belonging to different regions of India.

Materials and Methods

Participants

The cross sectional study includes fifty healthy male Indian Kho - Kho players in the age group of 16-31 years undergoing training in a national camp (Jan – Feb 2021) were recruited for the study. Based on their domicile, the players were divided into four groups; East, West, North and South regions. Kho-Kho players from Indian states such as Bihar, Jharkhand, Odisha and West Bengal and north east states were included in the East region; Goa, Gujarat and Maharashtra were included in the West region; Jammu & Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Haryana, Delhi, Rajasthan and Uttar Pradesh were included in the North region; Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Telangana and the union territory Puducherry were included in the South region. Information related socio-economic factors and demographic characteristics were recorded in questionnaire based interviews.The socio-demographic characteristics show that a majority of the Kho-Kho players belonged to West region (36%), followed by South (20%) and North (20%), East (14%), Union territory (6%) and North East (4%).

Study Approval

The study was approved by the institutional ethical committee and conducted according to the guidelines laid down in the declaration of Helsinki [17]. The players were explained about the study and the experimental protocol and their written consent was obtained. The inclusion criteria was absence of any illness or injury and exclusion criteria included intake of medication.

Dietary Diversity (DD)

Dietary diversity, which is a proxy indicator of nutrient adequacy [18, 19] hasbeen propagated as a health beneficial component of dietary behaviour [20]. Dietary diversity (DD) was defined as the number of food groups consumed by an individual during the dietary assessment period. In the present study, it was assessed using dietary diversity score (DDS) and food variety score (FVS) for a day. A structured questionnaire collapsed the food items into 17 food groups according to the United Nations Food and Agricultural Organization (FAO) food group classification [13] was used as a tool. Food groups considered were cereals & millets, pulses, vitamin – A rich vegetables, white roots and tubers, green leafy vegetables, other vegetables, milk and milk products, nuts and oilseeds, fats and oils, other fruits, vitamin -A-rich fruits, egg, seafood, organ meats, meat & poultry, sugars, spices and condiments. Food items which are frequently consumed by the Indian population were considered for adapted for the inclusion of food items in each food group [21]. The questionnaire was administered by a trained investigators through direct interview.

Dietary Diversity Score (DDS)

It was calculated by summing the number of food groups consumed in 24 hours to calculate DDS. If an individual consumed at least one food item from the food group was taken into count. The minimum and maximum score points ranged from 0-17.

Food Variety Score (FVS)

Individual food items consumed from each food group was counted to attain the FVS of the respective food group and then the total FVS was counted summing up the food items consumed from all the food groups. The maximum achievable FVS score points were 154. While counting the scores, RTC/RTE foods were excluded. To attain Food Variety Score (FVS), food items consumed in 24 hours was counted.

Lipid Indices

Blood sample (5mL) was taken after 8-12 hours of overnight fasting via vein puncture. Immediately the blood was transferred to a vacutainer and serum was separated by centrifuging at 4000 rpm for 10 min. The serum samples were stored at 180C till further analysis. The test for lipid profile was performed within 72 hours after obtaining the blood sample. The tests were performed using an automatic clinical chemistry analyser, Erba (Lachema) XL200, Germany.

Statistical Analysis

Statistical Package for Social Sciences (SPSS; IBM) version 27.0 was used for the analysis. Mean and Standard deviation were computed for the DDS and FVS. Percentage was computed for food choice and food behaviour, socio-economic and demographic characteristics and commonly consumed foods. To know the difference across different Indian regions for DDS and FVS, One way analysis of variance along with Tukey post hoc test was done. Linear regression was computed to find out the association lipid indices and dietary diversity. The difference was considered at $p<0.05$ and $p<0.01$.

Results and Discussion

The representation of players from West region states was higher in the camp (Table 1). The origin of Kho-Kho from Maharashtra (West India State), India [1] which would have influenced to participate in the sport and to reach the national level. The prevalence of non-vegetarianism (86%) was higher among Indian Kho-Kho players. A similar observation was made by Khanna et al. (2006) [22] in national Indian female athletes.

Dietary Diversity (DDS) and Food Variety Score (FVS)

The dietary diversity scores of Kho-Kho Players are given in Table 2. DDS showed that players were not consuming a few of the food groups daily, but players were consuming satisfactory levels of foods from various food groups as compared to the general population [10, 21]. Consumption of foods from cereals and millets, spices and condiments, fats and oils, sugars, other vegetables, milk and milk products contributed greatly to DDS, but showed no significant difference among the players belonging to different regions. However, green leafy vegetables (GLV) ($p<0.05$), nuts and oil seeds ($p<0.01$), egg ($p<0.05$) and sea foods ($p<0.01$) consumption was significantly different across different regions. GLV consumption was significantly higher ($p<0.05$) among North region players followed by West, South, and East region players.

Table 1. Socio Demographic Characteristics of Athletes.

Characteristics		Percentage
Age Group	16-19	20
	20-31	80
Indian State	East	14
	West	36
	North	20
	South	20
	North East	4
	Union Territory	6
Education	Primary	4
	Secondary	12
	Higher Secondary	12
	Graduation	52
	Post-Graduation	20
Family Type	Nuclear	54
	Joint	46
Type of Diet	Vegetarian	10
	Non-Vegetarian	86
	Lacto-Vegetarian	4
Sporting Years	1-5	10
	6-10	34
	11-15	34
	16-20	14
	21-22	6

Table 2. Dietary Diversity Score of Kho-Kho Players.

S.No	Food Group	Total	Region				F Value
			East	West	North	South	
			(n=7)	(n=19)	(n=13)	(n=11)	
1	Cereals & Millets	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	-
2	Pulses	0.46 (0.503)	0.43 (0.535)	0.47 (0.513)	0.62 (0.506)	0.27 (0.467)	0.934
3	Vitamin -A Rich Vegetables	0.30 (0.463)	0.14 (0.378)	0.32 (0.478)	0.23 (0.439)	0.45 (0.522)	0.771
4	Roots and Tubers	0.48 (0.505)	0.57 (0.535)	0.42 (0.507)	0.54 (0.519)	0.45 (0.522)	0.406
5	Green Leafy Vegetables	0.58 (0.388)	0.14(0.378)^{a}	0.63 (0.496)^{b}	0.85 (0.376)^{b}	0.45 (0.522)^{c}	3.925*
6	Other Vegetables	0.82 (0.388)	1 (0)	0.79 (0.419)	0.85 (0.376)	0.82 (0.388)	0.528
7	Milk and Milk Products	0.80 (0.404)	0.71 (0.488)	0.84 (0.375)	0.77 (0.439)	0.82 (0.405)	0.196
8	Nuts and Oil Seeds	0.51 (0.505)	0.14 (0.378)^{a}	0.84 (0.375)^{b}	0.31(0.480)^{c}	0.36 (0.505)^{c}	6.702**
9	Fats and Oils	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	-
10	Other Fruits	0.57 (0.500)	0.57(0.535)	0.61 (0.502)	0.62 (0.506)	0.45 (0.522)	0.259
11	Vitamin -A Rich Fruits	0.18 (0.391)	0.14 (0.378)	0.28 (0.461)	0.08 (0.277)	0.18 (0.405)	0.681
12	Egg	0.44 (0.501)	0.14 (0.378)^{a}	0.37 (0.496)^{b}	0.38 (0.506)^{b}	0.82 (0.405)^{c}	3.573*
13	Sea Foods	0.16 (0.370)	0.29 (0.488)^{a}	0.05 (0.229)^{b}	0 (0)^{b}	0.45 (0.522)^{c}	4.858**
14	Organ Meats	0.02 (0.141)	0 (0)	0 (0)	0.08 (0.279)	0 (0)	0.946
15	Meat & Poultry	0.20 (0.404)	0.14 (0.378)	0.05 (0.229)	0.31(0.480)	0.36 (0.505)	1.897
16	Sugars	0.90 (0.303)	0.86 (0.378)	0.89 (0.315)	0.92 (0.277)	0.90 (0.303)	0.073
17	Spices and Condiments	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	-
Total Dietary Diversity Score		9.40 (2.634)	8.29 (2.215)	9.53 (2.568)	9.54 (2.537)	9.73 (3.228)	0.483
RTE/RTC Foods		0.90 (0.303)	1 (0)	0.89 (0.315)	0.92 (0.277)	0.82 (0.405)	0.533

Expressed as Mean (SD); *$p<0.05$, **$p<0.01$; a,b,c Means having the same superscript do not differ significantly

Nuts and oil seeds consumption was significantly higher ($p<0.01$) among West region players followed by South, North and east region players. Egg ($p<0.05$) and sea foods ($p<0.01$) consumption was significantly higher among South region players followed by West, East and North region players. The DDS showed no significant difference between the players belonging to different regions.There is a variation across Indian states in the availability of a few of the foods especially leafy and other vegetables which could be the reason for less consumption of foods [24] and some of the foods were not consumed due to cultural and social beliefs and food preferences.

The food variety scores of Kho-Kho Players are given in Table 3. The number of foods consumed from food groups such as spices and condiments, GLV, other vegetables, fats and oils and other fruits consumption greatly contributed to FVS, but showed no significant difference among the players belonging to different regions other than GLV. The consumption of number of foods from green leafy vegetables ($p<0.05$), nuts and oil seeds ($p<0.01$), egg ($p<0.05$) and sea foods ($p<0.01$) was significantly different across different regions. Consumption of number of GLV was higher among South region players and also found a significant difference between than East and North region players. Nuts and oil seeds consumption was significantly higher ($p<0.01$) among West region players than South, North and East region players and also found a significant difference between East and South and North region players. Egg ($p<0.05$) and sea foods ($p<0.01$) consumption was significantly higher among South region players than West, East and North region players and consumption was not reported by North region players.

The players consumed a variety of foods on a daily basis. Participation in sports and the recognized importance of diet on sports performance would have played a role in the consumption of a wide variety of foods [23]. Dietary diversity and food variety fluctuate across various seasons. In winter, household food basket is more diverse and food variety and dietary diversity increase due to food choices in winter [24], would have influenced higher DD among players of the study.

Status of Lipid Indices

Regarding the lipid levels, lower HDL (15.3%) levels and higher serum TC (10.4%), TG (28%), LDL (22%), and VLDL (15.4%) levels were observed among the players (Fig.1). The majority of players were having normal lipid profile. Higher dietary diversity was associated with a lower risk of abnormal levels of blood lipids [25].

Association of Dietary Diversity with Lipid Indices

The regression analysis showed that total DDS and FVS showed no association with lipid indices other than LDL($p<0.01$)(Table 4).However, serum triglycerides and VLDL were significantly associated with DDS of milk items ($p<0.01$), egg ($p<0.01$), and FVS of spices ($p<0.01$).Unfortunately, there is no supporting/ deferring evidence in this direction on the athletic population. Milk and milk products have a hypercholesteraemic effect due to saturated fatty acid content,[26] larger quantities of milk and milk products may be avoided on a daily basis. The study showed a positive as-

Table 3. Food Variety Score of Kho-Kho Players.

S.No	Food Group	Total	Region				F Value
			East	West	North	South	
			(n=7)	(n=19)	(n=13)	(n=11)	
1	Cereals & Millets	1.94 (1.077)	2.0 (0.577)	2.05 (0.911)	2.0 (1.683)	1.64 (0.674)	0.367
2	Pulses	0.84 (1.462)	0.43 (0.535)	0.95 (1.580)	1.38 (1.981)	0.27 (0.467)	0.253
3	Vitamin -A Rich Vegetables	0.38 (0.635)	0.14 (0.378)	0.37(0.597)	0.38 (0.768)	0.55 (0.688)	0.561
4	Roots and Tubers	0.60 (0.670)	0.57 (0.535)	0.42 (0.507)	0.54 (0.519)	0.45 (0.522)	0.406
5	Green Leafy Vegetables	4.58 (3.150)	4.0 (2.648)^{a}	4.58 (3.024)^{a}	2.85(2.544)^{c}	5.09 (3.448)^{d}	3.154*
6	Other Vegetables	3.74 (2.870)	2.71(1.976)	3.63 (2.985)	4.38 (3.254)	3.18 (2.601)	0.625
7	Milk and Milk Products	1.50 (1.216)	1 (0.816)	1.68 (1.293)	1.69 (1.437)	1.27 (1.009)	0.52
8	Nuts and Oil Seeds	1.00 (1.278)	0.14 (0.378)^{a}	1.68 (1.376)^{b}	0.69(1.182)^{c}	0.73 (1.104)^{c}	3.859*
9	Fats and Oils	2.08 (1.291)	1.71 (1.113)	2.11 (1.629)	2.54 (0.967)	1.73 (1.009)	1.01
10	Other Fruits	2.04 (2.894)	2.0 (2.517)	2.44 (3.714)	2.23 (2.713)	1.18 (1.722)	0.443
11	Vitamin -A Rich Fruits	0.31 (0.796)	0.14 (0.378)	0.56 (1.149)	0.08 (0.277)	0.27 (0.647)	1.057
12	Egg	0.44 (0.501)	0.14 (0.378)^{a}	0.37 (0.496)^{b}	0.38(0.506)^{b}	0.82 (0.405)^{c}	3.573*
13	Sea Foods	0.20 (0.404)	0.29 (0.488)^{a}	0.05(0.229)^{b}	0 (0)^{c}	0.64 (0.505)^{d}	9.592**
14	Organ Meats	0.02 (0.141)	0 (0)	0 (0)	0.08 (0.279)	0 (0)	0.976
15	Meat & Poultry	0.24 (0.431)	0.14 (0.378)	0.11 (0.315)	0.38 (0.506)	0.36 (0.505)	1.578
16	Sugars	1.16 (0.584)	1.14 (0.690)	1.21 (0.631)	1.15 (0.535)	1.09 (0.539)	0.096
17	Spices and Condiments	6.22 (2.501)	7.57 (3.599)	6.42 (2.479)	5.92 (1.847)	5.36 (2.335)	-
Total Score		27.10 (9.884)	27.14 (7.335)	28.53 (12.460)	26.92 (10.06)	24.82 (5.98)	0.483
RTE/RTC Foods		2.66 (2.076)	1.57 (0.535)	2.47 (2.091)	3.38 (2.434)	2.66 (2.076)	1.261

Expressed as Mean (SD); *$p<0.05$, **$p<0.01$; a,b,c Means having the same superscript do not differ significantly

Figure 1. Lipid Profile of Kho-Kho Players.

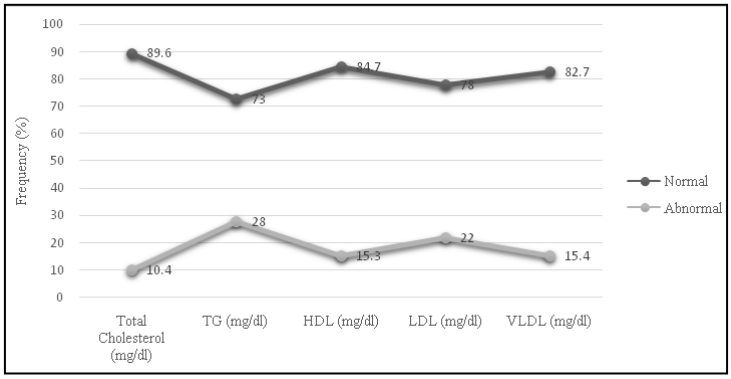

Table 4. Logistic Regression Model for Lipid Indices vs Dietary Diversity of Kho Kho Players.

Lipid Indices	Age,	Food Item	Standardized Coefficients	95% CI		't' value
	Dietary Diversity		B	Lower Bound	Upper Bound	
Triglycerides (mg/dl)	DDS	Milk	0.357	32.743	86.75	4.479**
		Meat	-0.417	-106.979	-38.908	-4.339**
		Egg	0.453	34.215	85.577	4.722**
		Nuts	-0.229	53.367	-6.885	-2.624**
	FVS	Spices	0.376	5.363	14.882	4.306**
HDL (mg/dl)	FVS	Roots and Tubers	-0.341	-8.342	-0.781	-2.430**
LDL (mg/dl)	DDS		0.229	0.692	6.169	2.530**
	DDS	Vit-A Rich Vegetables	-0.251	-23.318	-0.232	-2.061*
VLDL (mg/dl)	DDS	Milk	0.353	6.487	17.361	4.444**
		Meat	-0.43	-22.121	-8.333	-4.476**
		Egg	0.521	9.054	18.842	5.775**
		Nuts	-0.193	-9.696	-0.584	-2.286*
	FVS	Spices	0.484	1.26	3.222	4.629**

*p<0.05; **p<0.01; DDS –Dietary Diversity Score; FVS –Food Variety Score.

Table 5. Food Choices and Food Behaviour of Athletes.

Description	Food Choices and Food Behaviour
Frequency of Foods Consumption from Outside	Daily 02% 1-2 Times/week 44% 3-4 Times/week 14% Once in fortnight 04% Once in a month 14% Occasionally 10% Never 12%
Most Commonly Consumed Foods from Outside	Chicken Items 48% Samosa 18% Indian Sweets, Noodles and Mutton 16% Fish 14% Ice Cream and Biryani 12% Momo's 10%
Consumption of Foods Before Exercise	Yes – 82% No – 18%
Time of Consumption of Before Exercise	15-30 min 19.5% 45 min before 2.4% 60 Min before 12.1% 120 min before 4.9% Randomly 60.8%
Consumption of Foods During Exercise	Yes 52% No 48%
Type of Foods Consumed During Exercise	Water, Glucose Water, Lemon Water, Fruit juice, Tea, Energy Drink, Whey Protein
Consumption of Foods Immediately After Exercise	Yes 62% No 28%
Type of Foods Consumed After Exercise	Banana, Bengal Gram Whole, Milk, Biscuits, Bread, Apple, Egg, Soya Bean, Protein shake, Jaggery, Upma
Most Disliked Foods	Bitter Gourd, Brinjal, Pumpkin, Capsicum, Ladies Finger, Beef

sociation of daily egg consumption with TG and VLDL. Empirical evidence suggests that consumption of two eggs/day for 12 weeks would change the apolipoproteins and would not adversely affect the blood lipids in trained women [27]. The information on the number of eggs consumption/day would have provided a better understanding of its effect on lipid indices.

The health benefits of Indian spices have been reported [40, 41], but in the present study the intake of spices and condiments were significantly associated with TG and VLDL. Spicy food was positively associated with serum TAG [42, 43]. High energy and fat intake act as mediators along with spicy food in increasing the risk of abdominal obesity [44]. We also assume that the players consuming high energy and fat diets could have mediated an increase in TG and VLDL. Additional studies on mechanisms that are involved in the potential role of spicy food consumption in lipid metabolism may support the findings.

In the present study, TG and VLDL were inversely associated ($p<0.01$) with DDS of meat. Meat is rich in protein, lipoic acids, creatinine, zinc, iron and B-vitamins etc, the scientific evidence suggests reducing consumption of meat and meat products due to high saturated fat content and its link with chronic diseases [28-31]. But, Protein, Lipoic acid, creatinine, vitamins and minerals are beneficial for active trained men [32, 33] and would have influenced a decrease in TG and VLDL.

The players showed a significantly inversely association ($p<0.01$) with DDS of nuts with TG and VLDL. Nuts have high levels of unsaturated fatty acids and bioactive compounds (minerals, polyphenols, Phyto esters, fibre) may improve cardiometabolic health, endothelial function, improved glycemic control, lower blood pressure and body weight [34]. Nuts lower the serum cholesterol levels by lowering the absorption of cholesterol, inhibiting HMG-CoA reductase and increasing bile acid production by stimulation of 7-α hydroxylase [35]. Consumption of >5g/day to < 25g/day of nuts showed a positive association in reducing the cardiovascular disease risk in the untrained population [36].

DDS of other vegetables were inversely associated ($p<0.01$) with LDL and FVS of roots and tubers was inversely associated with HDL. Intake of whole grains, vegetables and fruits would provide adequate intake of vitamins, minerals and antioxidants, beneficial for reducing CVD risk factors [37, 38], increase skin carotenoids and reduce body fat in athletes [39]. Increasing the dietary diversity score with a wide variety of seasonal vegetables and fruits and controlling the energy intake as per the requirement may be beneficial for improving blood lipid indices.

Food Choices and Behaviour of Kho-Kho Players

Food choice is influenced by various factors physiological, psychological, social and economic factors and also varies within and between individuals and populations [23]. Foods choices and food behaviour of players showed that 44% of the players consumed other than home foods once or twice a week, and the top consumed foods were chicken items (48%), followed by Samosa (18%) (Indian savory), Indian sweets (16%), Noodles(16%), Mutton items(16%), Fish items(14%), Ice cream (12%), Biryani (12%) and Momo's (10%). There is a strong link between food availability and food choice [45]. The commonly consumed foods in the present study represent the factors related to the availability of foods, cost, taste and social and cultural beliefs in making food choices (Table 5).

Athletes have nutrition knowledge for healthy food choices [46] and are aware of consuming foods before, during and after exercise [47]. A majority of players (82 %)reported that they consume foods before an exercise program,but 60.8%playersreported that they do not follow the timings. 52% of the players consume foods during exercise and the top reported foods were liquid foods such as water, glucose water, lemon water, fruit juice, tea, energy drink, whey protein. 62% of the players consume immediately after exercise program and the reported foods were banana, Bengal gram whole, milk, biscuits, bread, apple, egg, soya bean, protein shake, jaggery, upma (an Indian Breakfast recipe). The most disliked foods were bitter gourd, brinjal, pumpkin, capsicum, ladies finger and beef (table.5). Athletes have nutrition knowledge for healthy food choices [46] and are aware of consuming foods before, during and after exercise [47]. The players may adopt appropriate sport nutrition strategies that meet the sporting demands before, during and after exercise and may value convenient foods that are easy to carry to the training areas. Nutrition education sessions may be provided to players to make significant food behavioural changes [48]. DD may be an useful tool to assess and monitor the food behaviour of players.

Limitations

The study represents a smaller sample, involving players with differing physiological requirements (adolescents and adults). Self-reported dietary intake is prone to recall bias, mis or underreporting [5, 49, 50]. Quantitative intake of foods and information on dietary supplements were not recorded. Availability of athletic specific and country specific diet quality index would have been a better tool to evaluate dietary diversity and its role on various biomarkers of players.

Conclusion

Dietary diversity was higher among Kho-Kho players with consumption of more than nine food groups and more than twenty seven variety of foods on a daily basis. Lipid indices other than LDL were not associated with DDS and FVS, but individual DDS were associated with TG, VLDL, LDL and HDL.TG and VLDL may decrease with consumption less quantities of whole milk and milk products, eggs and with daily consumption of meat and nuts. LDL may decrease with consumption of vitamin- A rich vegetables and HDL may increase with less intake of roots and tubers. High energy and fat foods may act as mediators along with spices intake in increasing TG, and VLDL.

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Author Contributions

Conceptualization: KK, GLK; Data Curation: AY, RS, VS and Formal Analysis: KK; Funding Acquisition: GLK; Investigation, Methodology: KK, GLK; Project Administration, Supervision: GLK; Manuscript writing: KK; Review of Manuscript: KK, GLK

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Ethical Approval

This study was approved by theInstitutional Ethical Committee of Shri Guru Gobind Singh Tricentenary (SGT) University, Gurgaon, Haryana, India.

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