Research Article / Araştırma Makalesi

Spor Hekimliği Dergisi, 54(4): 215-224; 2019
Turkish Journal of Sports Medicine
DOI: 10.5152/tjsm.2019.135

Analysis of Physical and Physiological Requirements of Indian Male Junior Kabaddi Players in Relation to their Playing Positions

Hintli Genç Kabaddi Oyuncularının Oyun Pozisyonlarına İlişkin Fiziksel ve Fizyolojik Gereksinimlerinin Analizi

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ABSTRACT

Objective: The present study was undertaken to evaluate and compare selected physical and physiological variables in Indian male junior kabaddi players according to their different playing positions, and to establish relationships between those variables.

Materials and Methods: The present study was carried out on 24 male kabaddi players namely all-rounders (n=9, 17.2 ± 1.8 years), raiders (n= 7, 16.3 ± 2.0 years) and covers (n= 8, 17.1 ± 2.5 years). The variables studied on these players include height, body mass, body mass index, body fat ratio, muscle mass, aerobic power (VO_2max), maximum, minimum and average anaerobic power, fatigue index following standard protocols.

Results: Significant difference (p=0.001) was observed only in VO_2max when compared among the groups. Significant strong positive correlations were found for muscle mass with maximum anaerobic power (r=0.761, p<0.001), minimum anaerobic power (r=0.714, p<0.001) and average anaerobic power (r=0.799, p<0.001) while moderate significant correlation with fatigue index emerged (r=0.526, p= 0.008). A significant strong positive correlation was found between body mass and average anaerobic power (r=0.712, p<0.001) while significant moderate positive correlations with maximum anaerobic power (r=0.63, p=0.001) and minimum anaerobic power (r=0.692, p<0.001) were depicted. BMI was found to have significant positive moderate correlations with minimum anaerobic power (r=0.546, p= 0.006) and average anaerobic power (r=0.456, p=0.022).

Conclusion: The present study was conducted to provide a reference to coaches to enhance and compare performance of kabaddi players based on their specific requirements.

Keywords: Kabaddi, physiology, aerobic power, anaerobic power, playing position

ÖZ

Amaç: Bu çalışma Hintli genç kabaddi oyuncularının bazı fiziksel ve fizyolojik değişkenlerinin farklı oyun konumlarına göre değerlendirilmesi ve karşılaştırılması, bu değişkenler arasındaki ilişkiyi tanımlamak amacıyla yapıldı.

Gereç ve Yöntemler: Bu çalışma 24 erkek kabaddi oyuncusundan; “all-rounders” (n = 9, 17.2 ± 1.8 yıl), “raiders” (n = 7, 16.3 ± 2.0 yıl) ve “covers” (n = 8, 17.1 ± 2.5 yıl) pozisyonlarında mücadele edenler üzerinde yapıldı. Bu oyuncular üzerinde çalışılan değişkenler arasında yükseklik, vücut kütlesi, vücut kitle indeksi, vücut yağ oranı, kas kütlesi, aerobik güç (VO2max), maksimum, minimum ve ortalama anaerobik güç, standart protokolleri takip eden yorgunluk endeksi bulunmaktaydı.

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Geliş Tarihi/Date Received:
20.12.2018

Kabul Tarihi/Date Accepted:
18.03.2019

Yayın Tarihi/Published Online:
14.06.2019

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Bulgular: Gruplar arası karşılaştırmada anlamlı fark (p = 0.001) sadece VO2max'ta gözlendi. Maksimum anaerobik güçle kas kütlesi (r = 0.761, p <0.001), minimum anaerobik güç (r = 0.714, p <0.001) ve ortalama anaerobik güç (r = 0.799, p <0.001) için anlamlı güçlü pozitif korelasyon bulundu, yorgunluk indeksi ile anlamlı bir korelasyon ortaya çıktı (r = 0.526, p = 0.008). Vücut kitlesi ile ortalama anaerobik güç arasında anlamlı bir pozitif korelasyon bulunurken (r = 0.712, p <0.001), maksimum anaerobik güç (r = 0.63, p = 0.001) ile minimum anaerobik güç (r = 0.692, p <0.001) arasında orta düzeyde pozitif korelasyon görüldü. VKİ, minimum anaerobik güç (r = 0.546, p = 0.006) ve ortalama anaerobik güç (r = 0.456, p = 0.022) ile pozitif yönde anlamlı korelasyon gösterdi.

Sonuç: Bu çalışma, kabaddi oyuncularının performanslarını spesifik gereksinimlerine göre arttırmak ve karşılaştırmak için antrenörlere referans vermek amacıyla yapılmıştır.

Anahtar Sözcükler: Kabaddi, fizyoloji, aerobik güç, anaerobik güç, oyuncu pozisyonu

Available at: http://journalofsportsmedicine.org and http://dx.doi.org/10.5152/tjsm.2019.135

Cite this article as: Aggarwala J, Dhingra M, Bhatia V, et.al. Analysis of physical and physiological requirements of Indian male junior kabaddi players in relation to their playing positions. Turk J Sports Med. 2019;54(4):215-24.

INTRODUCTION

Kabaddi is a conventional outdoor game played almost in all parts of India - in fact, is popular throughout South Asia and has also extended to Southeast Asia, Japan and Iran. Kabaddi is played between two teams of seven players a side. It is played in two halves of 20 min each, with an interval of five minutes. It requires a small soft natural soil field area of 12.5×10m, and interestingly this sport requires no equipment to play (1). The fundamental idea of the game is to achieve points by entering into opponents' court and touching as many defence players as possible without getting trapped in a single breath (2).

Kabaddi players, on the basis of their role in the game, can be divided into four groups, namely Raiders, Corners, Coverers and All-rounders. The raiders are attackers; corners and coverers are defenders, whereas all-rounders perform both duties of attacking and defending. The main responsibility of the corners is to initiate the tackles at the right moment, as they are the main targets for the opposition's raiders to score points from. The "coverers" of the team usually take up the positions inside of the "corners" and "ins" on both sides of the mat, and act as a support system to the chain comprised of the former (corners and ins). However, their primary responsibility is to save their star raiders, who take up the safest position on the mat i.e the "center", from getting touched out by the opposition raiders. The "ins" of the team usually comprise of the raiders, who form a chain with the "corners", and help them maintain their balance on the mat. With the chain formed, they help the corners contain the opponent's raiders, and also try to block the raiders in their tracks.

Since kabaddi is an intermittent type of sport, it requires both aerobic and anaerobic endurance together with a healthy physique. The rest time during the game is sufficient to allow recovery to a clear extent (3). Kabaddi requires remarkable physical fitness, agility, muscular strength, neuromuscular coordination, lung capacity, intelligence and clearness of mind for both attackers and defenders (4). Kabaddi players of different playing positions perform different specified skills during competitions, which require specific body shape and capacity. Therefore, the possession of essential anthropometric characteristics provides an edge to players, to outperform his/her opponents. Various studies have explored the relationships between anthropometric and physiological characteristics of kabaddi players (4-7). However, only few studies have been conducted so far to study scientifically differences in requirements of Kabaddi players in relation to their playing positions. Kumar (8) reported that the all-rounder had significantly ($p<0.05$) higher total arm length, followed by raiders, corners and coverer kabaddi players. The longer arm length helps the all-rounder and raiders touch the opponent from a safer distance without being caught. As yet, there is no study observed evaluating and comparing the physiological profile of kabaddi players in relation to their playing positions. To fulfil the lacunae of the literature, the aims of the present study were i) to evaluate and compare selective physical and physiological variables in Indian male junior kabaddi players according to their different playing positions, and ii) to establish relationships of selective physical characteristics with these physiological variables.

MATERIAL and METHODS

Selection of Subjects

The present cross-sectional study was carried out on 24 male kabaddi players classified according to their specific playing position as all-rounders (n=9, mean age=17.2 ± 1.8 yrs), raiders (n= 7, mean age=16.3 ± 2.0 yrs) and covers (n= 8, mean age= 17.1 ± 2.5 yrs). All the players belonged to the Indian Police Family Welfare Society (PFWS) competing at zonal, state and national levels in kabaddi, having a minimum of one year of systematic training history. All of them were assessed for various physical and physiological parameters at a Human Performance Laboratory. At the end of the competition season, data were collected from the players at approximately the same time of the day to prevent effects of diurnal variation. Before conducting the tests, all the players were clinically examined by Sports Medicine Doctors following standard procedure (9). Subjects who were medically fit, healthy, with no history of any hereditary or cardiorespiratory diseases, were selected for the study. Prior to that, a complete explanation of the purposes, procedures and potential risks and benefits of the assessments were provided to all players, and their written consents were obtained. The present study was conducted following guidelines as laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the local Ethics Committee.

Procedure

Measurements were performed with the participants barefoot and in minimal clothing, following collection of anthropometric data. The physical characteristics including height (cm) and body mass (kg) of the players were obtained through use of anthropometric rod and digital weighing machine respectively, by standardized protocols (10). The age of all players were calculated from their date of birth as evidenced from original birth certificates. Body mass index (BMI) was calculated from body height and weight following standard equation (11). Pre-exercise heart rates were measured using a heart rate (HR) monitor (Polar H7, Kempele, Finland) applied on the chest of the players. HRs were recorded as displayed on the monitor (12).

Measurement of Body Fat and Fat Free Mass

The participants were instructed a day before to come for the test fasting and with empty bladder, and all metal accessories, coins and mobile phones got removed from the body. Total fat free mass (kg) and body fat (%) of each subject was assessed using a multi-frequency body composition analyzer (Model mBCA 515, SECA, Hamburg, Germany) which is an eight electrode segmental multi-frequency bioelectric impedance analyzer (MFBIA) that measures impedance at 19 different frequencies ranging from 1 kHz to 1 MHz under uniform and controlled laboratory conditions. It is a “stand-on” device where subjects put their feet on top of the electrodes in such a way that their heel is placed central to the smaller posterior electrode, and the forefoot is placed central to the larger 152 anterior electrode. Each side of the handrail has six electrodes; two are selected depending on the height of the subject with the angle of about 30° between arms and the body. The hands touch the electrodes in such a way that the electrode separator is located between the middle and ring fingers. Each measurement in the multi frequency analyzer takes approximately 20 s. MFBIA scores obtained at 5 and 50 kHz are applied in the predictive equations (13).

Measurement of Aerobic Power and Anaerobic Power

For the estimation of the maximum, minimum and average anaerobic power parameters and fatigue index, the Running-based anaerobic sprint test (RAST) was applied. The test was preceded by players' body weight measurement. This test consisted of six repeated 35 m maximum sprints with 10 s passive recovery between each sprint. The time for each sprint effort was measured using a system of photocells (Globus Ergo Timer, Timing System, Codogne, Italy) located at the beginning and end of 35 m. Using the time of each effort, the peak power output (P) of the player in each effort (P=total body mass × $distance^2$)/$time^3$) was determined. From the six sprint times and peak power output; maximum, minimum and average anaerobic power of the player was determined. Fatigue index (FI) as [(Maximum anaerobic power-minimum anaerobic power)/Total time for the six sprints] represents the rate at which the power declines in the player's performance (14).

For the estimation of the aerobic power (VO_2max), Multi-stage fitness test (MSFT) or Bleep test was used, which involved continuous running between two lines 20 m apart (distance is marked out with chalk) in time to recorded beeps. The players were instructed to stand behind one of the lines facing the second line, and begun running guided by the beep, as instructed. The players kept on running between the two lines, turning according to recorded beeps. There are total 21 levels in the beep test and each level has a set amount of stages/shuttles to complete. Each level goes for 1 min. After one minute, a sound indicates an increase in beep tempo, and the beeps get closer together. If the player would not reach in time before the scheduled beep, he was asked to run to the line, turn and try to catch up with the pace within two more scheduled beeps. However, if the subject failed to reach the line for two consecutive beeps then the test was stopped. The subject's score, i.e. the levels and number of shuttles reached before he is unable to maintain with the beep tempo was recorded. This level and shuttle score was then converted to a VO_2max equivalent score using the beep test standardized calculator (15).

Statistical analysis: The normality of data was checked using the Shapiro Wilk test. To assess differences among kabaddi players according to their specific playing position, one-way analysis of variance (ANOVA) was used with multiple post-hoc Tukey's tests. Pearson's correlation coefficient was also used in order to test the relationships between physical characteristics and different physiological variables. The correlation coefficients (r) were categorized as very weak (0.0-0.2), weak (0.2-0.4), moderate (0.4-0.7), strong (0.7-0.9) or very strong (0.9-1.0) in the study. Multiple linear regression models analyzed the effects of average anaerobic power and fatigue index on different physical parameters. Statistical analysis was carried out using the SPSS v20.0 package (SPSS Inc., Chicago, IL, USA). All the values were presented as mean ± standard deviation (sd). An alpha level of $p \leq 0.05$ was used to mark statistical significances.

RESULTS

Tables 1 and 2 represent various physical and physiological parameters of Indian male junior kabaddi players according to their specific playing positions, ie. all-rounders, raiders and covers respectively. No significant dissimilarities were noticed among the three groups in any of the physical parameters like age, height, body mass, BMI, body fat ratio and muscle mass. Among the physiological parameters (Table 2), all the parameters, except VO_2max, were comparable among the three groups, revealing no significant differences. Significant difference ($p=0.001$) was observed only in VO_2max when compared among the groups. VO_2max was found to be highest in the raiders (41.2 ± 4.5 ml/min/kg), followed by all-rounders (39.9 ± 5.8 ml/min/kg) and covers (33.2 ± 4.5 ml/min/kg). Tukey's post-hoc multiple comparison test also yielded significant difference ($p<0.05$) in mean VO_2max of raiders in comparison with both all-rounders and covers.

Table 1. Physical characteristics of kabaddi players according to their playing positions

Physical Parameters	All-rounders (n=9)	Raiders (n=7)	Covers (n=8)	F (2,21)	p-value
Age (yrs)	17.2 ± 1.8	16.3 ± 2.0	17.1 ± 2.5	0.464	0.635
TExp (mo)	13.8 ± 8.7	24.0 ± 12.0	17.8 ± 13.0	1.632	0.219
Height (cm)	169.9 ± 10.1	178.1 ± 5.9	169.9 ± 6.7	2.595	0.098
Mass (kg)	63.7 ± 10.0	65.5 ± 10.3	66.5 ± 14.4	0.126	0.883
BMI (kg/m^2)	22.0 ± 2.4	20.6 ± 2.5	22.9 ± 4.2	1.028	0.375
Body fat (%)	13.4 ± 5.8	10.4 ± 4.5	14.9 ± 6.2	1.283	0.298
Muscle mass (kg)	27.5 ± 4.9	28.2 ± 3.9	27.3 ± 5.1	0.079	0.924

Values are (mean ± sd); BMI: body mass index; TExp: training experience; mo: months

Table 2. Physiological characteristics of the kabaddi players according to their playing positions

Physiological Parameters	All-rounders (n=9)	Raiders (n=7)	Covers (n=8)	F (2,21)	p-value	Tukey's post-hoc
VO_2max (ml/min/kg)	39.9 ± 5.8	41.2 ± 4.5	33.2 ± 4.5	9.387	0.001	2 vs 1*& 3*
AnPmax (W)	474 ± 145	502 ± 117	397 ± 136	1.274	0.300	-
AnPmin (W)	273 ± 92	249 ± 68	230 ± 75	0.617	0.549	-
AnPave (W)	349 ± 110	351 ± 70	303 ± 89	0.695	0.510	-
Fatigue index (W/s)	5.64 ± 2.17	6.75 ± 3.22	4.29 ± 2.17	1.807	0.189	-
Pre-ex HR (bpm)	72.7 ± 12.5	74.3 ± 9.2	83.1 ± 12.5	1.906	0.174	-

Values are (mean ± sd); *: p<0.05, 1: all-rounder, 2: raider, 3: cover; VO_2max: max aerobic power; AnP: anaerobic power; ave: average; HR: heart rate; Pre-ex: pre-exercise; sign: significance

Table 3 represents correlation coefficients of different physical parameters with physiological parameters of kabaddi players. Significant moderate and positive correlations were found between age and maximum anaerobic power (r=0.653, p=0.001), minimum anaerobic power (r=0.636, p=0.001), average anaerobic power (r=0.678, p<0.001) and fatigue index (r=0.455, p=0.026). A significant strong positive correlation was found for height with maximum anaerobic power (r=0.711, p<0.001), and significant moderate positive correlations with minimum anaerobic power (r=0.487, p=0.016), average anaerobic power (r=0.641, p=0.001) and fatigue index (r=0.644, p=0.001). A significant strong positive correlation was found between body mass and average anaerobic power (r=0.712, p<0.001), and significant moderate positive correlations with maximum anaerobic power (r=0.63, p=0.001) and minimum anaerobic power (r=0.692, p<0.001).

Table 3. Pearson's correlation coefficient of different physical parameters with physiological parameters

Parameters	VO_2max (ml/min/kg/)	AnPmax (W)	AnPmin (W)	AnPave (W)	FI (W/s)	Pre ex HR (bpm)
Age (yrs)	$-0.139^{0.517}$	$0.653^{0.001}$	$0.636^{0.001}$	$0.678^{<0.001}$	$0.455^{0.026}$	$-0.003^{0.988}$
Height (cm)	$0.085^{0.693}$	$0.711^{<0.001}$	$0.487^{0.016}$	$0.641^{0.001}$	$0.644^{0.001}$	$-0.149^{0.488}$
Mass (kg)	$-0.181^{0.396}$	$0.630^{0.001}$	$0.692^{<0.001}$	$0.712^{<0.001}$	$0.337^{0.107}$	$0.054^{0.802}$
BMI (kg/m^2)	$-0.286^{0.175}$	$0.312^{0.138}$	$0.546^{0.006}$	$0.456^{0.022}$	$-0.012^{0.955}$	$0.161^{0.452}$
TExp (mo)	$-0.157^{0.465}$	$0.294^{0.164}$	$0.312^{0.138}$	$0.344^{0.100}$	$0.140^{0.513}$	$0.183^{0.392}$
Body fat (%)	$-0.327^{0.119}$	$0.024^{0.910}$	$0.309^{0.142}$	$0.179^{0.401}$	$0.248^{0.243}$	$0.137^{0.522}$
Muscle mass (kg)	$-0.004^{0.985}$	$0.761^{<0.001}$	$0.714^{<0.001}$	$0.799^{<0.001}$	$-0.526^{0.008}$	$0.009^{0.968}$

n=24; BMI: body mass index; VO_2max: max aerobic power; AnP: anaerobic power; ave: average; FI: fatigue index; Pre-ex HR: pre-exercise heart rate; BMI: body mass index; TExp: training experience; mo: months
Significance levels have been indicated as superscripts next to the values

Based on the previous correlations, and in order to further examine the relationships between physiological and physical variables, linear multiple regressions were performed to evaluate the possible predictors of average anaerobic power and fatigue index as depicted in Table 4. The first multiple regression model used average anaerobic power (W) as dependent variable, and age (yrs), height (cm), body mass (kg), BMI (kg/m^2), training experience (mo), body fat ratio (%), and muscle mass (kg) as explanatory variables. Results showed that all seven predictors produced R=0.833, R^2=0.693, F(7,16)=5.168, p=0.003, meaning that all physical variables of the athletes explained 69% of their average anaerobic power. However, beta coefficients indicated that age (Beta=0.309, t=1.316, p=0.207), height (Beta=0.071, t=0.063, p= 0.951), body mass (Beta=0.281, t=0.139, p=0.891), BMI (Beta=0.014, t=0.008, p=0.993), training experience (Beta=0.074, t=0.434, p=0.67), fat ratio (Beta=0.261, t=-0.848, p=0.409) and muscle mass (Beta=0.317, t=0.552, p=0.588) did not significantly predict average anaerobic power.

BMI was found to have significant positive moderate correlations with minimum anaerobic power (r=0.546, p=0.006) and average anaerobic power (r=0.456, p=0.022). No significant correlations were observed for VO_2max and pre-exercise HR rate with any of the studied physical parameters. However, significant strong positive correlations were found for muscle mass with maximum anaerobic power (r=0.761, p<0.001), minimum anaerobic power (r=0.714, p<0.001) and average anaerobic power (r=0.799, p<0.001), and moderate significant correlation with fatigue index (r=0.526, p=0.008).

Table 4. Multiple linear regression analysis to evaluate the possible predictors of AnPave FI of the players

	R	R^2	F(7, 16)	Sig F-chg	Beta	t-value	p-value	Collinearity statistic	
								tolerance	VIF
AnPave (W)	0.833	0.693	5.168	0.003					
Age (yrs)					0.309	1.316	0.207	0.348	2.876
Height (cm)					0.071	0.063	0.951	0.015	66.626
Mass (kg)					0.281	0.139	0.891	0.005	214.492
BMI (kg/m²)					0.014	0.008	0.993	0.007	137.400
TExp (mo)					0.074	0.434	0.670	0.656	1.525
Body fat (%)					-0.261	-0.848	0.409	0.202	4.961
Muscle mass (kg)					0.317	0.552	0.588	0.058	17.180
Fatigue index(W/s)	0.793	0.629	3.874	0.012					
Age (yrs)					0.496	1.920	0.073	0.348	2.876
Height (cm)					-1.571	-1.264	0.224	0.015	66.626
Mass (kg)					3.150	1.412	0.177	0.005	214.492
BMI (kg/m²)					-2.771	-1.552	0.140	0.007	137.400
TExp (mo)					0.086	0.459	0.653	0.656	1.525
Body fat (%)					-0.461	-1.360	0.193	0.202	4.961
Muscle mass (kg)					0.365	0.578	0.571	0.058	17.180

n= 24; AnP: anaerobic power; ave: average; BMI: body mass index; TExp: training experience; mo: months; FI: fatigue index; Pre-ex HR: pre-exercise heart rate

The second multiple regression model used fatigue index (W/s) as dependent variable, and age (yrs), height (cm), body mass (kg), BMI (kg/m²), training experience (mo), body fat ratio (%) and muscle mass (kg) as explanatory variables. Results revealed that all seven predictors produced R=0.793, R^2=0.629, F(7,16)=3.874, p=0.012, meaning that all physical variables of the athletes explained 63% of their fatigue index. However, beta coefficients indicated that age (Beta=0.496, t=1.92, p= 0.073), height (Beta=-1.571, t=-1.264, p=0.224), body mass (Beta=3.15, t=1.412, p=0.177), BMI (Beta=-2.771, t=-1.552, p=0.14), training experience (Beta=0.086, t=0.459, p=0.653), fat ratio (Beta=-0.461, t=-1.36, p=0.193) and muscle mass (Beta=0.365, t=0.578, p=0.571) did not significantly predict fatigue index level.

DISCUSSION

Kabaddi is a sport coalescing the actions of various games like wrestling, gymnastics, judo, rugby, etc. (4). Kabaddi players require a high level of physical fitness to execute offensive pushes, falls, turns, sudden changes of direction, holding, bending, jumping, leg and hand touch, and maintaining hold and respiration. Kabaddi requires both skill and power (16). Players at different playing positions have different anthropometric and physiological requirements. The present study revealed that raiders were superior than the all-rounders and covers in the mean differences in height, BMI, body fat ratio and muscle mass content, although all differences were not found to be statistically significant. Differences in anthropometric variables existing among kabaddi players of different playing positions might be due to the fact that those positions require different physical structure that helps the players to exhibit their playing potential at the optimum level (8).

Although there was some difference observed in training experience for the three groups (13.8 months for all-rounders, 24 months for raiders and 17.8 months for covers), this difference was not found to be statistically significant. The mean height and body weight of the kabaddi players of all groups was better than those of the Indian male population (17). In the present study, the raiders were found to have less body fat ratio and more muscle mass in comparison to the all-rounders and covers, although the differences were found to be statistically insignificant. The optimum body fat ratio for different sports disciplines varies from 6 to 15% in Indian athletes (18), except for heavyweight wrestlers and weightlifters. In kabaddi, excess body fat will inhibit rapid movement across the court, and the execution of explosive and agile movements and jumps. More muscle content and less body fat will increase strength which, in turn, is helpful for raiding as well as catching. A raider can push the catchers and make an escape more readily if he is physically stronger and the same holds true for catching the raider.

For the measurement of aerobic power, multi stage fitness test (MSFT) was used instead of the direct measurement through gas analysis. The validity and the reliability of MSFT have been studied earlier (19-21). A key benefit of the 20 m shuttle run is the use of the similar procedure for all age groups, making longitudinal or cross-sectional evaluation at all ages possible. The 20 m shuttle run assessment was found to be consistent both in children ($r=0.89$) and adults ($r=0.95$) (22). Significant differences in VO_2max levels were noticed between all-rounders and raiders ($p<0.05$), and between that of raiders and covers ($p<0.05$). The result so obtained was particularly because of the differences in training patterns and the nature of work.

All-rounders and raiders are more involved in running activities as compared with the covers, thus, VO_2max levels are higher in all-rounders and raiders than in covers and, that of raiders was the highest of all. However, no significant differences were found in the mean value of pre-exercise HR among the groups. From a study (3), it was concluded that 48 ml/min/kg of VO_2max is satisfactory for the kabaddi players, still higher values are advantageous for better performance in the game or tournament. Considering the facts that all the players participated in the study were young, and undergoing systematic training for less than two years, the present data obtained with regards to VO_2max are well behind of that reported by Khanna et al (3). All the data were collected in the off-season phase of their training, which might be speculated as another reason of discrepancy.

Analysis of anaerobic power and fatigue was done using running-based anaerobic sprint test (RAST). Although the Wingate anaerobic test (WanT) is a rapid analysis that is simple to pertain, and at relatively low expenditure, it is generally executed on a cycle ergometer, and therefore is not suitable for running sports (23). On the other hand, RAST, which is an adaptation of the WAnT to running (24), has been extensively used to evaluate anaerobic power. Zagatto et al (14) has shown that RAST is a reproducible, reliable and valid process for testing anaerobic power. It is recognized as a good predictor of running performance (35 to 400 m), which can be effortlessly added to the training regimen. No significant differences were found concerning anaerobic powers of kabaddi players of all the three positions.

There was no significant difference obtained in the fatigue index among the three groups. Previous studies have reported that while raiding, the main source of energy metabolism is anaerobic (3), thus raiders show higher anaerobic power as compared with other positions, which might be attributed to the fact that training of raiders comprise both speed and strength components of training. During raiding, players do not take any breath, and have to execute intense spurts of explosive action - jumping, moving and quick turning- into the opponents' court, while continuously repeating the word "kabaddi". The strenuous training of the raiders in turn leads to additional muscular hypertrophy. Consequently they have the highest lean body mass as compared with the other groups in the present study (Table 1).

Correlation analysis of anthropometric characteristics like age, height, weight, BMI, body fat ratio and muscle mass with physiological parameters like anaerobic power and fatigue index have given some interesting findings. Muscle mass is highly significantly positively related with anaerobic power, indicating that greater muscle content is required for better anaerobic power. However, positive correlation of fatigue index with muscle content could not be justified. This is indicative of the fact that the recovery kinetics of kabaddi players is not proper in spite of having high muscle content. Lower level of training period for these young players could be a suitable explanation for this. Anaerobic power also shows positive correlation with height and BMI of players. Minimum and average anaerobic power have moderately significant positive relationships with BMI; however, maximum anaerobic power has no significant relationship with BMI. For the yield of maximum power, factors other than BMI become more significant. With increasing age, setting up of early fatigue is seen in kabaddi players, fatigue index revealing positive correlation with age (0.455*).

Multiple linear regression of average anaerobic power shows that variables like age, height, weight, BMI, training experience, muscle content and body fat ratio are major predictors of average anaerobic power (R^2=0.69). Body fat has a negative effect on anaerobic power, unlike the rest of the parameters. Height, BMI and body fat ratio have negative impact on fatigue index. The value of squared R for fatigue index is 0.629 due to factors like age, height, weight, BMI, muscle mass, body fat ratio and training experience. Certainly, these results expose the need for further research in future to establish the specific physiological variables and trainable distinctiveness needed to get better performance in male junior kabaddi players, and should incorporate other important parameters related to muscular performance that were not evaluated in the current study.

There are some limitations with this study that should be highlighted. Firstly, the cross-sectional pattern of the study does not allow one to assume a cause-and-effect. Thus, it is indistinct whether decreases or increases in BMI and other body composition parameters (body fat ratio or fat free mass) directly control anaerobic or aerobic performance results. Secondly, the sample size taken for the present study was relatively small. Larger sample sizes in future research will be essential to better comprehend positional specific dissimilarities and relationships in kabaddi players. Thirdly, training experience for these players was low, being a maximum of two years. Also, there was a variation in training experience between the three groups, all-rounders having a mean training experience of 13.8 months, and raiders having an experience of 24 months, which may have influenced the results, and hence warrants further research. Fourthly, only male players aged 16-19 years were studied, which prevents generalizing the results to female players and male players of older or younger age groups. Fifthly, indirect measurements were used to quantify both aerobic and anaerobic power among the kabaddi players. Finally, all the measurements were done in the players at the end of the competitive season. Analysis and comparison of physiological parameters before and during the competitive season among kabaddi players will impart a distinct picture of systematic training effect as per their specific playing positions.

CONCLUSION

Variability in the anthropometric parameters of kabaddi players according to their playing position has been studied earlier. However, no study has been conducted till date to study the physiological differences in the players according to their positions. The present study was conducted to provide a reference to coaches and sports scientists working to enhance and compare the performance of kabaddi players based on their positionally specific physiological requirements.

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