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A Study on the Factor Structure of Selected Anthropometric Variables of University Level Women Soccer Players

Renjith T. A.
Assistant Professor, Department of Physical Education,
Kerala University of Fisheries and Ocean Studies Kerala, India
Mariya T. Cheeran
Assistant Professor, Department of Business Administration and Management,
Kerala University of Fisheries and Ocean Studies, Kerala, India
George Joseph
Assistant Professor, Department of Business Administration and Management,
Kerala University of Fisheries and Ocean Studies, Kerala, India

Abstract:
Soccer is one of the most popular spectacle games in world. Performance at optimal levels requires high levels of technical, tactical and physiological skills. Identification and selection of talented soccer players are not straightforward procedures. The data collected was analyzed by applying Descriptive statistics such as mean, mode, median, standard deviation, minimum score and maximum score were found out and Factor analysis was done to found out the prominent factors comprising of any one or all of the selected 10 anthropometric variables namely such as Height, Sitting height, Weight Arm length Leg length Thigh girth Calf girth, BMI, ponderal index, Crural index of selecd among women soccer players the unloaded factors obtained were then rotated by very max method to the final solution. This was used to find out the factor structure of selected anthropometric variables of university level women soccer players The women game gained international credibility in 1991 when the first world cup for women's team took place in China in the winning nation was the USA, the games now widely played. Sweden was the host of the second world cup finals in 1997. it still has to be developed in a majority of countries, where women's participation in sport is restricted by cultural domestic and economic circumstances. Success in competitive sports and games can be attributed to many factors. Anthropometrical and psychological variables may differ in sports man.

Keywords: *Soccer, anthropometric, performance, factor analysis*

1. Introduction

People all over the world are becoming more and healthier conscious, the priority has been shifting from everything else to the fact that the most important thing in life, is to keep oneself in shape and fit, to enjoy things in life. Keeping fit, means capturing the days of youth and all the fun of those days alive. Man can give up everything for the sake of keeping himself young. In spite of all the kinds of treatments that have been flourishing the market, the people have not been driven crazy, they still trust the basic natural way of keeping in shape, i.e., by exercising Regularly and maintaining a working routine. It is very necessary to go for a complete fitness training, which takes care of all the aspects of making a fit body, beginning from making note about the right kind of diet and right kind of exercises which suits the physical conditions of the body. Physical activity offers a broad range of benefits, including the prevention of obesity, improved self confidence, and an overall sense of well-being. Physical education programs within the school setting can set the stage for how children view physical fitness, activity levels, and future health. Physical education programs also include general health and safety information in addition to providing opportunities for players to learn how to cooperate with one another in a team setting. Physical education has a considerable role in a planed education it is a part of total education. The term education does not confine intellectual field alone. It has a wider notation in the realms of physical mental and spiritual existence of mankind.

2. Background of the Study

The research scholar has gone through related literature available which ware relevant to the present Study. The relevant study found in the various sources which the researcher has come across are enumerated bellow

- Almagià a et.al (2015) anthropometric proportionality method election in a sport population; comparison of three methods the proportionality model application, based on ideal proportions, would have a great impact on high performance sports, due to best athletes to resemble anthropometrically.The objective of this study was to compare the following anthropometric methods of proportionality: phantom, combined and scalable, in male champion university chilean soccer players in 2012 and 2013, using south american professional soccer players as criterion, in order to find the most appropriate proportionality method to sports populations. The measurement of 22 kinanthropometric variables was performed, according to the isak protocol, to a sample constituted of 13 members of the men's soccer team of the pontificia universidad católica de valparaíso. `The z-values of the anthropometrics variables of each method were obtained using their respective equations. it was used as criterion population south american soccer players. a similar trend was observed between the three methods. Significant differences ($p < 0.05$) were found in some z-values of scalable and combined methods compared to phantom method. no significant differences were observed between the results obtained by the combined and scalable methods, except in wrist, thigh and hip perimeters. it is more appropriate to use the scalable method over the combined and phantom methods for the comparison of z values in kin anthropometric variables in athletes of the same discipline.
- Blus E et.al (2015)chosen anthropometric parameters and concentrations of leptin and adiponectin in extreme obese patients treated with implantation of a gastric balloonFatty tissue derived adipocytokines regulate appetite, but in abnormal concentration impair systemic metabolic homeostasis and make the patients prone to inflammatory related disorders.The aim of study was to examine whether weight loss in patients after implementation of a gastric balloon is reflected in changes in chosen anthropometrical parameters and in the concentration of leptin and adiponectin in serum. The study group consisted of 18 extreme obese patients (BMI > 39.9, mean age 39.5 ± 12.1 years, 12 men, 6 women), undergoing implementation of a gastric balloon for 6 months. The control group consisted of 18 healthy volunteers. The adiponectin and leptin concentrations in the sera and the calculated % body fat and indicators: BMI, WHR, VAI, BAI, WHtR were determined prior to implementation and after the balloon removal and then further parameters were calculated: % excessive weight loss, % weight loss. All the parameters and leptin concentration in the tested group were markedly upregulated and adiponectin concentration was significantly lower compared to controls. Reduction in the body mass in patients subjected to BIB, reflected in leptin and anthropometrical parameters down-regulation, (except WHR and VAI), was accompanied with normalization of adiponectin concentration that affect metabolism and is important regulator of hunger and satiety.

3. Methodology

In this chapter the methodology adopted for the study namely selection of subject, selection of variables, reliability of data, testers competency, instrument reliability, testers reliability, criterion measures, orientation of the subject, collection data, test administration and analysis were presented.

3.1. Selection of Subject

Thirty six (N=36) women soccer players who belong to Calicut University and M.G University participant in the inter University women soccer tournament was selected as the subjects for the study.

3.2. Selection of Variables

The following variables were selected for the study:

The following anthropometric variables are selected for the study

Height**,** sitting height, Weight, Arm length, Leg length, Thigh girth, Calf girth.BMI, ponderel index, crural index

I .Instrument reliability: The instrument used for the collection of data is of international standard and their test reliability was already set.

II. Tester's reliability: The tester's competency was established by test retest method under the supervision of experts in the field of physical education and sports.

III. Reliability of Data: The reliability of data was censured by establishing the instrument reliability and testers competency.

3.3. Criterion Measures

3.3.1 Anthropometric Variables

Height	Stadiometer	centimeters
Sitting height	Stadiometer	centimeters
Weight	Weighing machine	kilograms
Arm length	Steel measuring tape	centimeters
Leg length	Steel measuring tape	centimeters
Thigh girth	Steel measuring tape	centimeters
Calf girth	Steel measuring tape	Centimetres
BMI	$\frac{\text{(weight in kilograms)}}{\text{height in meters}^2}$	points
ponderel index	$\text{Mass}/\ \text{height}^3$	points
crural index	$\frac{\text{Lower leg length}}{\text{Thigh length}}$	points

Table 1: Correlation on test retest scores of selected anthropometric variables to the tester's competency

No	Variables	Co-efficient of Correlation
1	Height	0.97
2	Sitting height	0.93
3	Weight	0.94
4	Arm length	0.92
5	Leg length	0.95
6	Thigh girth	0.96
7	Calf girth	0.93
8	BMI	0.98
9	ponderel index	0.91
10	crural index	0.92

Table 2

3.3.2. Orientation of the Subject

Before measuring the anthropometric the investigator had briefly explained to the subject the purpose of study and their role in the study.

3.3.3. Collection of Data

The data pertaining to selected anthropometric measurements such as height, weight, arm length, leg length, thigh girth, calf girth, BMI, Ponderal index, Croral index were collected by administrating appropriate standard tests using correct measurement procedure.

3.4. Test Administration

3.4.1. Anthropometric Variables

1. Weight

Purpose : To measure the weight of the subject
Equipment : Weighing machine
Procedure : The weight of the subject was taken with a level type laboratory anthropometric weighing machine. The subject stood at the centre of the weighing machine and weight evenly distributed between both feet. The weight was recorded from the indicator needle of dial.
Scoring : The weight was read and recorded correct to the half of a kilogram

2. Height

Purpose : To measure the standing height of the individual
Equipment : Stadiometer, Hard board
Procedure : Height is the erect body length from sole of the foot to vertex. The subjects stood bare footed, erect, buttocks and upper back in contact the scale, the arms were hung naturally on the sides. The flat hand board was placed horizontally on his head and marked on the wall, the subject was asked to step out and the reading indicated by the hard board was read from the scale.
Scoring : The highest point of the head was recorded to the nearest centimetre.

3. Sitting Height

Purpose : To measure the sitting height of the individual
Equipment : Stadiometer, Hard board
Procedure : Height of the point vertex from horizontal table top which the subject sit with his / her hanging down while the thighs completely rest on the table top
Scoring : The highest point of the head was recorded to the nearest centimetre.

4. Arm length

Purpose : To measure the arm length of the subject
Equipment : Steel tape
Procedure : The subjects wore sleeveless banyan. The initial end of the measuring tape was placed on the acromion process and the arm was brought to abduction position, the tape was brought firmly up to the arm with the middle finger and the tape.
Scoring: : The reading was taken to the nearest $1/100^{th}$ of a centimetre

5. Leg Length

Purpose	:	To measure subjects leg length
Equipment	:	Measuring steel tape, Pencil, Score sheet
Procedure	:	The subject wore ideal clothing at the time of measuring the measuring tape's initial end was placed on the greater trochanter of femur (or anterior superior spine of the ilium) and firmly brought towards the sole of the foot and the tape recording was recorded.
Scoring	:	The reading was taken nearest $1/100^{th}$ of a centimetre.

6. Calf girth

Purpose	:	To measure the circumference of the calf
Procedure	:	Calf girth was measured with a tape is wrapped horizontally around the naked lower leg of the subject at the maximal bulge of the calf muscle with slight up and down movements of the steel tape keeping it in a horizontal direction. The maximal circumferential measurements give the value of calf circumference.
Equipment	:	Measuring steel tape
Scoring	:	Measurement was taken in Centimetre.

7. Thigh girth

Purpose	:	To measure the circumference of the thigh at midpoint of femur length.
Equipment	:	Measuring steel tape
Procedure	:	Thigh Circumferences was measured with a tape placed around the thigh at a midpoint of femur length horizontally.
Scoring	:	Measurement was taken in Centimetre

8. BMI

Purpose	:	To measure Body mass index
Equipment	:	BMI index scale
Procedure	:	$\frac{\text{(weight in kilograms)}}{\text{height in meters}^2}$
Scoring	:	points

9. Ponderal index

Purpose	:	To measure ponderal index
Equipment	:	ponderal index scale
Procedure	:	Mass/ height^3
Scoring	:	points

10. Crural index

Purpose	:	To measure crural index
Equipment	:	Crural index scale
Procedure	:	Lower leg length /Thigh length
Scoring	:	points

3.5. Statistical Technique

Descriptive statistics such as mean, mode, median, standard deviation, minimum score and maximum score were found out and this have given an idea of distribution of scores and features obtained from the data collected for the purpose of the study on all the 10 anthropometric variables namely such as Height**,** Sitting height, Weight Arm length Leg length Thigh girth Calf girth, BMI, ponderal index, Crural index of selecd women soccer players. Factor analysis was done to found out the prominent factors comprising of any one or all of the selected anthropometric variables among women soccer players the unloaded factors obtained were then rotated by very max method to the final solution.

4. **Analysis of Data and Result of the Study**

The statistical analysis of data collected from all subjects and result of the study have been presented in this chapter

For the purpose of the study totally 36 women soccer players who participated in all India inter university women soccer tournament were chosen as subjects descriptive analysis was done on all the selected 10 Anthropometric variables namely Height, Weight, sitting height, Leg Length, arm length, Calf Girth, Thigh Girth, BMI, ponderal index, Crural index of selected women soccer players to find out the mean, median, mode, standard deviation, coefficient correlation minimum score and maximum score. This has given in idea of the distribution of scores and feature obtained from the data collected for the purpose of this study.

4.1. Factors Analysis

Factor analysis describes a procedure to identify those linear combinations of variables (called as factors), which have large variances, ignoring the linear combination, which have small variances. In this study the principal component method was selected for the primary solution of factor analysis. Scores on all the 10 Anthropometric variables of women soccer players were subject to correlation analysis which is shown in table 3 in the form of correlation matrices. Correlation matrices obtained for the women soccer players used in the principal component analysis. With the help of principal component analysis, the entire 10 Anthropometric variable were divided into various factors. The unloaded factors obtained were then rotated by varimax method to find the final solutions. The rotation of the factor is important in order to avoid the overlapping of variable in different factors. Each of the three factors obtained from the selected women soccer players were interpreted and given names. Items with loading greater than or equal to 0.70 of varimax solution were selected for discussing each factor.

4.2. Findings

variables	Valid N	Mean	Median	Mode	Minimum	Maximum	Std dev
Height	36	157.83	157.00	159.50	150.00	169.00	5.39
Weight	36	50.81	48.50	55.42	40.00	64.00	7.79
Sitting height	36	75.64	75.00	76.92	66.00	82.00	3.79
Leg length	36	92.69	92.00	94.08	84.00	109.00	4.81
Arm length	36	70.83	71.00	70.50	62.00	77.00	3.58
Thigh girth	36	51.00	48.50	56.00	42.00	64.00	6.61
Calf girth	36	32.22	32.00	32.67	26.00	36.00	2.27
BMI	36	20.38	19.54	22.04	15.43	25.96	2.83
Ponderal index	36	12.93	12.87	13.03	9.58	16.54	1.83
Crural index	36	1.23	1.24	1.21	1.04	1.78	0.15
P rating	36	6.14	6.00	6.42	5.00	8.00	1.02

Table 3: Descriptive profile of selected anthropometric Variables of women soccer players

Table number 3 was indicates the scores of descriptive profile such as mean, median, mode, standard deviation, minimum score, and maximum score of the selected anthropometric variable namely Height, Weight, sitting height, Leg Length, arm length, Calf Girth, Thigh Girth, BMI, ponderal index, Crural index of the women soccer players.

Variables	H	S H	W	A. L	L.L	T.G	C.G	BMI	P.I	C.I	P.R
Height	1.000										
Sitting Height	0.6314	1.000									
Weight	0.4002	0.5085	1.000								
Leg length	0.5639	0.16	0.317	1.000							
Arm length	0.1511	-0.2678	0.0111	0.6289	1.000						
Thigh girth	0.1341	0.1073	0.4949	0.2652	0.2584	1.000					
Calf girth	0.5269	0.455	0.6197	0.331	-0.0832	0.3259	1.000				
BMI	-0.0228	0.2509	0.9061	0.0891	-0.0552	0.4721	0.4392	1.000			
Ponderal index	-0.2483	0.0921	0.7862	-0.0387	-0.0845	0.4239	0.3087	0.9738	1.000		
Crural index	-0.3456	0.0515	-0.2981	-0.57	-0.4332	-0.3491	-0.2208	-0.1652	-0.0822	1.000	
Performance Rating	0.5722	0.4947	0.3707	0.6155	0.3042	0.1741	0.3077	0.1366	0.0017	-0.2762	1.000

Table 4: Correlation matrix on selected anthropometric variables of women soccer players

Table number 4 was indicates the scores of correlation matrix of the selected Anthropornetric variable namely Height, Weight, sitting height, Leg Length, arm length, Calf Girth, Thigh Girth, BMI, ponderal index, crural index of the women soccer players Height, Weight, sitting height Leg length was significantly correlates the women soccer players performance among this study.

	FACTOR 1	FACTOR 2	FACTOR 3
Eigen value	3.915857	2.334341	1.758595
Total variance. Exp	39.7	23.34	17.6
Cum. Variance. Exp	39.7	62.50	80.1
Height	0.497134	-0.60499	-0.55362
Sitting height	0.504283	-0.01236	0.74398
Weight	0.950251	0.226087	-0.04431
Arm length	0.507593	-0.72981	0.144685
Leg length	0.507593	-0.72981	0.144685
Thigh girth	0.72108	-0.04775	-0.35473
Calf girth	0.627296	-0.00811	0.349215
BMI, ,	0.80699	0.524241	0.210704
ponderal index	0.668508	0.642982	0.333144
Crural index	-0.46473	0.531237	-0.36251

Table 5: Principal Component Analysis of women soccer Players (Un-Rotated Factor Loading)

	FACTOR1	FACTOR 2	FACTOR3	
Eigen value	3.915857	2.334341	1.758595	
Total variance. Exp	39.7	23.34	17.6	
% Variance. Exp	39.7	62.50	80.1	
Height	-0.14413	0.369411	0.87161	0.992781
Sitting height	0.13469	-0.18713	0.868796	0.737657
Weight	0.834378	0.146069	0.488398	0.999699
Arm length	-0.05075	0.857051	-0.20455	0.602192
Leg length	0.019346	0.826999	0.356244	0.676839
Thigh girth	0.584389	0.412298	0.063383	0.384073
Calf girth	0.405195	0.117867	0.68556	0.542907
BMI	0.976822	-0.00815	0.12732	0.999952
Ponderal index	0.978535	-0.08847	-0.07717	0.9999
Crural index	-0.16962	-0.76786	-0.10597	0.476703

Table 6: Principal Component Analysis of women soccer Players (Rotated factor loading)

Item No	Name of the variables	Factor loading
3	Weight	0.834378
8	BMI(body mass index)	0.976822
9	Ponderal index	0.978535

Table 7: Factor 1 Women soccer players after rotated factor loading (Varimax solution)

Factor 1 Women soccer players in table 6 was characterized by 3 anthropometric variable of selected 10 variables namely weight, BMI, ponderal index since the weight variable such as BMI and ponderal index are heavy loaded items. These factors could be called as weight factors accounted for 39.7% of the total common factors accounted by all the three factors.

Item No	Name of the variables	Factor loading
4	Arm length	0.857051
5	Leg length	0.826999

Table 8: Factor 2 Women soccer players after rotated factor loading (Varimax solution)

Factor 2 Women soccer players in table 7 were characterized by 2 anthropometric variables of selected 10 variables namely Arm length and Leg length are heavy loaded items. This factor could be called as Length factor. This factor accounted for 23.34% of the total common factors accounted by all the three factors.

Item No	Name of the variables	Factor loading
1	Height	0.873161
2	Sitting height	0.868796
3	Calf girth	0.68556

Table 9: Factor 3 Women soccer players after rotated factor loading (Varimax solution)

Factor 3 Women soccer players in table 8s were characterized by 3 anthropometric variables of selected 10 variables namely Height, sitting height, calf girth. Since height variables such as height and sitting height are heavy loaded items This factor could be called as height factor. This factor accounted for 17.6% of the total common factors accounted by all the three factors.

4.3. Discussion of Findings

Weight factors comprising of the bmi and ponderal index are contributing heavly to the performance of the women soccer players. Weight closely related to the BMI and ponderal index and proportionate height and weight will influence the total performance in women soccer players. The weight also provides total body strength. It will also influence the performance. The importance group of muscle in upper extremities and lower extremities namely hamstring groups and quadriceps groups, forms the thigh muscle and gastronomies group forms the calf muscle, thereby might have contributed to increase the ball kicking ability, tacking defending in women soccer players.

The factor 2 length factor comprising of arm length and leg length are contributing heavily to performance women soccer players .Height and leg length are closely related to each other and contributing factors for performance. Hence leg length and arm length are help to attain maximum stride length, maximum speed it provide ball dribbling, shooting, trapping capacity in women soccer.

The third factor is known as height factor comprising of height and sitting height, calf girth. The height factor is closely related to the total performance of women soccer players. Height increase then the agility decrease but it attain high ball receiving capacity and heading capacity, in women soccer. it will increase the total women soccer performance.

4.4. Discussion of Hypothesis

The result of the study enables hypothesis was formulated to be accepted as three prominent contributing factors have been extracted after rotated principal component analysis in women soccer players weight factor, length factor, height factor

Based on the factor analysis of the study, only 8 anthropometric variables of selected 10 variables influence the women soccer players performance. Thigh girth and crural index is not influence the women soccer performance.

5. Summary Conclusion Recommendation

5.1. Summary

The purpose of the study was to find out the prominent contributing factors to performances in women soccer players from among the selected anthropometric variables.36 women soccer players who participated in all India interuniversity women soccer championship were selected as the subject of the study .Each subject were measured for 10 related anthropometric measurements namely Height, Weight Sitting height, Leg length, Arm length, Thigh girth Calf girth, BMI, ponderal index, Crural index are selected for the study. Factor analysis (principal component analysis) was done to find out prominent factors comprising of any one or all of the selected anthropometric variables among the selected 36 women soccer players. The unloaded factors obtained were then rotated by varimax method to find out the final solution. Item with loading greater than or equal to ± 0.70 of varimax solution were selected for discussing each factor.

5.2. Conclusions

Based on the analysis and within these limitations of the present study the following conclusions can be drawn. In women soccer players, the three prominent factors extracted after factor analysis were weight factor, length factor and height factor. Weight factor heavily loaded with variable of BMI and ponderal index. Length factor is heavily loaded with variable of arm length and leg length. Height factor was heavily loaded with the variable of height and sitting height.

5.3. Recommendations

1. The result may be used by teachers and coaches in selection of women soccer players.
2. Similar study may helpful to the physical education teachers and coaches to evaluate the performance of their players.
3. Similar study may be helpful to prepare a different level women soccer team.
4. Similar study may be also conducted state level and national level men soccer players.
5. Similar study may be conducted for boys
6. This study may be conducted for other games.
7. Similar study may be conducted with subject of different age group other than used in this study.

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