

## **Physical, Physiological and Anthropometric Measures as Determinants of Performance in Kho-Kho Skills - A Correlational Study**

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**ABSTRACT :** *The purpose of this study is to find out the relationships of selected physical, physiological and anthropometric variables with skill performance in Kho-Kho game. 18 to 20 years in age ranged fifty (n=50) male kho-kho players, those who participated Zonal, Inter-zonal, District, Inter- District, State and National Games, were selected from four districts in West Bengal. Cardiorespiratory endurance, agility and speed were tested as physical variable, VO2 max and resting pulse rate as physiological variable and standing height, body weight, BMI, arm length, leg length were measured as anthropometric variables. Different Kho-Kho skills of the subject were also tested using Chair-Kho Test, Squat Run Dodging Test, Ring Game Test, Audio-Visual Reaction Test, Biped Covering the Path Test, and Zig-Zag Play Test. Using Pearson product moment coefficients of correlation it was found that the overall coefficient of correlation among three physical measures and kho-kho skills ranges between 0.58 to 0.65, among two physiological measures and kho-kho skills were 0.64 and 0.56, and among anthropometric measures and kho-kho skills ranges between 0.59 to 0.75 which all were significant at 0.01 level. When the subjects were categorized into high, average and low in the physical, physiological and anthropometric measures, using Multiple Step-up Regression analysis, it was observed that, higher cardiorespiratory endurance, agility, and speed; higher VO2 max and lower resting pulse rate; and average height and weight; higher BMI, arm length and leg length can predict one's kho-kho skills.*

**KEY WORDS:** *Anthropometric variables, physiological variables, physical variables, Kho-Kho Skill, Multiple step-up regressions*

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### **I. INTRODUCTION:**

Man by nature, is highly competitive and in pursuit of performance he has always been striving to jump higher and farther, to run faster and to demonstrate greater strength and skill. Sports and games in the modern era occupy a very prominent and important place in the life of people and also in every sphere of life. Sport consists of physical activity carried out with a purpose for competition, for self-enjoyment, to attain excellence, for the development of a skill, or more often, some combination of these. A high level of activity is commonplace in traditional subsistence societies. Physical and physiological characteristics of individuals, including skill performance and anthropometric variables, could be limiting factors when performing daily tasks. But in sport, players with same height and weight may not be similar in the efficiency of execution of movement and sustainable capacity since the segments of body part are varied in terms of its length, width, and circumference (Ulrich, 2000). To access meaningful relationship between anthropometric and physical performance of 87 male high school students measuring running, hop-test and jump, it was observed that all variables as measured in a body showed significant relationship with criterion beyond the 0.05 level of confidence (Baacke, 1984). As fitness and sports go hand in glove there is a need to develop the ability in an individual to play the game with good skill and perform consistently well (Raut, 2012). One such sport is Kho-Kho which is a very popular game with fast and quick action. Every standard game has its own skill and has proper norms for their evaluation, which is not available in the case of 'Kho-Kho'. There are suitable research based criteria for selection of standard players, the same is also lacking in 'Kho-Kho'. The information stated above, in fact, suggest that research based experience is always helpful even for the development of various game and sports, which is especially essential for 'Kho-Kho'.

**Objectives of the study:** The objective of the study is to correlate and predict Kho-Kho skill performance on the basis of physical, physiological and anthropometric measures.

## II. METHOD AND MATERIALS:

18 to 20 years in age ranged fifty (N=50) Kho-Kho players from four districts in West Bengal those who represented West Bengal State in Zonal, Inter-zonal, District, Inter-District, State and National Games in Kho-Kho were randomly selected as subjects in this study. Necessary permissions from the institution as well as from the coaches were obtained. Necessary instructions on the conduct of tests were discussed to the subjects before administration of the tests. 12-min run & walk test for cardiorespiratory endurance, 10x4m shuttle run test for agility, and 50 m dash test for speed were administered on the subject as the physical variables. For physiological variables,  $VO_2$  max was calculated from cooper's 12- min Run & Walk equation;  $VO_2$  max =  $\{(22.351 \times Km) - 11.288\}$ . Height, weight, BMI, arm length, and leg length of the subject were measured as per ISAK direction.

Standardized six kho-kho skill tests i.e. **Chair Kho test** to measure the ability of 'Giving Fast Kho' and 'Perfect Kho'; **Squat Run Dodging Test** to measure dodging skill involving the ability to do quick movement of sitting and running quickly within the squares; **Ring Game Test** to measure the stamina, speed, agility, quickness, and alertness; **Audio-Visual Reaction Test** to measure the ability to react quickly to audio & visual signs; **Biped Covering the Path Test** to measure speed, ability to cover the distance in the cross-lane within a shortest possible period; and **Zig-Zag Play Test** to assess the agility through 'Chain Game' skill in a zig-zag manner were administered on the subjects using necessary equipments.

Descriptive statistics, Pearson product moment coefficients correlation and Multiple Step-up Regression analysis were used as statistical measures.

## III. RESULTS AND DISCUSSION:

Mean and SD of the physical, physiological, anthropometric characteristics along with kho-kho skill abilities of the kho-kho players were tabulated and presented in the Table-1.

**Table-1: Mean and SD in Physical, Physiological, Anthropometric variables and Kho-Kho Skill performances of the 18-20 Yrs Kho-Kho Players**

	Physical variable			Physiological variable		Anthropometric variable					Kho-Kho Skill					
	Cardio-Resp Endu (Mt)	Agility (sec)	50m Dash (sec)	$VO_2$ Max (ml/kg/min)	Resting Pulse Rate (Beats/min)	Height (cm)	Weight (kg)	BMI	Arm Length (inch)	Leg Length (inch)	Chair Kho	Squat Run dodging	Ring game	A-V reaction	Biped path	Zig zag
Mean	2270.37	9.23	6.45	39.47	67.32	167.61	58.4	20.74	29.09	37.08	22.94	12.08	22.3	10.85	12.78	14.79
SD	181.23	0.58	0.28	4.07	4.24	4.31	3.71	1.08	1.02	2.5	0.69	0.74	0.81	0.42	0.51	0.47

### Results of overall relationship between physical, physiological, anthropometric variables and kho-kho skills for 18-20 yrs Kho-Kho players

The coefficients of correlation along with overall relationship between each measure of physical, physiological, and anthropometric variables and kho-kho skills of the 18-20 yrs kho-kho players were obtained separately and shown in the following Tables.

**Table 2: Overall relationship between Physical variables and Kho-Kho skills**

Physical variables	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zag play</i>	
CRE	0.59	0.61	0.58	0.54	0.59	0.55	0.58
Agility	0.63	0.60	0.61	0.59	0.57	0.59	0.60
50 m Dash	0.71	0.57	0.65	0.64	0.66	0.68	0.65

The overall coefficients of correlation between Kho-Kho skills with cardio-respiratory endurance, agility and 50m dash were found 0.58, 0.60, and 0.65 respectively. The results suggested that all the selected physical variables were significantly ( $p < .01$ ) related with the Kho-Kho skills.

**Table 3: Overall relationship between Physiological variables and Kho-Kho skills**

Physiological variables	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zag play</i>	
VO <sub>2</sub> max	0.62	0.68	0.69	0.58	0.60	0.66	0.64
Resting Pulse Rate	0.57	0.57	0.55	0.55	0.55	0.57	0.56

Table 3 revealed that the overall coefficients of correlation between Kho-Kho skills with VO<sub>2</sub> max and resting pulse rate were 0.64 and 0.56 respectively. The results suggested that the selected physiological variables were also significantly ( $p < .01$ ) related with the Kho-Kho skills.

**Table 4: Overall relationship between Physiological variables and Kho-Kho skills**

Anthropometric variables	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zag play</i>	
Height	0.78	0.76	0.76	0.72	0.72	0.77	0.75
Body weight	0.58	0.58	0.62	0.59	0.58	0.56	0.59
BMI	0.69	0.72	0.66	0.69	0.65	0.66	0.68
Arm length	0.68	0.63	0.64	0.67	0.64	0.66	0.65
Leg length	0.67	0.66	0.68	0.70	0.70	0.68	0.68

The overall coefficients of correlation between Kho-Kho skills with height, weight, BMI, arm length, and leg length were found 0.75, 0.59, 0.68, 0.65, and 0.68 respectively. The results suggested that all the selected anthropometric variables were also significantly ( $p < .01$ ) related with the Kho-Kho skills.

The results of overall coefficient of correlation indicated that although many of the physical, physiological and anthropometric variables were closely associated with the Kho-Kho skills of the players of 18-20 yrs age group, but they cannot predict the skill performance. Therefore, the physical, physiological and anthropometric statuses were categorized into three levels i.e., high, average and low and the results of the coefficients of relationship were shown below.

**Relationship between status-wise variables with Kho-Kho skills of 18-20 yrs Kho-Kho players:****Physical Variables:****Relationship between Cardio-respiratory endurance (CRE) and Kho-Kho Skill**

Cardio-respiratory endurance (CRE)

CRE =2275 -1925=350 (range)

High CRE =2200 &amp; above

Average CRE =1951 to 2199

Low CRE =1950 &amp; below

**Table-5: Relationship between Cardio-respiratory endurance and Kho-Kho skills**

Physical variable: CRE	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High CRE	0.81	0.82	0.79	0.78	0.83	0.78	0.80
Average CRE	0.72	0.71	0.67	0.62	0.66	0.64	0.67
Low CRE	0.24	0.30	0.27	0.23	0.27	0.24	0.26

The higher cardio-respiratory endurance (2275 M & above) kho-kho players showed high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.80.

**Relationship between Agility and Kho-Kho Skill**

Agility =9.96-7.96=2.00 (range)

High Agility =7.96 &amp; below

Average Agility =7.97 to 9.95

Low Agility =9.96 &amp; above

**Table-6: Relationship between Agility and Kho-Kho skills**

Physical variable: Agility	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Agility	0.86	0.82	0.85	0.86	0.87	0.87	0.86
Avg. Agility	0.75	0.76	0.73	0.74	0.65	0.76	0.73
Low Agility	0.29	0.24	0.25	0.19	0.21	0.16	0.22

The higher agility level (7.96 sec & below) players had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.86.

**Relationship between 50 m Dash (Speed) and Kho-Kho Skill**

Speed =7.12- 5.98=1.14 (range)

High Speed =6.20 &amp; below

Average Speed =6.21 to 6.45

Low Speed =6.46 &amp; above

**Table-7: Relationship between 50 m Dash and Kho-Kho skills**

Physical variable: Speed	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Speed	0.81	0.78	0.84	0.80	0.76	0.79	0.80
Avg. Speed	0.72	0.73	0.75	0.74	0.71	0.68	0.72
Low Speed	0.34	0.29	0.27	0.30	0.31	0.28	0.30

The high speed level (6.20 sec & below) Kho-Kho players showed high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.80.

**Physiological Variables:****Relationship between VO<sub>2</sub> max and Kho-Kho Skill**

VO<sub>2</sub> max = 46.74 – 31.60 = 15.14 (range)

High VO<sub>2</sub> max = 42.96 & above

Average VO<sub>2</sub> max = 38.86 to 42.95

Low VO<sub>2</sub> max = 38.85 & below

**Table-8: Relationship between VO<sub>2</sub> max and Kho-Kho skills**

Physiological variable: VO <sub>2</sub> max	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High VO <sub>2</sub> max	0.82	0.80	0.84	0.78	0.83	0.85	0.82
Avg. VO <sub>2</sub> max	0.72	0.69	0.75	0.69	0.66	0.76	0.71
Low VO <sub>2</sub> max	0.23	0.31	0.26	0.24	0.28	0.33	0.28

The higher VO<sub>2</sub> max (42.96ml/kg/min & above) had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.82.

**Relationship between Resting Pulse rate and Kho-Kho skill**

Resting pulse rate (RPR)

Resting pulse rate = 75 – 60 = 15 (range)

High Resting pulse rate = 75 & above

Avg. Resting pulse rate = 61 to 74

Low Resting pulse rate = 60 & below

**Table-9: Relationship between Resting Pulse rate and Kho-Kho skills**

Physiological Variable: RPR	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High RPR	0.19	0.21	0.16	0.12	0.15	0.14	0.16
Avg. RPR	0.69	0.72	0.76	0.69	0.77	0.76	0.67
Low RPR	0.87	0.85	0.84	0.86	0.88	0.87	0.86

The lower pulse rate (60 beats per min & below) had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.86.

#### Anthropometric variables:

##### Relationship between Height and Kho-Kho Skill

Height	=174 to 156=18 (range)
High Height	=170 & above
Average Height	=159 to 169
Low Height	=158 & below

**Table-10: Relationship between Height and Kho-Kho skills**

Anthropometric variable: Height	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair r-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Height	0.71	0.67	0.72	0.68	0.65	0.67	0.68
Average Height	0.84	0.84	0.82	0.81	0.79	0.84	0.82
Low Height	0.81	0.78	0.75	0.69	0.72	0.8	0.74

The average height (159 to 169 cm) had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.82.

##### Relationship between Body weight and Kho-Kho Skill

Weight	=50 to 68=18 (range)
High Weight	=65 & above
Average Weight	=55 to 64
Low Weight	=54 & below

**Table-11: Relationship between Body weight and Kho-Kho skills**

Anthropometric variable: Weight	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair -Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Weight	0.37	0.42	0.43	0.47	0.34	0.35	0.39
Average Weight	0.85	0.82	0.82	0.86	0.83	0.81	0.83
Low Weight	0.53	0.52	0.61	0.46	0.57	0.52	0.54

The average body-weight (55 to 64 Kg) showed high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.83.

##### Relationship between Body mass index (BMI) and Kho-Kho Skill

BMI	=18.75 to 23.20=4.25 (range)
High BMI	=23 & above
Average BMI	=19 to 22
Low BMI	=18 & below

**Table-12: Relationship between Body mass index and Kho-Kho skills**

Anthropometric variable: BMI	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High BMI	0.84	0.83	0.81	0.82	0.84	0.81	0.83
Average BMI	0.78	0.82	0.76	0.74	0.74	0.75	0.56
Low BMI	0.45	0.51	0.43	0.51	0.39	0.42	0.46

The high body-mass-index (23Kg/m<sup>2</sup> and above) showed high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.83.

#### Relationship between Arm length and Kho-Kho Skill

Arm length =27 to 33 inches =6 (range)  
 High Arm length =32 & above  
 Average Arm length =28 to 31  
 Low Arm length =27 & below

**Table-13: Relationship between Arm length and Kho-Kho skills**

Anthropometric variables	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Arm length	0.81	0.77	0.8	0.79	0.8	0.82	0.80
Avg. Arm length	0.73	0.7	0.7	0.72	0.68	0.71	0.57
Low Arm length	0.5	0.43	0.42	0.5	0.45	0.47	0.45

The high arm length (32 inches & above) had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.80.

#### Relationship between Leg length and Kho-Kho Skill

Leg length =33 to 41 inches =8 (range)  
 High Leg length =40 & above  
 Average Leg length =34 to 39  
 Low Leg length =33 & below.

**Table-14: Relationship between Leg length and Kho-Kho skills**

Anthropometric variables	Kho-Kho Skill test (r)						Overall relationship
	<i>Chair-Kho</i>	<i>Squat Run Dodging</i>	<i>Ring Game</i>	<i>Audio-visual reaction</i>	<i>Biped covering path</i>	<i>Zig-Zig play</i>	
High Leg length	0.83	0.81	0.83	0.82	0.82	0.82	0.82
Avg. Leg length	0.74	0.72	0.71	0.74	0.75	0.73	0.63
Low Leg length	0.44	0.46	0.51	0.56	0.53	0.5	0.50

The high leg length (40 inches and above) had high relationship with almost all the Kho-Kho skills and the overall coefficient of correlation was 0.82.

The above results revealed that the highly significant coefficients of relationship of high-, average-, and low- level of physical, physiological and anthropometric characteristics with Kho-Kho skills were to some extent conclusive and they may predict the skill performance. It was, therefore, thought desirable for further analysis with Multiple Step- up Regression and the results are presented below:

**Table-15: Multiple Step-Up Regression analysis of Physical, Physiological and Anthropometric variables for predicting Kho-Kho Skill performance (18-20 Yrs.)**

SL	Parameters	Level	Overall Kho-Kho Skill		
			'r'	Residual	Adjusted R <sup>2</sup>
01	Cardio-respiratory endurance	Low	0.268571	0.0031	0.042
		Average	0.660653	0.0070	0.249
		High	0.801428	0.0975	0.804**
02	Agility	Low	0.211429	0.0029	0.040
		Average	0.734137	0.0067	0.113
		High	0.854286	0.0953	0.806**
03	Speed	Low	0.302491	0.0425	0.053
		Average	0.723174	0.0647	0.142
		High	0.804762	0.0874	0.813**
04	VO <sub>2</sub> max	Low	0.284281	0.0038	0.058
		Average	0.713146	0.0592	0.184
		High	0.822146	0.1203	0.803**
05	Resting Pulse rate	Low	0.864286	0.1248	0.827**
		Average	0.673285	0.0086	0.127
		High	0.162854	0.0022	0.037

SL	Parameters	Level	Overall Kho-Kho Skill		
			'r'	Residual	Adjusted R <sup>2</sup>
06	Height	Low	0.743642	0.0630	0.483
		Average	0.824286	0.1109	0.807**
		High	0.681429	0.0431	0.125
07	Weight	Low	0.535714	0.0057	0.098
		Average	0.832857	0.9942	0.791**
		High	0.387143	0.0039	0.092
08	BMI	Low	0.455015	0.0047	0.103
		Average	0.555714	0.0064	0.127
		High	0.825714	0.0943	0.802**
09	Arm length	Low	0.452857	0.0047	0.117
		Average	0.570428	0.0063	0.123
		High	0.802836	0.0989	0.807**
10	Leg length	Low	0.498571	0.0050	0.116
		Average	0.627143	0.0082	0.269
		High	0.818742	0.0993	0.817**
<b>*p&lt;0.05, **p&lt;0.01</b>					

Multiple step-up regressions revealed that adjusted R<sup>2</sup> in any of high, average, or low category of all the measures of physical, physiological and anthropometric characteristics with kho-kho skills of the 18-20 yrs kho-kho players were found significant. Adjusted R<sup>2</sup> of the higher cardio-respiratory endurance, agility, speed, VO<sub>2</sub> max, BMI, arm length, leg length, and whereas average height, weight and lower resting pulse rate were found significant (p < .01) and all these qualities may predict one's kho-kho skills.

#### IV. CONCLUSIONS:

On the basis of the results it may be concluded that:

- [1] Kho-Kho players having higher cardio-respiratory endurance, VO<sub>2</sub> max, agility, speed, BMI, arm and leg length may be the good performer in kho-kho game as these qualities are the good predictors of kho-kho skills. Average and low statuses are unsuitable for the game.
- [2] Average height and weight of the kho-kho players are very appropriate for the game whereas high and low are not suitable.
- [3] A Kho-Kho player with lower resting pulse rate is also a good predictor of kho-kho skills. High and average categories are inappropriate.



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