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Original Article

Evaluation of Dietary Intakes, Body Composition, and Cardiometabolic Parameters in Adolescent Team Sports Elite Athletes: A Cross-sectional Study

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Abstract

Background: Nutritional intake is an important issue in adolescent athletes. Proper athletes' performance is a multifactorial outcome of good training, body composition, and nutritional status. The aim of the present study was to assess nutritional status, body composition, and cardiometabolic factors in adolescent elite athlete's province of Isfahan, Iran. **Materials and Methods:** In this cross-sectional study, 100 adolescent elite athletes from volleyball, basketball, and soccer teams were selected for the study. Demographic, anthropometric, and cardiometabolic parameters were assessed. Nutritional intakes of participants were recorded using three 24-h recall questioners. **Results:** Thirty-four female athletes and 66 male athletes participated in this study. Body mass index had not significantly different between the sexes. Energy, protein, carbohydrate, iron, and fat intakes were significantly higher in male athletes ($P = 0.02$), but calcium and folic acid intakes were not significantly different between the sexes, and Vitamin D intake was significantly higher in females ($P = 0.01$). Systolic and diastolic blood pressure was significantly higher in males ($P = 0.04$) and heart rate had not significantly different between the sexes ($P = 0.09$). Heart murmurs and heart sounds in the majority of participants were normal. **Conclusion:** All the evaluated anthropometric and cardiometabolic parameters were in normal range in the majority of participants. The results showed that dietary intake in these athletes is approximately normal but micronutrients intake status in these athletes needs to be investigated further and longer.

Keywords: *Adolescent athletes, body composition, cardiometabolic risk factors, diet records*

Introduction

Proper athletes' performance is a multifactorial outcome of good training, body composition, and nutritional status.[1] Nutritional requirement of adolescents are higher than any other time in lifecycle, except for the first year of life.[2,3] In addition, adolescent athletes have more nutritional needs than other adolescents because of high physical activity levels and physiological development, especially those with heavy exercise program.[4] Training and competing at professional levels require optimal body function which relies on adequate dietary intake, and providing sufficient energy as well as macro-and micro-nutrients.[5,6]

Nutritional status of junior elite Canadian female soccer players in relation with their anthropometric parameters was evaluated that showed players did not intake adequate energy, carbohydrate, iron, and Vitamin D.[7] Evaluated body composition and cardiorespiratory function in adolescent female basketball player and volleyball player and their corresponding results reflected that body composition and cardiorespiratory activity is normal in these athletes.[8] Evaluated heart rate of athletes per minute, but majority of these studies focused on the assessment of heart rate variability during training and rest and maximum rate and normality of heart rate in rest state is not investigated.[9-12]

Nutritional status and cardiometabolic and anthropometric parameters markedly influence on athletic performance.[7,13] Macro- and micro-nutrients intake impact on body composition and cardiometabolic parameters such as blood pressure and heart rate and thus athletic performance.[14,15]

According to studies, it seems that diet, body composition, and cardiometabolic parameters such as blood pressure and heart murmurs have not been studied

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together in athletes, especially among adolescent athletes. The purpose of the present study was to assess nutritional status, body composition, and cardiometabolic factors in adolescent elite athletes who played soccer, volleyball, and basketball professionally in the province of Isfahan, Iran, so that recognize nutritional deficiencies, cardiometabolic problems, or defects in anthropometric indices in adolescent athletes if there are and help improve athletic performance in this age group.

Materials and Methods

Participants' characteristics

We performed a descriptive and analytical cross-sectional study on dietary intake, several body composition, and cardiometabolic parameters of 100 adolescent elite athletes (12–17 years) of Isfahan province who belonged to national Olympiad teams, from October to December 2013. Cases included 48 football players, 18 volleyball players, and 34 basketball players. We selected all of players. They trained on a defined schedule (6–8 training sessions per week and each session for 1.5 h) and with their club teams participate in seasonal tournaments throughout the year and every year, as the representatives of province participate in national competitions. During data collection, participants were free-living. All participants, their coaches, and parents were informed of study purposes and informed consent was given before the study. Exclusion criteria included lack of complete the questionnaire and unwillingness of individuals to continue to participate in the study.

Dietary assessment

Dietary intake of athletes recorded using three 24 h recall questionnaire (two business days and one holiday day) by trained dietitian.[16,17] The recorded intake for each food item was converted to a daily food intake. Portion sizes of reported foods were changed to grams by using a household measurements book.[16,18] Food intake analysis and their consumed energy and nutrients was estimated using NIV software (Nutritionist IV, diet analysis module, N-Squared Computing, Sydney, Australia, version 3.5.2).

Body composition

Information about athletes' body composition including body weight, height, body mass index (BMI), and percent body fat (PBF) were assessed by a physical educationer using bioelectrical impendence analyzer (BIA). All anthropometric measurements were performed in the morning, between 8 and 10 am. Height was measured using a stadiometer, with an accuracy of 0.5 cm (Seca 700, Germany). Body weight, BMI, and PBF were determined using bioelectrical impendence analysis equipment (ioi 353 BIA) with accuracy of 0.1 kg, 0.1 kg/m^2, 0.1%, respectively. Room temperature was regulated between 26°C and 33°C at the ideal moisture, to help cases relax and eschew low-temperature-induced muscle hardness. Measurements were done in little cloths.

Cardiometabolic parameters

Cardiometabolic parameters including systolic and diastolic blood pressure (SBP and DBP), heart rate, heart sounds, and heart murmurs were assessed. All cardiometabolic data were recorded by a sports medicine specialist in the morning, between 8 and 10 am. Blood pressure was measured using calibrated sphygmomanometer and stethoscope after rest, according to a standard protocol (Accurtorr 1A; Datascope, Japan). Heart rate, heart sounds, and heart murmurs were evaluated using stethoscope (stethoscope MDF, City USA).

Statistical analyses

All data were presented as mean ± standard deviation. SPSS software (SPSS Inc., Chicago, United States, version 16) was used for data analysis. Independent samples *t*-tests and Chi-square test were used for comparison between quantitative and qualitative variables for comparison between the sexes in one sport, respectively. Amounts of macronutrients and micronutrients intake were adjusted for their daily energy consumption, using linear regression test, and residual method. Data were checked for normal distribution using Kolmogorov–Smirnov test. One-way analysis of variance analysis and Chi-square test were used to compare variables between sport fields and they were separated by genders, separately. Significant level of ≤0.05 was considered statistically significant threshold.

Results

Anthropometric characteristics

Age and anthropometric characteristics of participants are provided in Table 1. The ages of male and female athletes were 14.8 ± 0.8 and 14.1 ± 0.9 years (P = 0.001), respectively. Average individuals' sporting experience for males and females was about 5.8 ± 2.2 and 5.2 ± 2.1 years (P = 0.009), respectively. Male athletes were significantly heavier than females in basketball players and taller than females in three sports, but average of BMI showed no significant difference between sexes (P = 0.11) and the amount of PBF were higher in female athletes than males (P = 0.000). The highest BMI (22.0 ± 2.6) and PBF (23.4 ± 4.3) were seen in male basketball players and female volleyball players, respectively.

Nutritional intake

Energy, macronutrients, and micronutrients intake of athletes are provided in Table 2. Mean energy intake of males and females were 3609 ± 942 and 2789 ± 738 kcal/day (P = 0.000), respectively. Average energy, protein, carbohydrate, fat, iron, and folic acid intake in males were significantly higher than that of females, but mean Vitamin D intake in females was significantly higher

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Table 1: Comparison of age and body composition parameters of participants between two genders, according to Wii sports

Sports variables	Volleyball (*n*=18)			Basketball (*n*=34)			Football (*n*=48)			P^a	P^b
	Male (*n*=8)	Female (*n*=10)	*P*	Male (*n*=18)	Female (*n*=16)	*P*	Male (*n*=40)	Female (*n*=8)	*P*		
Age (year)	15.6±1.1	14.7±1.0	0.10	15.4±0.7	14.3±0.7	<0.001**	14.5±0.5	13.1±0.6	<0.001**	<0.001**	0.001**
Weight (kg)	68.0±4.1	62.1±11.1	0.18	74.8±12.8	60.0±9.0	0.001**	61.1±6.7	53.3±11.3	0.11	<0.001**	0.18
Height (cm)	181.1±7.2	173.4±7.5	0.04*	183.7±8.4	167.3±4.8	<0.001**	174.6±6.6	160.3±4.5	<0.001**	<0.001**	0.001**
BMI (kg/m²)	20.8±1.7	21.6±2.5	0.45	22.0±2.6	21.3±2.6	0.46	20.0±1.5	20.6±3.2	0.61	0.02*	0.74
PBF (%)	12.6±1.9	23.4±4.3	<0.001**	13.1±5.0	24.4±5.0	<0.001**	10.6±3.4	22.5±5.7	<0.001**	0.06	0.68

All variables are presented as mean±SD. *Significant amounts at CI 95%, **Significant amounts at CI 99%, [a]*P* comparison of variables between male adolescents in three sport fields, [b]*P* comparison of variables between female adolescents in three sport fields. BMI: Body mass index, PBF: Percent body fat, CI: Confidence interval, SD: Standard deviation

Table 2: Comparison of dietary intake of participants between two genders, according to Wii sports

Wii sports variables	Volleyball (*n*=18)			Basketball (*n*=34)			Football (*n*=48)			P^a	P^b
	Male (*n*=8)	Female (*n*=10)	*P*	Male (*n*=18)	Female (*n*=16)	*P*	Male (*n*=40)	Female (*n*=8)	*P*		
Energy (kcal)	3725±753	2786±529	0.005*	3878±940	2460±796	<0.001**	3223±467	3122±746	0.249	<0.001**	0.14
Protein (g)	124±17	100±38	0.125	166±59	76±24	<0.001**	102±29	86±17	0.129	<0.001**	0.119
Carbohydrate (g)	520±98	356±91	0.002*	578±151	362±114	<0.001**	434±92	445±93	0.76	<0.001**	0.143
Fat (g)	127±39	106±29	0.219	99±14	78±23	0.004*	119±39	110±32	0.573	0.021*	0.01*
Calcium (mg)	1637±339	1399±639	0.359	1533±391	1104±471	0.007*	1235±449	1197±451	0.832	0.01*	0.38
Iron (mg)	30.6±11.9	17±4.3	0.004*	33.2±7.7	18±6.1	<0.001**	20.9±6.1	29.7±11.4	0.003*	<0.001**	0.001**
Vitamin D (µg)	7.5±5.6	6.8±3.5	0.754	4.8±2.8	7.2±4.3	0.148	3.2±2.5	5.4±1.8	0.026*	0.019*	0.31
Folic acid (µg)	408±189	317±170	0.298	446±127	275±117	<0.001**	272±82	255±111	0.618	<0.001**	0.59
Protein adjusted[#] (g)	113±17	109±35	0.82	128±43	119±15	0.44	103±25	81±20	0.02	0.02	0.004
Carbohydrate adjusted (g)	462±111	403±62	0.18	501±171	449±56	0.24	438±72	423±56	0.58	0.34	0.16
Fat adjusted (g)	108±22	121±21	0.26	90±15	88±20	0.67	121±28	100±12	0.05	<0.001**	0.001
Calcium adjusted (g)	1490±296	1517±608	0.91	1310±371	1355±335	0.71	1246±395	1141±54	0.53	0.25	0.27
Iron adjusted (g)	24.7±8.2	21.7±4.7	0.35	27.9±8.7	23.9±3.6	0.09	21.2±5.6	28.2±8.6	0.006	0.004	0.06
Vitamin D adjusted (g)	7.8±5.8	6.9±3.5	0.67	5.4±4.8	6.7±4.2	0.42	2.9±2.2	4.5±1.7	0.06	0.03	0.11
Folic acid adjusted (g)	383±198	337±163	0.59	374±122	356±88	0.62	274±80	250±109	0.47	0.01	0.13

All variables are presented as mean ± SD. *Significant amounts at CI 95%, **Significant amounts at CI 99%, [a]*P* comparison of variables between male adolescents in three sport fields, [b]*P* comparison of variables between female adolescents in three sport fields, [#]Adjusted for their daily energy consumption. CI: Confidence interval, SD: Standard deviation

than that of males ($P = 0.002$) and mean calcium intake had no significant difference between genders ($P = 0.154$).

Cardiometabolic parameters

Cardiometabolic parameters according to sex of athletes are provided in Table 3. Mean SBP and DBP in males and females were 114 ± 7.8/68.6 ± 4.2, and 102.3 ± 9.4/63.5 ± 3.9 mmHg ($P = 0.005$), respectively. Average heart rate in males and females was 80.1 ± 17.7 and 77 ± 11.2 beats/min, respectively, and there was no significant difference between sexes ($P = 0.12$). Heart murmur status of both sexes was 100% normal. Heart sounds in female athletes was 100% normal and in male athletes was 95.4% normal.

Discussion

This study assessed several health status parameters of adolescent elite athletes and its findings will be helpful to improve athlete teenagers' health status and their sporting outcome.

Average body weight, height, and BMI of all athletes in the current study were higher than standard values for teenagers.[16] Average PBF in females was in normal range and higher than males' PBF in every three sports.[16] Melrose *et al*.,[19] Subramanian *et al*.,[20] and Nikolaidis[13] have reported BMI and PBF in normal range for American, Hindi, and Greek volleyball, basketball, and soccer players, but BMI and PBF of these adolescents

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Table 3. Comparison of cardiometabolic parameters of participants between two genders divided according to Wii sports

Sports variables	Volleyball (*n*=18)			Basketball (*n*=34)			Football (*n*=48)			*P*[a]	*P*[b]
	Male (*n*=8)	Female (*n*=10)	*P*	Male (*n*=18)	Female (*n*=16)	*P*	Male (*n*=40)	Female (*n*=8)	*P*		
SBP (mmHg)	115±6.4	106±11.9	0.092	113.8±5.0	102.8±6.6	<0.001**	115.2±9.1	96.8±9.6	<0.001**	0.833	0.121
DBP (mmHg)	66.4±4.3	63.7±4.9	0.257	68.9±3.0	64.1±3.5	<0.001**	68.8±4.7	62.3±3.5	0.001	0.363	0.596
Pulse rate[c]	73.4±14.4	72.8±9.5	0.915	62.5±9.4	81.1±11.6	<0.001**	89.2±14.4	74±10.8	0.005*	<0.001**	0.129
Heart murmurs (%)	100 N [(d)]	100 N	1.000	100 N	100 N	1.000	100 N	100 N	1.000	1.000	1.000
Heart sounds (%)	100 N	100 N	1.000	100 N	100 N	1.000	92.5 N	100 N	0.424	0.374	1.000

Quantitative data are presented as mean ± SD and qualitative data as shown as percentage of normal and abnormal. *Significant amounts at CI 95%, **Significant amounts at CI 99%, [a]*P* comparison of variables between male adolescents in three sport fields, [b]*P* comparison of variables between female adolescents in three sport fields, [c]beats/min, [d]N: Normal. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, CI: Confidence interval, SD: Standard deviation

were different from adolescents in this study. The difference in BMI and PBF among athletes participating in this study and athletes from other studies can be attributed to differences in diet composition, strips, living environment or differences in training load and genetic background of athletes.

Average energy, protein, carbohydrate, and fat intake for all athletes in three fields were approximately proportional to their needs and in accordance with recommended amounts, but average Vitamin D and folic acid intake in athletes was less than recommended dietary allowance (RDA) that need to be investigated further in these teenagers and other adolescent athletes and appropriate measures should be taken in case of deficiency.[16] Average calcium intake in male volleyball and basketball players and in female volleyball players was higher than RDA but according to heavy training in these athletes seems to be needed and in other athletes was lower than RDA that according to important roles of calcium in development and proper functioning of muscles should be made more precise monitoring of calcium intake on adolescent athletes. Average iron intake in all athletes was higher than RDA but according to heavy training in these athletes seems to be needed.

In contrast to Daneshvar *et al*. study which reported that consumption of energy, macro-and micro-nutrients in young male wrestlers were higher than recommended values, except for Vitamin D, biotin, zinc, iodine, chromium, and molybdenum,[21] our results showed that energy and macronutrients intake were in the range of normal values, but calcium and iron intake were higher than recommended values and Vitamin D intake was less than RDA like the aforementioned study. Lovell evaluated Vitamin D status of professional female gymnasts and they suggested that possibly athletes in gymnastic and other indoor environments such as volleyball and basketball should be checked for Vitamin D and calcium status,[22] and also our study indicated that Vitamin D intake was insufficient and more studies are needed to more accurately monitor Vitamin D status in adolescent athletes. Gibson *et al*. evaluated the nutritional status of junior elite Canadian female soccer players in relation to their anthropometric parameters. They examined anthropometric measurements and 4-day food record questionnaires. Results showed that players did not intake adequate energy, carbohydrate, iron, and Vitamin D, and explained that female's performance can be affected by their poor nutritional status[7] while in our study energy, carbohydrate and iron intake was sufficient but Vitamin D intake was inadequate.

According to performed comparisons to other studies, energy, macro- and micro-nutrients intake in our adolescent athletes was higher than the majority of athletes investigated in other countries and this can be a reason for higher BMI of adolescents our study.[4,7,23-25]

Mean heart rate, SBP, and DBP in rest state were normal in male and female athletes. In some studies that examined the heart rate, SBP and DBP in rest state, average heart rate, SBP and DBP were higher or lower than our adolescents but they were in normal range.[21,23,26,27] Perhaps the main reasons for the difference in heart rate, SBP and DBP in our adolescents with adolescents other countries are the difference in intensity and duration of physical training, genetic and racial differences and different dietary intake; however, there are many reasons for it. All athletes had not experienced any problem for heart murmur and was normal whereas 6.3% of Portuguese adolescents, 18.9% of American students and 1.19% of Chinese athletes had problem for heart murmur and was abnormal.[24,28,29] Heart sounds in all athletes participating in this study was normal except for three of the males footballer who had trouble in heart sounds and were referred to a cardiologist for further evaluation.

The strengths of this survey can be pointed to the high number of participants and investigation of nutritional, anthropometric, and cardiometabolic parameters together, although this study had restrictions such as lack of assessment of biochemical factors in adolescent athletes

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but results of it can help in the future research and improve the nutritional status, health status and athletic performance of adolescent athletes.

Conclusion

According to the results of the present study, the nutritional status of the participating athletes in terms of energy and macronutrients intake was approximately normal, although the type of macronutrients intake needs to be reformed but to determine the status of micronutrients intake requires further investigations. The results of anthropometric and cardiometabolic indices approximately were normal and we recommend athletes monitoring cardiometabolic and anthropometric indicators regularly. At the end, we refer to this point that further studies are needed in this field on athletes, especially adolescent athletes.

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Conflicts of interest

There are no conflicts of interest.

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