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Role of Specific Playing Position on Various Anthropometric, Body Composition and Physical Fitness Parameters of Indian Male Sepak Takraw Players

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Abstract

Background: Anthropometric and physiologic properties have influence on exercise performance in sepak takraw and physiological profiles of athletes differ between sports and playing positions.
Objectives: Present study was aimed to determine the effect of playing position on anthropometric, body composition and physical fitness parameters in young male sepak takraw players.
Methods: The cross-sectional study was conducted on three positional groups of total 44 male Indian sepak takraw players (spiker/killer, n = 14; tekong, n = 14; and feeder, n = 16) of national level. Anthropometric parameters, body composition profile, physical fitness variables including 30m flying, 6X10m shuttle run, vertical jump, sit up, endurance and anaerobic power were assessed by following standard protocols.
Results: Significant differences were observed in height, weight and leg length among the positional groups. Almost all body composition parameters were significantly ($P < 0.01$) higher among 'tekong' position except fat mass. Handgrip strength, back strength, vertical jump, sit up, VO_{2max}, explosive leg power and maximum anaerobic power were found to be significantly differed among the three positional groups of sepak takraw. Regression prediction model identified back strength ($P = 0.034$), peak explosive power ($P < 0.001$) and leg length ($P < 0.001$) as the significant predictor of vertical jump ($R^2 = 0.930$ and $P < 0.001$).
Conclusions: Players of 'tekong' position were better in anthropometric and body composition profiles than 'spiker and feeder'. Whereas, 'spiker' position was found to have higher back strength, explosive power, vertical jump and sit up abilities. Regression model identifies back strength, peak explosive power and leg length as the significant predictors of performance in sepak takraw.

Keywords: Sepak Takraw, Spiker, Tekong, Feeder, Explosive Strength, Vertical Jump

1. Background

Sepak takraw or kick volleyball is a complex net-barrier game that involves kicking, jumping, quick reflexes, turns and acrobatic twists (1). Malay word "Sepak" means kick and Thai word "Takraw" means woven ball. The players are only allowed to use head, chest, feet and thighs to kick the ball over the barrier. Many skills like setting and spiking required immense capability of agility, precision, leg strength and timing. The intensity of sepak takraw game is intermittent type and it depends on the length of rallies following a serve just like badminton, squash and tennis (2-4).

As a powerful high impact team sport, sepak takraw requires the player to be physically fit, strong, and masterful in technique especially of lower body parts. Takraw imposes offensive movements by jumping with back to the net and kicking the ball over the shoulder while flipping (5, 6). This kind movement in the game needs a high muscular explosive strength in the lower extremities along with an additional improved iso-static strength which can complement the balancing of the players during action (2).

Sepak takraw team called 'Regu' which consist of three positions i.e., tekong, feeder and spiker. Each position has

their particular role during the game. However, the player may change the position at anytime if necessary or order from the coach. Since the role of each player in a regu is different, physical attribute demand may be different associated with performances (7). Further Steinhagen et al. (8) also reported that physiological profiles of athletes differ between sports and playing positions.

Still there are insufficient knowledge about positional physiological needs and talent identification characteristics in sepak takraw especially with reference to Indian context. Although some reports show the influence of anthropometric and physiologic properties on exercise performance in sepak takraw (3, 5, 9). But the relevance of physical fitness parameters along with its body composition and anthropometric profile in sepak takraw according to their specific playing positions is still unclear. Although, there is no such evidential study to identify the predictor parameters for the superiority in sepak performance.

2. Objectives

The present study was undertaken with the objectives (i) to evaluate and compare the various anthropometric, body composition and physical fitness parameters, (ii) to identify the significant predictor for optimizing the physical performance indices in young Indian male sepak takraw players according to their specific playing positions.

3. Methods

3.1. Selection of Subject

The present cross-sectional study was carried out on 44 young Indian male sepak takraw players which includes - spiker/killer (n = 14, mean age = 15.6 $\pm$ 2.43 years), tekong (n = 14, mean age = 15.1 $\pm$ 1.78 years) and feeder (n = 16, mean age = 15.4 $\pm$ 1.61 years). All players belong to various schemes of Sports Authority of India (SAI), Imphal. Present studied players were national level performer with minimum 4 years of formal training history. Players belonged to almost similar socio-economic status, dietary habits and got trained in similar environmental/climatic condition which made them homogeneous in nature. Players were clinically examined by the physicians of sports medicine just before commencing the study protocol. Informed consent was taken from each player and the study protocol confirms the ethical guidelines of the Declaration of Helsinki, 1975. Proper ethical clearance (Ref No. 44/SAI/HPL/2018-19) was also obtained from the Institutional Human Ethical Committee (IHEC).

3.2. Training Regimen

The training regimen for the sepak takraw players were irrespective of their playing positions and it was held on an average 4 hours every day (except Sundays). Daily training was divided into two sessions (i.e., morning and evening session) which consist of one hour physical conditioning and two hours skill training. Various strength and muscular endurance training protocol were included in the main physical training schedule along with flexibility exercises. Warm up and cool down sessions were also included before and after of the main practice session. Besides the techno-tactical training, psychological training session was also provided to the players.

3.3. Anthropometric Measurements

Body weight (kg) was recorded by using a Seca alpha weighing scale (model 770, Seca Deutschland, Germany) and height (cm) was measured by using a Seca stadiometer (model - 213) with standard procedure (10). Body Mass Index (BMI) was calculated from the following equation (11).

BMI (kg/m^2) = Body mass (kg) / Body height (m^2)

Grip strength (both right and left hand) (kg) and back muscle strength were measured by using handgrip and back strength dynamometer respectively (Takei, A5401, Takei Scientific Instruments Co., Ltd., Niigara City, Japan) following the standard procedure (12). Relative back strength (RBS) was calculated after dividing the absolute value by the body weight.

3.4. Estimation of VO_{2max} and Anaerobic Power

Endurance capacity (VO_{2max}) was predicted by using modified 20 meter multi-stage fitness test (Beep test). Players were instructed to maintain the running speed against the progressive frequency of 'beep' sound over 20 m distance. The test was terminated when he/she (i) could not match the pace of "beeps" against two successful shuttles and/or (ii) stopped voluntarily (13). Athlete's anaerobic power was predicted by using running-based anaerobic sprint test (RAST). Participants were asked to perform six consecutive sprints at maximal speed over the distance of 35 m with a 10 s rest period between each sprint. Timing of each sprint was recorded by using a Brower timing gate system (Brower Timing Systems, USA) (14).

3.5. Measurement of Body Composition Parameters

Multi-frequency bioelectrical impedance analyzer (MF-BIA, Maltron International Ltd., Rayleigh, UK) was used to measure various body composition variables i.e., basal metabolic rate (BMR), fat mass (FM), fat free mass (FFM), body cell mass (BCM), muscle mass (MM) and glycogen content. An alternate current (0.2 mA) with four dissimilar

frequencies (i.e., 5, 50, 100 and 200 kHz) was used as electrical impedance to analyze the body composition (Maltron Bioscan 920-II, operating and service manual) (10).

3.6. Measurement of Physical Fitness Variables

Various fitness variables were introduced to know the speed, agility, leg explosive power, abdominal strength of a sepak player. Vertical jump (VJ) (15), explosive leg strength (16), 30m flying start (17), 6X10m shuttle run (18) and sit up (17). Only the leg explosive power (peak and average) was measured via equations made by Johnson and Bahamonde (16) which mentioned as follows.

Peak power (W) = 78.5 × VJ (cm) + 60.6 × mass (kg) - 15.3 × height (cm) - 1308

Average power (W) = 41.4 × VJ (cm) + 31.2 × mass (kg) - 13.9 × height (cm) + 431

3.7. Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 18.0 (SPSS Inc., Chicago, Il, USA) was used to analyze the research data. Shapiro-Wilk test was done to assume the normality of data. Between group differences were calculated using the one-way analysis of variance (ANOVA) at 95% ($P < 0.05$) confidence interval with Scheffe's Post hoc analysis. Linear regression model (R^2 linear) was done to identify the significant predictors for performance analysis. All values were expressed as means ± standard deviation (SD).

4. Results

Table 1 reveals significant differences in body weight ($P < 0.01$), height ($P < 0.01$) and leg length ($P < 0.001$) when compared among the three groups. Scheffe's post hoc test reveals that tekong players were significantly ($P < 0.05$) taller and heavier as well as having long leg length in comparison to the other two groups i.e. spikers and feeders.

Table 2 depicts significant ($P < 0.01$) differences in BMI, BMR, FM%, FFM, MM, glycogen content and BCM ($P < 0.05$) when compared among the groups. Scheffe's post hoc test reveals that tekongs were having significantly ($P < 0.05$) higher BMI, BMR, FFM, MM and glycogen content than the other two groups. Further BCM content was found to be significantly ($P < 0.05$) more in tekongs in comparison to the feeders. Whereas FM % was found to be significantly ($P < 0.05$) more in feeders than the spikers.

Table 3 reveals significant difference ($P < 0.05$) in handgrip strength (both left and right), RBS, peak explosive power, VO_{2max} and maximum anaerobic capacity except VJ ($P < 0.001$) and sit up ($P < 0.01$). Grip strength of both hands were found to be significantly ($P < 0.05$) more in tekongs in comparison to the feeders. On the other hand, RBS and peak explosive power were found to be significantly ($P < 0.05$) more in spikers in comparison to the feeders. Spikers and tekongs were found to have significantly more VO_{2max} ($P < 0.05$) and maximum anaerobic capacity ($P < 0.05$) than feeders. Further, vertical jump and sit up abilities were found to be significantly more in spikers ($P < 0.05$) in comparison with other groups.

Table 4 summarizes the result of multiple regression model where VJ was selected as independent variable against some dependent related indices i.e., RBS, peak explosive power and leg length. Among sepak players RBS ($P = 0.034$), peak explosive power ($P < 0.001$) and leg length ($P < 0.001$) were identified as the significant predictor of VJ dependent regression model ($R^2 = 0.930$, R adj = 0.924, $F = 176.234$, $P = 0.000$).

5. Discussion

Sepak takraw is a skillful sport which consists of three different playing positions i.e., spiker, tekong and feeder. The feeder and server were mainly restricted to receiving and passing the ball, whilst the spiker performed explosive jumps to block and spike the ball. Spiking involves a somersault-twisting and turning of the body to execute a powerful leg sweep at the ball in mid-air, and is often performed constantly during a long rally (6). However, in sepak takraw, player who possessed more skills is advantageous to the team (7).

Anthropometric characteristics and body composition vary from sport to sport depending on the game's physical needs and noted as important indices to optimize performance (5). According to the present study 'tekong' position was anthropometrically superior for a game like takraw as they possess highest body stature, trunk and leg length than other positional counterparts. Hamid et al. (5) and Aziz et al. (6) reported that a body stature of 154 - 176 cm was just appropriate for a sepak player (age ranged from U-15 to U-23) which corroborates with the present findings. Hamid et al. (5) stated that 'tekong' players with longer lower limbs are able to contact the ball at a higher point in mid-air and direct it downward in a sharper trajectory. BF% of the present study was ranged between 6% - 14% which also corroborates with the report of Hamid et al. (5) and Aziz et al. (6) where BF% was ranged between 6% - 15% and 8% - 12% respectively. Significantly highest BF% was found among 'feeder' positional players which may indicate that position as 'less active' one than the other two. A moderate amount of body weight and fat mass is needed along with a good stature which may help to produce a powerful circular momentum to transform a normal kick shot into an appropriate one. In accordance to the present study, players of 'tekong' position were found to have highest BMR,

Table 1. Comparison of Mean (± SD) of Anthropometric Parameters in Young Male Sepak Takraw Players

Parameters	Spiker/Killer (N = 14)	Tekong/Server (N = 14)	Feeder (N = 16)	Level of Significance (F Value)	Post Hoc (Scheffe's)
Age, y	15.6 ± 2.34	15.1 ± 1.78	15.3 ± 1.62	0.265 (NS)	-
Height, cm	157.3 ± 5.34	167.4 ± 7.99	157.4 ± 11.57	6.237[a]	TK vs. SP, FD
Weight, kg	48.9 ± 5.41	59.7 ± 8.69	49.8 ± 10.06	7.071[a]	TK vs. SP, FD
Trunk L, cm	51.5 ± 2.82	52.9 ± 2.96	51.6 ± 1.86	1.456 (NS)	-
Leg L, cm	77.0 ± 4.53	84.1 ± 4.06	76.6 ± 1.75	21.080[b]	TK vs. SP, FD

Abbreviations: FD, feeder; Leg L, leg length; NS, not significant; SP, spiker; TK, tekong; Trunk L, trunk length
[a] $P < 0.01$
[b] $P < 0.001$

Table 2. Comparison of Mean (± SD) of Body Composition Parameters in Young Male Sepak Takraw Players

Parameters	Spiker/Killer (N = 14)	Tekong/Server (N = 14)	Feeder (N = 16)	Level of Significance (F Value)	Post Hoc (Scheffe's)
BMI	19.7 ± 1.08	21.5 ± 2.06	19.6 ± 1.76	6.388[a]	TK vs. SP, FD
BMR	1655.7 ± 89.59	1868.6 ± 185.35	1645.3 ± 238.83	6.816[a]	TK vs. SP, FD
FM%	8.3 ± 2.73	10.0 ± 2.73	11.5 ± 2.68	5.107[a]	SP vs. FD
FFM, kg	44.6 ± 4.03	53.7 ± 8.00	43.7 ± 10.12	7.148[a]	TK vs. SP, FD
MM, kg	21.7 ± 1.98	26.0 ± 4.09	21.2 ± 4.99	6.528[a]	TK vs. SP, FD
BCM, kg	23.8 ± 2.32	27.1 ± 3.59	23.4 ± 5.24	3.845[b]	TK vs. FD
Gly, gm	405.1 ± 36.70	487.3 ± 72.70	396.5 ± 92.02	7.136[b]	TK vs. SP, FD

Abbreviations: BCM, body cell mass; BMI, body mass index; BMR, basal metabolic rate; FD, feeder; FFM, fat free mass; FM%, fat mass percentage; Gly, glycogen content; MM, muscle mass; NS, not significant; SP, spiker; TK, tekong
[a] $P < 0.01$
[b] $P < 0.05$

Table 3. Comparison of Mean (± SD) of Physical Fitness Variables in Young Male Sepak Takraw Players

Parameters	Spiker/Killer (N = 14)	Tekong/Server (N = 14)	Feeder (N = 16)	Level of Significance (F Value)	Post Hoc (Scheffe's)
HGS-R, kg	38.9 ± 4.35	44.9 ± 7.60	37.8 ± 9.50	3.786[a]	TK vs. FD
HGS-L, kg	37.6 ± 3.32	43.9 ± 8.36	35.4 ± 9.58	4.930[a]	TK vs. FD
RBS	1.5 ± 0.15	1.4 ± 0.17	1.3 ± 0.13	4.024[a]	SP vs. FD
30m flying, s	3.7 ± 0.06	3.7 ± 0.03	3.6 ± 0.30	0.936 (NS)	-
6X10m, s	14.7 ± 0.59	14.8 ± 0.49	14.7 ± 0.44	0.223 (NS)	-
VJ, cm	59.4 ± 10.78	49.4 ± 8.10	48.1 ± 6.66	7.753[b]	SP vs. TK, FD
Sit up, /min	62.3 ± 7.25	59.0 ± 5.00	55.5 ± 4.40	5.634[c]	SP vs. FD
VO2max, mL/kg/min	53.5 ± 5.09	52.3 ± 3.03	49.7 ± 3.34	3.804[a]	SP vs. FD
Max AP, W	457.3 ± 109.15	557.4 ± 202.03	376.8 ± 167.45	4.693[a]	TK vs. FD
Avg AP, W	333.0 ± 84.51	377.0 ± 137.36	281.2 ± 136.33	2.439 (NS)	-
AEP, W	1990.0 ± 484.74	1736.1 ± 458.27	1500.0 ± 293.99	5.350[c]	SP vs. FD
PEP, W	3904.4 ± 852.56	3615.6 ± 909.15	3025.5 ± 610.51	4.991[a]	SP vs. FD

Abbreviations: AEP, average explosive power; FD, feeder; HGS-L, left handgrip strength; HGS-R, right handgrip strength; Max AP, maximum anaerobic power; NS, not significant; PEP, peak explosive power; RBS, relative back strength; SP, spiker; TK, tekong; VJ, vertical jump; 6X10m, 6X10m shuttle run
[a] $P < 0.05$
[b] $P < 0.001$
[c] $P < 0.01$

MM, BCM and glycogen content with a moderate amount of BF%. Higher values in MM and BCM may count for muscular hypertrophy which helps tekong players for a perfect kicking (19).

Table 4. Multiple Regression Model of Some Selected Significant Variables

	R^2	Adjusted R	Beta	*t*	Sig.
Vertical jump	0.930	0.924			
Relative back strength			0.246	2.194	0.034
Peak explosive power			0.892	7.267	0.000
Leg length			-0.308	-5.589	0.000

Muscular strength and power are the main components requisite for sepak takraw, particularly in actions like kicking, jumping and blocking (9). In the present study, RBS was found to be highest in 'spiker' position which corroborates with the study of Hamid et al. (5). Present studied RBS for all three (i.e., spiker = 1.5 $\pm$ 1.05, tekong = 1.4 $\pm$ 0.17, feeder = 1.3 $\pm$ 0.13) positions were found to be much less in comparison with its international counterparts (spiker = 3.34 $\pm$ 0.14, tekong = 2.97 $\pm$ 0.27, feeder = 2.98 $\pm$ 0.21) (5). Handgrip strength (both right and left hand) was found to be highest in 'tekong' position which may help them to balance their body in time of the acrobatic in-air movement (20).

VJ and leg muscle explosive power (LEP)are two important variables to determine the degree of explosive power in a sepak takraw player. A sepak player required both powerful and explosive lower limbs movements to jump high (6). Indeed, the sepak players have admirable jumping ability of lower limb in compare to many other sports (20, 21). Present study showed highest value of VJ (59 cm) and LEP (both average = 1990 W and peak = 3904 W) were found among the players of 'spiker' position and then in the 'tekong' position. Baker and Nance (22) reported jumping ability as an important fundamental ability of lower extremity power for sepak players, especially for spikers. Chen and Xiao (9) reported that sepak players (especially strikers) include jumping activities in their skilled training regimen to strengthen the musculature and co-ordination development of lower extremities to jump higher to block or strike the ball. This result may indicate the most development of musculature of leg muscles was done in spiker position than others which may due to the effect of muscular hypertrophy caused by repetitive kicking action during the play. According to Chen and Xiao (9) 'spiker' position as less susceptible to injury and muscular tear as they have strong and femur muscles. Multiple regression model also identifies the significance of back strength, peak explosive power and leg length for predicting the superiority measure in vertical jump (R^2 = 0.930 and P = 0.000).

After analyzing the temporal characteristics of sepak takraw, the game was reported to be a short duration one; the average rally lasted only 5.5 s with the majority of rallies lasting < 6 s. The rally of shortest duration with intense exercise bouts which needs a high burst of energy throughout the sport which can make the sport as an anaerobic metabolism depended one (6, 23). Max anaerobic power was found to be significantly higher (557.4 W, P < 0.05) in 'tekong' position which may indicate the more developed anaerobic component among these players to match the game specific physiological need.

Although sepak takraw is an anaerobic i.e. alactic (orphosphagens) and lactic add energy systems dependent game whilst the contribution of the aerobic system is minimal (23). But Green (24) was reported that the aerobic system also plays a role in resynthesizing the used phosphagen during the pauses between rallies throughout the match. Even Gaitanos et al. (23) and Konig et al. (25) reported that high aerobic fitness is advantageous during intermittent-type exercise because it helps to sustain a high work rate, delays muscular fatigue and accelerates recovery from brief, high-intensity efforts. Jawis et al. (3) have also concluded that different levels of oxygen consumption and VO_{2max} were produced by three playing positions during a match among which the spiker group exhibited the higher levels of VO_2 compared to others. The present study findings corroborate with the findings of Jawis et al. (3) and Aziz et al. (6) where the 'spiker' position showed the highest VO_{2max} (53.5 mL/kg/min) than others. The positional difference in VO_{2max} among sepak takraw players may due to the variation in work intensity (3). In the present study, mean aerobic power was ranged between 46.4 - 58.6 mL/kg/min was clearly inferior to the athletes of the other intermittent sports whose values commonly ranged from > 55 to 70 mL/kg/min (25-28). As per the report of Jawis et al. (3) VO_{2max} was found to be much higher in all three positions (i.e., spiker = 53.5 $\pm$ 5.09 mL/kg/min, tekong = 52.3 $\pm$ 3.03 mL/kg/min, feeder = 49.7 $\pm$ 3.34 mL/kg/min) of the present studied sepak players than its international counterparts (i.e., spiker = 36.7 $\pm$ 5.4 mL/kg/min, tekong = 35.4 $\pm$ 2.2 mL/kg/min, feeder = 29.8 $\pm$ 2.8 mL/kg/min).

Motor variables are important and help us to know about the improvement in different playing skills of an athlete. 30m flying start, 6X10m shuttle run and sit-up are such parameters which can help to monitor the performance in terms of speed, agility and abdominal strength of a player (20). In the present study, 30m flying and 6X10

shuttle were found to be differed insignificantly among the different positional groups. This result may depict that systematic training can affect all three positions equally to develop their speed and agility. Sit up ability was found to be highest (62 min-1) in 'spiker' position which may help them to balance their body in time of jump and strike when the body is in air (9).

5.1. Conclusions

The present study identified height, leg length, back strength, vertical jump, explosive leg power as the first line performance determinator along with muscle mass, body cell mass, VO_{2max} and maximum anaerobic power as second line of important variables in sepak takraw. 'Tekong/server' position was found to be better than spiker and feeder in anthropometrical and body composition parameters. As per the high anaerobic capacity with a moderate aerobic energy need 'tekong and spiker' positions were found to have almost same superiority than feeders. Multiple regression model also identifies the significance of back strength, peak explosive power and leg length for predicting the superiority in vertical jump. Overall the present study helps coaches to identify players as per the game's need and to train them accordingly. These kinds of studies are more needed to create a better database of sepak play which will be helpful to monitor the physical and physiological improvements.

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Footnotes

Authors' Contribution: Surojit Sarkar: review of literature, manuscript preparation, statistical analysis. Suvam Dasgupta: data collection. Subhra Chatterjee: review of literature, statistical analysis of data. K Kosana Meitei: data collection. Amit Bandyopadhyay: review of literature, statistical analysis of data. Swapan Kumar Dey: study design, statistical analysis of data, manuscript correction.

Conflict of Interests: All authors declare that they have no conflict of interest.

Ethical Approval: Informed consent was taken from each player and the study protocol confirms the ethical guidelines of the Declaration of Helsinki, 1975. Proper ethical clearance (Ref No. 44/SAI/HPL/2018-19) was also obtained from the Institutional Human Ethical Committee (IHEC)

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