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A factor structure study on anthropometric and physical fitness variables of softball players

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Abstract
The study was to identify those prominent Anthropometric and Physical fitness factors among national level men softball players in Kerala. To achieve the above purpose of the study National level men softball players of Kerala were selected. A total of 40 men softball players were selected for the study and the age of the subjects ranged from 17-25 years. The subjects were from Malappuram (Dist), Pathanamthitta (Dist), Ernakulam (Dist), Alapuzha (Dist) and Wayanad (Dist). The Physical fitness variables and the related tests were Speed (40mts flying start), Endurance (1200 mts), Agility (4x10 shuttle run), Flexibility (sit and reach), abdominal strength (sit up in minutes), static balance, leg explosive strength (standing broad jump), hand explosive strength (cricket ball throw). Descriptive statistics such as mean, median, mode, standard deviation, kurtosis, skweness, co-efficient of variance, minimum, maximum range, 25th percentile score, 50th percentile score and, 75th percentile score were found in order to get the basic idea of the data distribution. Descriptive analysis were done on all the selected anthropometric variables.

Keywords: anthropometry, physical fitness, softball

Introduction
In the year 1944 and 1945 some of the boys played Softball Game with American army stationed in Jodhpur during Second World War. The Father of Indian soft ball Dr. Dashrath Mal Mehta was one of them, later he and his friends started playing Softball regularly. Later they discovered that games similar to Softball were being played in India. First time this game was started in Rajasthan and after that spread throughout the Country, Dr. Dashrath Ma! Mehta formed softball association of India on 21st Nov 1961 under the noble guidance of Dr. L.M. Singhavi, Mr. Anand Singh Kachawa, Mr. Madanlal Pungalia, Mr. K.D. Gautam and valued support of their good friends. Still they had confusion in rules and valued support of their good friends. Still they had confusion in rules and they were in search of Softball Association in America and had some addresses to clarify the rules. In the year 1964 they came in contact with the softball lovers who formed international softball federation for the promotion of the softball game headquartered in America.

Anthropometry is the science that deals with measurements of size, weight and proportions of human body. It provides scientific methods and observations on the living humans. Anthropometric techniques (Skinfold fat, circumference and diameter measurements) are popular for predicting body composition because they are not much expensive, require little space and can be performed easily (Behenke and Wilmore, 1974 and Pollock and Wilmore, 1990). Anthropometry is often used in physical education, sports science, physical activity and biomedical sciences. Anthropometric measurements can be divided into height, weight and lengths, breadth or width, circumferences or girths, depths and skinfolds. All measurements of individual are external dimensions of the body. Anthropometric measurements, body composition, body size and proportions are playing an important role in physical performance and fitness of the sportsman. Height and weight both are the indicators of overall body size and have been used for the grouping of children and youth in various kinds of activity according to their age and sex. Anthropometry is the systematized measurements that express the dimensions of human body. The research on anthropometric measurements may be useful in selecting the suitable game or sport for any individual.

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The idea behind the choice of a game or event by an individual of his interest is to give out the best possible abilities.

Physical fitness is a composite mixture of physical make up and physiological built up. The proficiency in physical variables and performance variables depends on the physical fitness and hence it becomes necessary to explain the term physical fitness and its importance. Bud has defined that physical fitness is the capacity of the heart blood vessels and muscles to function at optimal efficiency. The benefits of physical fitness are numerous. The person who is physically fit will have greater amount of strength, energy and stamina an improved sense of wellbeing better protection from injury because strong well developed muscle safeguard the bones, internal organs and joints and keep moving parts limber and improve cardio-respiratory function. For a good performance in any sport or athletic event, the high standard of fitness is the basic requirement. More participation in sports activity is not enough to improve fitness. The fitness must be gained through conditioning programmes The performance of any game largely depends on how much the player is physically fit, how much the player is proficient in fundamental skills of that particular game, how much the player is exposed at different difficult situations.

Statement of the problem
The purpose of the study was to identify those prominent Anthropometric and Physical fitness factors of national level men Softball Players in Kerala.

Delimitations
1. The study was delimited to 40 national level men Softball players in Kerala and this age between 17 and 25 years
2. The study was delimited to selected Anthropometric variables such as Height, Weight, Sitting height, Arm length, Calf length, Thigh girth, Ponderal index, Crural index Body mass index (BMI), Mid forearm circumference, Leg length and Biceps circumference.
3. The study was delimited to eight Physical fitness variables such as Speed, Explosive strength (Leg), Endurance, Agility, Explosive strength (hand), Abdomen strength, Flexibility and Balance.

Limitations
1. The heredity and environmental factors which would have influenced the performance among men Softball could not be controlled and this was considered as a limitation of this study.

2. In this study certain factors like diet, daily routine habits, training, and schedule might have influenced the results of this study which was not taken into consideration and this was considered as another limitation of this study.
3. No motivational techniques were used while administering the tests and this was considered limitation of this study.

Hypotheses
On the basis of available literature and discussions with experts the following hypothesis are formulated
1. There will not be any prominent Anthropometric factors among national level men Softball players in Kerala.
2. There will not be any prominent Physical fitness factor among national level men Softball players in Kerala.
3. There will not be any prominent Anthropometric and Physical fitness factors when both anthropometric and physical fitness are taken together.

Significance of the study
1. The study may help to identify the importance of Anthropometric and Physical fitness factors of men Softball players.
2. The study will help Physical education student's teachers and coaches of Softball to evaluate the men Softball players.
3. The findings of the study will provide valuable feedback to improve upon the coaching programme among national level men Softball players.

Methodology
In this chapter the methodology adopted for this study namely the selection of subjects. Selection of variables, criterion measures, administration of tests, statistical techniques employed for analyzing the data are given in detail.
The subjects selected for the study was 40 national level men Softball players of Kerala and they were from Malappuram District, Pathanamthitta District, Ernakulam District, Alapuzha District and Wayanad District.

Selection of variables and tests
Twelve Anthropometric variables such as Height, Weight, Sitting height, Leg length, Arm length, Thigh girth, Calf girth, Ponderal Index, Crural Index, Body mass index, Biceps circumference and Mid forearm circumference.
The related variables, various measuring devices and the Criterion measures related to Anthropometric variables used are given in Table 1.

Table 1: The criterion measures related to anthropometric variables

Variables	Test	Criterion Measures'
Weight	Weighing machine	Kilogram
Height	Stadiometer	Centimetres
Arm length	Measuring tape	Centimetres
Leg length	Measuring tape	Centimetres
Sitting height	Measuring tape	Centimetres
Thigh girth	Measuring tape	Centimetres
Calf girth	Measuring tape	Centimetres
BMI	Formulae	-
Ponderal index	Formulae	-
Crural index	Formulae	-
Mid forearm circumference	Measuring tape	Centimetres
Biceps circumference	Measuring tape	Centimetres

Eight Physical Fitness variables such as Speed, Endurance, Agility Flexibility, Shoulder strength, Explosive strength, Arm strength, Abdomen strength, and Balance.

The related variables, various measuring devices and the Criterion measures related to Physical fitness Variables are given in Table 2.

Table 2: The criterion measures related to physical fitness variables

Variables	Test	Criterion measures MEAS
Speed	40 m dash	1/100th sec
Cardiovascular endurance	1200 mtrs	1/100th sec
Agility	Shuttle run (4x10m)	1/100th sec
Flexibility	Sit and reach	Centimeters
Abdominal strength	Sit up	Numbers /one minutes
Explosive strength (leg)	Standing broad jump	Centimeters
Explosive strength (hand)	Cricket ball throw	Meters
Static balance	Stroke stands test	Seconds

Test administration
Weight
Purpose: To assess the weight of a subject

Equipment: A standard weighing machine

Procedure: The subject was asked to stand bare foot and wearing minimum cloth in the centre of a platform exerting equal pressure on both feet without any movement.

Scoring: Weight was recorded in kilogram**.**

Height
Purpose: To assess the height of a subject

Equipment: Wall scale and brace plane

Procedure: The subject stood erect, feet together with heels, buttock, upper back and rear of the head in contact with wall scale. As the scholar broad this square on to the subject's vertex, the subject was instructed to take a deep breath and a stretch up to his full height.

Scoring: Height was recorded to the nearest centimetre

Sitting height
Purpose: To assess the sitting height of the subject.

Equipment: Stadio meter was used.

Testing procedure: Sitting height is the vertical distance from sitting plane to the vertex.
The subject was seated on a stool, legs were hanged, and buttocks and upper back contacted the scale. The zero point of stadio meter was kept in line with the upper surface on the stool. The flat object was placed on the head. The highest point of the head was recorded to the nearest centimetres.

Arm Length
Equipments: Steel tape

Procedure: The subject stood erect in relaxed position and the arms were hanging naturally at the side. The arm length was measured from the acrominal process of shoulder to tip of the middle finger.

Thigh girth
Equipments: Steel measuring tape

Procedure: Thigh girth was measured with a steel tape

placed round the thigh horizontally with its top degree just under the fold of he buttock. The subject stood with his weight equally distributed on both feet.

Scoring: Measurement was recorded in centimetre sitting height.

Calf girth
Equipments: Steel measuring tape

Procedure: Calf girth was taken with a steel tape at the maximum circumference of the calf in a plane right ankle to its long axis. The leg was held hanging over table top that the tape measure was in horizontal place. In this position the calf muscle was quite relaxed.

Scoring: The measurement was recorded in centimetres.

Ponderal index (PI)
Equipment required: Scales and steadio meter for Measuring weight and height.

Procedure: PI is calculated from measurements of body mass (M) and height (H). PI= the cube root of body weight divided by height, where body mass is in kilograms and height in meters. Be aware that there are variation of this formula which are also sometimes called Ponderal index. There is also the reciprocal ponderal Index, which is of course the height divided by the cuberoot of body weight.

Ponderal index =Ht (m) /cube root of Wt (kg)

Scoring: The higher the score indicating higher levels of body fat.

Crural index
Procedure: Crural index =for leg length/ thigh length
The ratio was computed by dividing the score of fore leg Length by the corresponding score of thigh length and the obtained value was recorded correct to four decimal places. This ratios is named as crural ratio in literature.

Biceps circumference
Equipment: Flexible metal tape

Procedure: The biceps girth measurement is usually taken on the right side of the body. The arm is raised to a horizontal position in the sagittal plane, with the elbow at about 45 degrees. The subjects maximally contract the biceps muscle, and the large circumference is measured.

Scoring: The measurement was recorded in centimetres.

Leg length
Equipment: Steel measuring tape

Procedure: To determine the leg length the scholar stood facing the subject place the hand approximately 4 to 6 inches below the subject's waist on each hip and asked the subject to win the right leg back and forth slowly and to lift it to the outside. By manipulating the scholar could located the spot where the greater trochanter entered the pelvic girdle. The height of the greater tributes from the floor was measured. This procedure was followed three items with each subject.

Scoring: The measurement was recorded in centimetres

Mid Forearm Girth
Subject stands erect arm hanging with forearm and hand extended loosely. The circumference is taken in a plane at right angle to the long axis of the forearms with the tap placed at the point midway between the skin flexion line at the cubical fossa and the skin flexion line at the wrist.

Body Mass Index
BMI stands for body mass index. It is measure of body composition. BMI is calculated b taking a person's weight and dividing by their height squared.

Shuttle run
Equipment: Two blocks 2x2x4 inches and stop watch

Procedure: Two parallel lines on the floor forty feet apart (9.15 m) place blocks of wood behind one of the lines. The subject start from behind the other line, arm to the blocks, pick one up, runs back to the starting line, then runs back to pick up the block which she carries back across the starting line.

Scoring: Record the time of the better of the two trials of the nearest tenth of a second

Explosive strength (standing broad jump)
Equipments: measuring tape

Procedure: The subject stood stand with feet several inches apart and toes just behind the take of mind. Preparatory to jumping, the arms are swing backward and the knee bend the jump is done by extending the knees and by swinging the arms forward simultaneously. Measurement is taken from the take of lime of the heel or part of the body that touches the part nearest to the take off line.

Scoring: The score is the best of three trials recorded to nearest centimetre.

1200 MTS Run (Endurance)
Purpose: To measure the endurance

Equipment: 400 m running track, stop watch

Procedure: The aim of this test to complete the 1200m course in the quickest possible time. To start, all subjects line up behind the starting line. On the command "go", the clock will start, and they will begin running at their own pace. Cheering or calling out the elapsed time is also permitted to encourage the participant to achieve their best time

Scoring: The total time taken to run 1200m is recorded.

Strok Stand Test
Purpose: To assess the ability to balance on the ball of the foot.

Equipment: Flat, non-slip surface, stopwatch, paper and pencil.

Procedure: Remove the shoes and place the hands on the hips, then position the non-supporting foot against the inside knee of the supporting leg. The subject is given one minute to practice the balance. The subject raises the heel to balance on the ball of the foot. The stopwatch is started as the heel is raised from the floor. The stopwatch is stopped if any of the follow occurs: The hand(s) come off the hips. The supporting foot swivels or moves (hops) in any direction. The non-supporting foot loses contact with the knee. The heel of the supporting foot touches the floor.

Scoring: $1/100^{th}$ of a second is recorded. The score is the best of three Attempts

40 MTS run
Purpose: To measure the speed

Equipment: Flat non slip surface, cones, assistants, stop watch, and whistle.

Procedure: Marks out a 60 mts straight section with cone sand places a cone at the 30 mtr. From the sprint start with appropriate command "go" from the assistant the athlete sprint the 60 mts. the assistant start the stopwatch on the command "go". the assistant record the time the player torso crosses the 30 mts and the 60 mtr points.

Score: The total time taken to run 30m is recorded.

Sit Ups in 1 minute
Purpose: To measure the abdomen strength

Equipment: Mat and stop watch

Procedure: The subject lies on his or his back with knees bend at right angles hand should be clapped behind head. A partner holds the angle for support. On 'go' the subjects performs repeated sit-ups, doing as many as possible in one minute. After each movement, the subject is to return to the back lying position with shoulders touching the mat.

Scoring: The score is the numbers of correctly performed sit ups completed in one minute.

Sit and Reach Test
This test is used to measure the flexibility of the back and leg (hamstring muscle). It is a kind of absolute and linear test for flexibility.

Equipment: A testing box or a flexo measure and a yardstick.

Procedure: The subject is asked to remove shoes and place his/her feet against the testing box while sitting on the floor with straight knees. Now the subjects is asked to place one

hand on the top of other so that the middle finger of both hands are together at the same

Explosive strength: To measure the arm strength.
Subject is instructed to throw a cricket ball from allowed point and the distance covered by the ball should be calculated

Score: The score is the best of three trials recorded

Reliability of data
The reliability of data was ensured by instrument reliability and tester's competency.

Instrument reliability
The instrument used for the study was steadiometer, flexible steel tape, stop watch, and weighing machine. They were calibrated and accepted as accurate enough for research work. They were of I S I Standard obtained from research laboratories related to physical education and sports.

Tester's competency
To ensure that the scholar was well versed with the techniques of conducting the test, the scholar had a number of practice sessions in testing procedure under an expert. Tester's reliability was established by the consistency of results obtained uusing the correlation among the data collected by the expert and research scholar and is given in correlation obtained for testing tester's competency

Statistical Techniques
Descriptive profile
Various descriptive profiles such as Mean, Median, Mode, Standard deviation,
Kurtosis, Skewness, Coefficient of variance, Minimum score, Maximum score, Range, 25th Percentile, 50th Percentile and 75thPercentile.

Factor analysis
Three different factor analyses are done Oneexclusively for Anthropometric variables the second exclusively for Physical fitness variables and the third one by combining both Anthropometric variables and Physical fitness variables as single group.

Analysis and Interpertation of Data
The collected data pertaining to the study has been analyzed and presented in this chapter.

The analyses of data are presented in the following ways
1. Descriptive analysis
Descriptive statistics such as mean, median, mode, standard deviation, kurtosis, skweness, co-efficient of variance, minimum, maximum range, 25th percentile score, 50th percentile score and, 75th percentile score were found in order to get the basic idea of the data distribution. Descriptive analysis were done on all the selected anthropometric variables namely; weight, height, sitting height, arm length, leg length, calf girth, thigh girth, BMI, pondural index, crural index, Mid forearm circumference and Biceps circumference and selected physical fitness variables such as; speed, endurance, agility flexibility, static balance, abdomen strength, balance, explosive strength hand and explosive strength leg.

2. Factor Analysis
Factor analysis describes a procedure to identify those linear combinations of variables (called 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 selected twelve anthropometric, eight physical fitness variables and all the twenty (both anthropometric and physical fitness variables) of national level men softball players in Kerala were subjected to correlation analysis in the form of correlation matrices. These correlation matrices were used in the principal component analysis.
With the help of principal component analysis, all the variables (only anthropometric variables, only physical fitness variables and both anthropometric and physical fitness variables) were divided in to various factors. With the help of Kaiser's criteria suggested by Guttman, only those factors having latent rules greater than one were considered as common factor. Owing to these criteria three factors were retained in each group. The unloaded factors obtained were then rotated by varimax method to find the final solutions. Rotation of the factors is important in order to avoid the overlapping of variable in different factors.
Each of these factors obtained from the selected groups namely anthropometric, physical fitness and both anthropometric and physical fitness were interpreted and given names. Items with loading greater than or equal to ±0.60 of varimax solution were selected for discussing each factor.

Descriptive Analysis
Descriptive analysis of anthropometric and physical fitness variables were presented in the following tables.

Discussion on Findings
Within the limitations of the study the investigator used factor analysis to meet the objectives of the study. On the basis of statistical analysis, following findings were drawn applicable to men softball players.

Anthropometric variables
The loaded Factor (factor one) comprises of weight were heavily loaded item, the girth Factor (factor two) which comprises the mid. Forearm circumference was heavily loaded item, the another length factor (factor three) which comprising of leg length were heavily loaded items among men softball players.

Physical fitness variables
In the case of physical fitness variables, the strength Factor (factor one) which comprises of leg explosive strength was heavily loaded items, the strength Factor (factor two) which comprises the abdominal strength were heavily loaded item, the another loaded factor is strength Factor (factor three) which comprises the cardio vascular endurance were heavily loaded item among men softball players.

Both anthropometric and physical fitness variables
In case of both anthropometric and physical fitness variables, the weight factor (factor one) which comprises the weight were heavily loaded item, the height factor (factor two) which comprises the height were heavily loaded item, the balance factor (factor three) which comprises the static balance were heavily loaded item.
This might have been due to the fact that softball game is a

dynamic team game requiring high level of skills, excellent conditioning for individual effort. It demands that all the players should be adapted to all the situations either defending or attacking. In this game there are lot of skills namely; throwing, hitting and running. Therefore the softball players need better physical condition in terms of leg length, endurance, explosive strength both arm and leg, flexibility, weight, mid. forearm circumference etc. and if softball players have average weight with more biceps circumference and leg length, then they can perform better than other players.

Discussions on Hypothesis

1. The first hypothesis was framed for study declaim that there will not be any prominent Anthropometric factors among national level senior men judo players in Kerala. Six prominent factors have been extracted after factor analysis from among the selected Anthropometric variables; hence the null hypothesis thus formulated was rejected.

2. Second hypothesis was framed for study declaim that there will not be any prominent Physical fitness factor among national level men judo players. Three prominent factors have been extracted after factor analysis from among the selected Physical fitness variables; hence the null hypothesis thus formulated was rejected.

3. The third hypothesis was framed for study declaim that there will not be any prominent Anthropometric and Physical fitness factors when both anthropometric and physical fitness are taken together. A combination of both Anthropometric and Physical fitness variables, have been extracted after factor analysis; hence the null hypothesis thus formulated was rejected.

Summary, Conclusions and Recommendations

The purpose of the study was to identify those prominent Anthropometric and Physical fitness factors among national level men softball players in Kerala.

To achieve the above purpose of the study National level men softball players of Kerala were selected. A total of 40 men softball players were selected for the study and the age of the subjects ranged from 17-25 years. The subjects were from Malappuram (Dist), Pathanamthitta (Dist), Ernakulam (Dist), Alapuzha (Dist) and Wayanad (Dist).

The purpose of the study was to find out prominent Anthropometric and Physical fitness factors contributing to performance in male softball players. The Physical fitness variables and the related tests were Speed (40mts flying start), Endurance (1200 mts), Agility (4x10 shuttle run), Flexibility (Sit and reach), abdominal strength (Sit up in minutes), static balance, leg explosive strength (Standing broad jump), hand explosive strength (Cricket ball throw).

Descriptive statistics such as mean, median, mode, standard deviation, kurtosis, skweness, co-efficient of variance, minimum, maximum range, 25th percentile score, 50th percentile score and, 75th percentile score were found in order to get the basic idea of the data distribution. Descriptive analysis were done on all the selected anthropometric variables namely; weight, height, sitting height, arm length, leg length, calf girth, thigh girth, ponderal index and crural index biceps girth and mid forearm circumference and selected physical fitness variables such as; speed, endurance, agility, flexibility, abdominal strength, leg explosive strength and hand explosive strength and static balance.

Factor analysis describes a procedure to identify those linear combinations of variables (Called 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.

Since there was very less study on anthropometric and physical fitness variables done on Hockey players, The scholar has undertaken this study to explore the importance of Anthropometric and Physical fitness variables among softball players

Conclusions

Within the limitations of the study the following conclusions were drawn from the present study applicable to male softball players.

Anthropometric variables

The loaded Factor (Factor one) comprises of weight were heavily loaded item, the girth Factor (Factor two) which comprises the mid. Forearm circumference was heavily loaded item, the another length factor (factor three) which comprising of leg length were heavily loaded items among men softball players.

Physical fitness variables

In the case of physical fitness variables, the strength Factor (factor one) which comprises of leg explosive strength was heavily loaded items, the strength Factor (factor two) which comprises the abdominal strength were heavily loaded item, the another loaded factor is strength Factor (factor three) which comprises the cardio vascular endurance were heavily loaded item among men softball players.

Both anthropometric and physical fitness variables

In case of both anthropometric and physical fitness variables, the weight factor (factor one) which comprises the weight were heavily loaded item, the height factor (factor two) which comprises the height were heavily loaded item, the balance factor (factor three) which comprises the static balance were heavily loaded item.

Recommendations

The investigator makes the following recommendations for the research scholars, teachers, physical teachers, coaches and softball players.

1. Since there was very less study on anthropometric and physical fitness variables done on softball players so, similar studies may be conducted using university level men softball players.

2. The same study may be extended to the large no of sample size.

3. Similar studies may be conducted using female Hockey players of other states.

4. It is also recommended that coaches and trainers design the training plan for actual performance.

5. Similar study may be conducted using female softball players.

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