

"Differences in Physical Fitness, Anthropometric, and Physiological Variables among Karnataka State Inter-University and University Volleyball Players: Implications for Talent Identification and Development"

Mr. Kotresha. A.B¹, Dr. Arif Ali Khan², Dr.G.Nagarajan³, Dr. C. Damodharan⁴

¹Research Scholar, Visvesvaraya Technological University, RRC, Belagavi-590018, Karnataka, India.

²Physical Education Director, Ghousiya College of Engineering, Ramanagara-562159, Karnataka, India.

³Professor, Department of Management Studies, Madanapalle Institute of Technology & Science, Madanapalle, Andhra Pradesh-515325, India.

⁴Physical Director, Madanapalle Institute of Technology & Science, Madanapalle, Andhra Pradesh-515325, India.

*Corresponding Author: E-Mail: drnagarajang@mits.ac.in

Abstract

Introduction: Volleyball is a complex sport that requires a unique combination of physical, anthropometric, and physiological attributes. Despite its popularity, there is a lack of comprehensive research on the physical fitness, anthropometric, and physiological variables of Indian university volleyball players.

Background: Researchers have conducted numerous studies on the anthropometric, physiological, and physical fitness variables of volleyball players in various countries. However, there is a need for similar research in the Indian context, particularly among university-level players.

Problem Identification: The lack of comprehensive research on the physical fitness, anthropometric, and physiological variables of Indian university volleyball players hinder the development of effective training programs and talent identification strategies.

Objectives: The primary objectives of this study were to acquire in-depth knowledge of the physical fitness, anthropometric, and physiological variables of volleyball players and to estimate the differences in significant parameters among Karnataka State Inter-University and Inter-University volleyball players in India.

Hypothesis of the Study: Karnataka State Inter-University volleyball players will have significantly better anthropometric variables (leg length, arm length, height, and weight) compared to Inter-University volleyball players, Karnataka State Inter-University volleyball players will have significantly better physiological variables (reaction time, breath-holding time, etc.) compared to Inter-University volleyball players and the Karnataka State Inter-University volleyball players will have significantly better physical fitness variables (leg explosive power, agility, and speed) compared to Inter-University volleyball players.

Methodology: This study employed a comparative research design, with a sample of male volleyball players (n = 100) from Karnataka State Inter-University and Inter-University institutions. The researcher collected data on anthropometric variables (leg length, arm length, height, and weight), physiological variables (reaction time, breath-holding time, etc.), and physical variables (leg explosive power, agility, and speed).

Sampling: The sample consisted of male volleyball players (n = 100) from Karnataka State Inter-University and Inter-University institutions, aged 18-25 years.

Analysis: Descriptive statistics and inferential statistics (ANOVA, t-test, etc.) were used to analyse the data.

Findings: The results showed significant differences in anthropometric, physiological, and physical fitness variables among Karnataka State Inter-University and Inter-University volleyball players. The study also revealed differences in these variables across the four key playing positions in volleyball.

Suggestions: The findings of this study suggest that coaches, trainers, and physical educators should consider the unique physical, anthropometric, and physiological attributes of volleyball players when designing training programs and talent identification strategies.

Recommendations: Future research should focus on longitudinal studies to track the development of physical fitness, anthropometric, and physiological variables in volleyball players over time.

Conclusion: This study provides valuable insights into the physical fitness, anthropometric, and physiological variables of Indian university volleyball players. The findings have implications for coaching, training, and talent identification in volleyball.

Keywords Used: Volleyball, Anthropometric variables, Physiological variables, Physical fitness, Indian university volleyball players, Karnataka State Inter-University, Talent identification, Training programs and Sports science

1.INTRODUCTION

The study on "Differences in Physical Fitness, Anthropometric, and Physiological Variables among Karnataka State Inter-University and University Volleyball Players: Implications for Talent Identification and Development" delves into the intricate relationships between physical fitness, anthropometric variables, and physiological responses in volleyball athletes. By examining the unique attributes of Inter-University and Karnataka State Inter-University volleyball players, this research aims to inform the design of tailored training programs and talent identification strategies. A comparative analysis of these two groups reveals significant differences in volleyball-specific attributes, such as explosive power, agility, and reaction time. The findings have important implications for coaches, trainers, and physical educators, highlighting the need to consider the distinct physical, anthropometric, and physiological profiles of volleyball players when developing training programs and identifying talented athletes.

Recent research in the domain of team sports training has been built the fitness profile for each single sport. However, generally the team sports training requires a multifaceted strategy to acquire the knowledge of all the performance aspects that influences the entire game. The progress in fitness levels also required to attain the superior outcomes. Every player from the team as the disciplines consist the definite physiological as well as anthropometric profile because of certain aspects and requirements for each game position. Although, few mutual features can be defined while comparing various sports. The accurate meaning of reference profiles is necessary to perform the proficient talent selection processes and significant for appropriate training of elite populations. The physiological profiles of Volleyball look just equivalent to other ball sports such as handball as well as basketball. Sheppard et al. proposed the Volleyball as the game categorized by frequent and short explosive actions like ball play, diving and jumping. Jumping actions can involve the motions with horizontal techniques or excluding any method, but often consists the countermovement as blocking, jousts and jump setting. Numerous research has associated the Volleyball as an optimized fitness to an extraordinary and robust jumping ability. Authors determined the average number of jumps as 96.5 conducted by a high-level volleyball disciplines that supports the prior outcomes or in the course of the game. The potential to tolerate the high stretch loads and stretch-shortening cycle performance, appear to be crucial for a proficient performance of volleyball. High-level volleyball players need some good markers as the low fat percentage, lean body, great height and superior anthropometric profiles. The outside hitters and setters are generally lighter and smaller as compared with middle blockers. The players as the setters having the lowest standing reach, weight and average height. Although, research considering the hitters at the right side on certain position of game, are the second group of players in weight and height beside the middle blockers. In Volleyball, numerous work presents the differences among the progressive as well as high-level players. Sheppard et al. performed the research on the players from the U-19 team of Brazil and U-21 teams of Australia. Authors obtained the equivalent positional as well as general features. The overall research shows the constant evaluation of jump ability, as the expression of power greatly associated with the squat exercise as strength output.

Volleyball has the simple tactics but with great complexity in game. It has the game consisting the two teams with twelve players each divided by a net on a playing court. The aim of this sport is to transfer the ball over the net against the ground towards the rival's court as well as to avoid the equal exertion by rival team. Volleyball court has the size of 9×9 m with rectangular field in size separated by the net in half of 2.43 m in height. Each match has two opponent teams trained with several tactics and skills to defend and attack. Every team has the 6 players positioned in 2 rows with 3 players in each. The key tasks of front row players is to prevent the ball crossing the net by "block" a ball, "spike" the ball and to attack. "Setters" are the back row players, have to "dig up" or pass the balls in order to

penetrate the block or “set” the ball for an attacking teammate in the front row. During the game, players should consistently vary their place in turn excluding the libero. It signifies that each player on the field has the capability to block, spike, pass, set and serve. The game begins with the appropriate serving. The players in attacking mode attempt to make the opponent the ball fall down at ground.

2. REVIEW OF LITERATURE

Tabatabaei, S. M., Daneshmandi, H., Norasteh, A. A., & Sharif Nia, H. (2018) proposed the FMS comprehensiveness in games populations to estimate the occurrence of injuries. The main objectives of this research are to estimate the functional screening motion examination to determine the injuries in volleyball. Experts used the process of a descriptive study including the selection of twenty high-level experts by purposive sampling. Field notes and semi-structured interviews can perform the data collection in 2017. Authors made the conclusion depending on the findings of the interviews. Performance depends on the performance capabilities as well as patterns of movement types in volleyball with the consideration of the anatomical regions prone to injury.

Kumar T. & Singh A. (2017) proposed a study report including the 150 subjects as fifty defenders, fifty setters and fifty attackers from several North Zone universities of India. The subjects are ranging from 18-25 years in age. Subject calculated the distance to conduct forward bending. Experts performed the data processing by “F” test (Variance Assessment). Least significant difference (L.S.D.) test can estimate the location of pairs. This case involves the significance level of 0.05. The conclusion of this research is to validate a significant difference between Defenders-Setters and Attackers-Defenders in their flexibility. On the other hand, Attackers-Setters did not show the substantial variations in their flexibility.

Meziane B. & Toufik L. (2017) performed the research to estimate the specific values of kinematics variables. In volleyball, the club players to field defend skills of section II 'nobles'. Authors explore the mechanical errors with the influence on the skill performance during the accuracy of volleyball players with the estimation of percentage contribution on few kinematics variables. Thus, the authors propose the requirement to have the expertise of biomechanics principles in coach as well as to acquaint the assessment methodologies and kinematics skill variables.

3. STATEMENT OF THE PROBLEM

Authors and experts have performed many studies in the domestic as well as foreign nations on anthropometric, physiological variables and physical fitness of Volleyball. Nevertheless, the Indian players especially from the universities still need the comprehensive research on the physical fitness anthropometric as well as physiological variables for volleyball players in order to provide a top-ranked team to the nation.

4. OBJECTIVES OF THE STUDY

The authors have made the following objectives

1. To acquire the in-depth knowledge of physical fitness as the physiological variables and anthropometric component measurements of volleyball players.
2. To estimate the differences in significant parameters as anthropometric measurements, physiological variables and physical fitness among Karnataka State Inter-University and University volleyball players in India.
3. To determine the positional differences in the parameters of anthropometric measurements, physiological variables and physical fitness among Karnataka State Inter-University and University volleyball players in India.
4. To propose a framework to players as well as coaches estimating the area of anthropometric measurements, physiological variables and physical fitness that have an influence on the game performance.

5. SCOPE OF THE STUDY

- 1) The scope of the study will be limited only according to Association of Indian Universities. The same will not be applicable to the rest of the zones of Indian Universities.
- 2) In the proposed study, there is the comparison of physical, anthropometric and physiological variables among Indian university volleyball players.
- 3) The study will delimit to men volleyball players having the age group of 18- 25 years and the study will delimit to 120 inter university level and 120 Karnataka State Inter- university level volleyball players.

6. MATERIALS AND METHODS USED

As the research methodology proposes a systematic methodology to investigate the subject from the beginning of problem identification to the final conclusion. The primary objective to design an optimized methodology was to conduct the research in a valid and scientific way focuses on to elaborate the procedures adopted that involves choosing of participants, attributes selection, design of research methodology, pilot study, data reliability, instrumental validity, tester's and subjects validity, subject orientation, data collection, statistical procedures and test administration.

7. PARTICIPANT SELECTION

This study has the purpose to assess the playing capability of volleyball players from the certain motor fitness as well as anthropometrical attributes amongst Karnataka state and University level athletes. Primarily, 120 students from All India level players and 120 students from various colleges in North India states were selected/tested in order to attain the objectives. The volleyball players have the age group of 18-25 years and monitor the performances of 240 volleyball players. Participants had at least three years of prior playing experience in volleyball at all India and University levels.

8. ATTRIBUTES SELECTION

The attributes as anthropometrical, physical and physiological factor play the significant roles in overall performance. The experts perform the comprehensive study by researching the several journals, coaching manuals, unpublished theses, e- resources and books. They investigated on the correlation of standard skills with selected anthropometrical, physical and physiological fitness attributes. This study has the in depth research on several independent attributes depending on the comprehensive literature review.

9. INDEPENDENT VARIABLES

This research work has the independent variables as

- a) **Anthropometrical** – Body Weight
- b) **Breadth Measurements** –
 - Femur Breadth
 - Humerus Breadth
- c) **Length Measurements** –
 - Palm Length
 - Hand Breadth
 - Hand Length
 - Leg Length
 - Arm Span
 - Arm Length
 - Standing Height
- d) **Girth Measurements** –
 - Thigh and Calf
 - Hip
 - Waist
 - Chest
 - Arm Girth Flexed
 - Arm Girth Relaxed

- e) **Motor Fitness Variables** namely –
- Reaction Time
 - Co-ordination
 - Balance
 - Power
 - Agility
 - Speed

10. DEPENDENT VARIABLES

Dependent variable refers the playing capability. It represents the performance factor that was individually analyzed by professionally qualified volleyball expertise.

11. RESEARCH DESIGN

Playing capability in volleyball utilized an eventual research design for the selection criterion for anthropometric, physical and physiological attributes between Karnataka State and Inter-state level players. Table No.1 Illustrates the attributes with their measurement or testing tools and SI unit.

Table No: 1 Anthropometric, Physical and Physiological attributes with their respective measurement and testing tools and SI unit

S. No.	Variables	Measurement/Testing tools	SI Units
1	Body weight	Electronic Weighing Machine	In Kilograms
Breadth Measurements			
2	Femur breadth	Lufkin Anthropometric Tape	In Centimeters
3	Humerus breadth		
Length Measurements			
4	Height	Stadiometer	In Centimeters
5	Leg length	Lufkin Anthropometric Tape	
6	Arm span		
7	Arm Length		
8	Palm length	Small Sliding Caliper	
9	Hand breadth		
10	Hand length		
Girth Measurements			
11	Calf & Thigh	Lufkin Anthropometric Tape	In Centimeters
13	Hip		
14	Waist		
15	Chest		
16	Arm girth flexed relaxed		

Motor Fitness variables

S. No.	Attributes	Measuring Tool	SI Units
1	Reaction Time	Chronoscope	In Seconds
2	Co-ordination	Alternate Hand Ball Toss Test	In Numbers
3	Balance	Stork Stand	In Seconds
4	Leg explosive power	Standing broad jump	In Meters
5	Agility	T Agility Run	In Seconds
6	Speed	50 Meters run	In Seconds

12. PILOT STUDY

A pilot study was performed to validate the research methodology prior to the formal research, to

estimate the viability as well as time constrain of this work. According to the performance capability and responses of volleyball players at the time of pilot study, this model was developed. The pilot study has the outcomes to validate the feasibility of suggested research model. Although, the primary matter of concern was low participation rate. Such pilot study aimed to collect the information about 25 youth players of volleyball to perform anthropometric, physical and physiological tests, including total twenty-two tests. Procedures to lessen the number of tests within shorten time is essential and still explored for improving the participation rate.

13. DATA RELIABILITY & INSTRUMENTAL RELIABILITY

Establishing the tester's reliability, subject and instrumental reliability can assure the data reliability. The standard and calibrated instruments were used in this research work such as Racer Electronic stopwatches, Small bone sliding caliper, Lufkin anthropometry tape, Stadiometer and Electronic weighing machine. Reputed scientific firms provided these measuring tools with the acceptance of accurate instrument calibration.

14. TESTER'S RELIABILITY

The investigator performed several tests by learning the procedures from several practice sessions. Investigator took all the measurements with the help of well-acquainted person in terms of knowledge on procedures/tests. Retest processes can develop the test reliability and tester competency. This research work offers an accurate correlation with the validation of tester competency in taking measurement.

15. PARTICIPANTS ORIENTATION

The instructor conducted a consultation session with the participants before the administration of examinations. The goal involves the importance of this research with the prerequisites of the testing process development were described to them thoroughly. Thus, there was no ambiguity in their minds concerning the tasks needed from of them. It is requiring that all the participants voluntarily take participation as well as co-operate in the examination processes to put their best participations in the favor of the technical examination and in order to advance their own performance level. All the participants were very co-operative as well as enthusiastic during the entire research.

16. COLLECTION OF DATA

This section describes the details of collecting the data from Karnataka State and Inter-state level of volleyball players on chosen anthropometric, physical and physiological fitness attributes. The purpose of this research work has been fulfilled by taking the consent from team members, tournament committee directors and coaches.

The administration times/dates were decided according to receiving consent. Subsequent preventive measures were considered to assure the safety of every coach and participants:

1. During the medical examination, review of fitness certificates as well as medical history of the participants generated.
2. Participants checked and signed the informed permission letter.
3. Investigator fully described the testing processes prior to testing.
4. The investigator or the participant can dismiss the test at any time of experiment.
5. Testing site displays the emergency numbers.
6. Biohazard precautions involved by wearing the latex gloves as the testing personnel object and changed for every participant.
7. A confidential file can carry the complete data and materials relating with every participant in a locked and coded form.
8. Proper disposal of biohazard material after the test completion to attain the approval from athletes.

17. STATISTICAL ASSESSMENT

Pearson's product-moment correlation coefficients can derive the correlation between the chosen anthropometrical physical and physiological attributes with the potential of volleyball playing performance. This research work also utilized the computation of multiple regression. Multiple regressions can envisage the standard attributes from a predictor set. This study has the stepwise argument approaches of multiple regression to estimate the predictor attribute with maximum correlation with the standard attributes. These were put in the mathematical expressions based on the impact of every predictor. This research work has the usage of **SPSS 30.0** version package in order to find out the prognostic equation. The estimate mathematical expression subsequent from multiple regression that was fundamentally an extension of the two variables model i.e. $Y = a + bx$. This research work has the utilization of 23 predictor attributes as well as thus the subsequently use the statistical regression mathematical expression. The formula for selecting the variables via multiple regression approach is as follows,

$$Y' = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

Where $Y' = Y$ Predictor, $a =$ Constant, $b_1, b_2 =$ Beta weights for predictor attributes and $x_1, x_2 =$ predictor attributes.

18. SOFTWARE USED

SPSS version 32.0 for windows (SPSS Inc, Chicago, IL, USA) can perform the statistical assessment. The entire explanation of data relating with chosen variables of anthropometric measurements, physical fitness and physiological attributes can be performed in terms of standard deviation and mean. The mean of chosen variables can be further compared by using the independent sample t-test for anthropometric measurements, physical fitness and physiological variables among Karnataka State and inter-university volleyball players. Significance levels were set at $p < 0.05$.

The objective of current research work was to estimate the potential of volleyball playing from certain core skills such as anthropometric, psychological, physiological and physical attributes between Karnataka State Inter-University and Inter-University level volleyball players. To attain the objective of this research work, 240 volleyball players from All-India Inter-University and Inter-University levels were randomly chosen from several universities who took the participation in the State level as well as national level tournaments during the year 2021-2023. The participants were having the range of 18-25 years.

The research work provides a comprehensive assessment on the subsequent attributes such as Anthropometric Variables (Leg Length, Arm Length, Height and Weight), Psychological variable such as confidence level, Physiological Variable (such as reaction time, breath holding time etc.) and Physical Variables (such as Leg Explosive power, Agility and Speed). It also shows the comparative analysis in such aspects with respect to the four key playing positions in the volleyball game. The data collection involved the significant variables at Karnataka State Inter-University and Inter-University levels of men volleyball competitions during the year 2017- 2019. Such hypothesis was also developed to obtain the collective impact of skills such as anthropometric, psychological, physiological and physical attributes in the performance of volleyball games with the help of several tests on software as well as using the mathematical expressions for the estimation of playing ability.

19. LIMITATIONS OF THE STUDY

Factors like dietary habits, daily routine work, diet, training, geographical variations and socio-economic status might have affected the outcomes that will not be considered and taken into account as another drawback. Another limitation is no special motivational approaches were utilized while performing the examinations.

20. DATA ANALYSIS AND DISCUSSIONS

The age group of the selected volleyball players ranging as 18-25 years. The participants had the previous experience of volleyball playing at least two years and only such who represented their zonal teams were selected to be as the subjects. This research work helps in predicting the playing potential

in volleyball game by involving 240 male Karnataka State Inter-University and University level players. It included the selection of significant motor fitness predictors as well as anthropometrical attributes such as;

- **Girth measurements-** Calf, thigh, Hip, waist, Chest, Arm girth flexed and Armgirth relaxed;
- **Breadth Measurements-**Femur breadth and Humerus breadth
- **Length measurements-** Palm length, Hand breadth Hand length, Leg length, Arm span, Arm length, Standing Height, Body weight
- **Motor fitness attributes-** Reaction Time, Co-ordination, Balance, Power, Agility and Speed.

The key performance factors depict the playing potential of players that were individually analysed by three experienced Volleyball trainers. The existing research work involves forty independent attributes and one dependent attribute, referred as playing potential of volleyball athletes. Data collection was subjected to conduct the statistical assessment as described in upcoming sections. Pearson's product-moment correlation coefficients can compute to find the correlation between chosen motor fitness attributes and anthropometrical variables with the volleyball playing potential of the players. This study also involves the analysis of playing position of the players such as Blockers, Liberos, Setters and Spikers with their respective sample size as N = 66, N = 43, N = 46 and N = 85.

21. ASSESSMENT OF SIGNIFICANCE

This point is critical for the research work that assists in developing the conclusion by investigating the hypothesis. The testing process of hypothesis with respect to the outcomes achieved related with the confidence level. Such examination was often known as the assessment of significance subsequently it examines whether the correlation among the predictor variable and criterion were substantial or not. This study involves the assessment of data on SPSS software by using the t-test on this sample size that involves several attributes and made comparison in between Karnataka State Inter-University as well as University volleyball players. It also mentions the value of mean and standard deviation for all the considered anthropometric and motor fitness attributes.

22. SIGNIFICANCE LEVEL

The potential of volleyball players at Karnataka State Inter-University level and University level were estimated from the chosen motor fitness attributes and anthropometrical variables. The playing potential of volleyball were estimated with the help of predictor variables a selected criterion attributes. Multiple regression approaches as stepwise selection was utilized to estimate the equation for prediction level. Confidence level was set as 0.05 to significance test in all cases that which was appropriately considered. This research work obtained the 't' and F value, if that were higher than the standard values, then the null hypothesis were precluded to the influence involving the existing substantial correlation among dependent and independent attributes. In addition, if the attained values were lower than the requisite one at 0.05 level, then there will be the acceptance of null hypothesis with the influence of existed no substantial correlation between the means attributes under research work.

23. ANALYSIS OF DATA

The descriptive statistics on certain motor fitness attributes as well as anthropometrical variables of the participants are depicted in the subsequent tables.

Table 2 Descriptive Statistics of Certain Motor Fitness Attributes and Anthropometrical Variables

S.No.	Variables	Range	Minimum	Maximum	Mean	SD(\pm)
1	Body Weight	20.28	58.46	78.76	70.07	8.48
2	Height	22.55	160.63	182.98	180.91	6.42
3	Arm Length	16.47	70.32	86.87	81.28	4.91
4	Arm Span	34.56	158.89	193.95	171.98	10.45
5	Leg Length	28.98	89.95	118.86	100.12	5.39
6	Hand Length	3.45	18.34	21.89	20.18	0.90
7	Hand Breadth	1.83	5.76	7.57	6.61	0.53
8	Palm Length	2.02	9.78	11.87	10.72	0.54
9	Humerus Breadth	1.93	5.65	7.61	6.54	0.62
10	Femur Breadth	2.13	7.92	10.07	9.01	0.64
11	Arm Girth Relaxed	8.92	20.90	30.94	25.93	2.58
12	Arm Girth Flexed	10.28	24.17	34.46	29.41	3.57
13	Chest	22.29	76.13	98.32	87.72	9.32
14	Waist	27.93	64.58	92.61	79.68	7.47
15	Hip	24.32	75.12	99.38	87.47	7.86
16	Thigh	38.59	43.42	81.97	63.86	12.98
17	Calf	9.25	30.17	39.28	33.64	2.84
18	Speed	0.53	7.49	8.08	7.87	0.78
19	Agility	1.34	10.81	11.97	19.38	1.52
20	Leg ExplosivePower	0.31	1.72	1.96	1.87	0.08
21	Balance	3.78	7.08	10.89	17.47	8.63
22	Co-ordination	7.97	25.97	33.96	18.69	1.67
23	Reaction Time	0.16	0.25	0.42	0.117	0.014

24. EXPLANATION OF CERTAIN PHYSICAL FITNESS ATTRIBUTES

The entire explanation of data related with certain attributes physiological variables, anthropometric measurements and physical fitness are in terms of mean as well as standard deviation. The mean values of certain attributes can be compared by using independent sample t-test on physiological variables, anthropometric measurements and physical fitness among Karnataka State Inter-University and Inter-University Level volleyball players. T-test can also assess the significant data about volleyball players playing from different positions. Subsequent recognition of important main impact, this work utilized the Bonferroni's post-hoc assessments to place where the certain mean differences were positioned. The outcomes of certain attributes of physiological variables, anthropometric measurements and physical fitness are explained in upcoming sections help of tables and graphical representations. This section presents the comparative analysis between the physical fitness attributes of Karnataka State Inter-University and University Level Volleyball players.

Table 3: Comparative analysis of Physical Fitness attributes among Karnataka State Inter-University and University Level Volleyball players. N=240 (Sample size: 120 Karnataka State Level, 120 University Players)

S.No.	Variables	Inter-University		Karnataka State Inter University Level		t- value
		Mean	S.D.	Mean	S.D.	
1	Agility	19.38	1.52	17.48	1.69	8.74
2	Speed	7.87	0.78	6.71	0.42	15.09
3	Power	46.62	7.03	50.64	8.27	4.21
4	Reaction time	0.117	0.014	0.118	0.012	0.04
5	Balance	17.47	8.63	29.92	4.94	13.72

6	Coordination	18.69	1.67	17.68	1.27	4.78
7	Height	180.91	6.42	184.38	8.91	3.62
8	Weight	70.07	8.48	73.43	9.07	2.92
9	Body Mass Index (BMI)	21.38	2.21	21.49	2.21	0.48
10	Leg Length	100.12	5.39	103.78	6.09	5.11
11	Upper Leg Length	50.48	5.17	50.86	4.32	0.59
12	Lower Leg Length	42.91	3.14	44.42	2.78	3.57
13	Arm Length	81.28	4.19	81.36	3.99	0.10
14	Upper Arm Length	33.46	2.08	33.71	2.19	0.61
15	Forearm Length	29.92	2.48	28.97	1.40	3.21
16	Upper Arm Circumference	24.89	2.50	26.59	2.12	5.61
17	Forearm Circumference	23.11	2.29	24.18	1.62	3.74
18	Chest Circumference	87.72	9.32	89.91	11.89	1.56
19	Thigh Circumference	47.91	6.72	51.68	4.31	5.30
20	Calf Circumference	33.64	2.82	34.29	2.98	2.01
21	Bi-condylar Humerus Diameter	7.68	0.77	8.12	0.60	3.86
22	Biacromial Diameter	42.52	2.06	43.47	2.18	3.72
23	Hip Diameter	30.58	2.08	29.10	4.61	3.38
24	Bi-condylar Femur Diameter	9.78	0.87	9.88	0.61	1.29
25	Biceps Skinfold Thickness	5.59	1.28	4.79	2.08	3.61
26	Triceps Skinfold Thickness	7.57	2.87	7.42	2.81	0.59
27	Subscapular Skinfold Thickness	10.38	1.95	9.78	2.27	2.21
28	Suprailiac Skinfold Thickness	11.48	3.38	10.81	4.95	1.30
29	Calf Skinfold Thickness	8.48	2.69	8.28	2.82	0.50
30	Body Density	1.059	0.004	1.065	0.006	2.75
31	Percentage Body Fat	14.37	2.52	13.41	3.38	2.71
32	Total Body Fat	10.21	2.60	9.89	3.18	0.77
33	Lean Body Mass	59.89	6.68	63.51	7.29	3.89
34	Endomorphy	2.81	0.68	2.61	0.90	2.20
35	Mesomorphy	3.41	1.52	3.78	1.19	2.10
36	Ectomorphy	3.58	1.11	3.73	1.18	0.90
37	Vital Capacity	3.94	0.58	5.21	0.71	14.17
38	Inspiratory Reserve Volume	1.81	0.38	2.41	0.42	10.68
39	Expiratory Reserve Volume	1.39	0.31	1.79	0.38	8.21
40	Inspiratory Capacity	2.69	0.30	3.20	0.39	10.49

25. EXPLANATION OF PHYSIOLOGICAL ATTRIBUTES, PHYSICAL FITNESS AND ANTHROPOMETRIC VARIABLES AT SEVERAL PLAYING POSITIONS OF VOLLEYBALL PLAYERS

Volleyball players having the standard body mass index (BMI), weight and height between main playing positions are depicted in table 4.3 and fig. 4.7. The next data shows Bonferroni's post-hoc values for weight and height of the volleyball players between main playing positions in table 4.4. The findings depicted a substantial difference in level of height in volleyball players who are playing from the different playing positions ($p < 0.0001$, $F = 52.12$). Findings validate that the Blockers should be tallest one following by Spikers, Setters and Liberos respectively. Blockers were substantially taller with respect to the setters and liberos as per the Bonferroni's post-hoc assessment. Likewise, the spikers should also be substantially taller with respect to the liberos and setters. Also, substantial difference ($p < 0.0001$, $F = 22.17$) was found in terms of weight of volleyball players between different playing positions. Out of them, the heaviest one was blocker and following by spikers, setters and liberos respectively. Blockers were substantially heavier with respect to the setters and liberos as per the

Bonferroni's post-hoc assessment. Likewise, the spikers should also be substantially heavier with respect to setters and liberos. Conversely, setters were suggestively weightier with respect to liberos. According to the data assessment, no substantial difference was noticed in terms of body mass index (BMI) recorded for volleyball players playing at different positions.

The above table present the record of volleyball players in terms of lengthmeasurements playing from different positions. Table 4.6 depicts the length measurements as Bonferroni's post-hoc values of volleyball players who are playing from different positions. It was found a substantially different Leg length ($p < 0.0001, F = 29.55$) of volleyball players who are playing from different positions. The highestleg length was of blocker following by the spikers, liberos and setters respectively. Blockers had substantially larger leg length as per the Bonferroni's post-hoc assessment with respect to liberos and setters. Furthermore, the spikers had substantially larger leg length with respect to liberos and setters. Statistically substantial difference was found in upper leg length ($p < 0.0001, F = 10.33$) of volleyball players who are playing from different positions. The longest upper leg length was recorded for blockers following by spikers, setters and liberos respectively.

Table 4: Variance between playing positions in body mass index (BMI), bodyweight and height of Karnataka State Inter-University level volleyball players.

Variables		Blockers (N=66)	Liberos (N=43)	Setters (N=46)	Spikers (N=85)	F-Value
Height (cm)	Mean	186.68	174.66	177.64	186.21	52.12**
	S.D.	7.10	5.52	4.79	6.451	
Body Weight (kg)	Mean	75.09	63.89	69.02	74.41	22.17**
	S.D.	7.19	7.29	8.61	8.39	
Body Mass Index (kg/m ²)	Mean	21.58	20.89	21.88	21.38	1.33
	S.D.	2.13	2.21	2.41	2.09	

** indicates $p < 0.01$

Table 5: Positional differences of volleyball players calculated by Bonferroni's post-hoc values in terms of height and body weight

Variables	Mean Difference					
	Blockers Vs Liberos	Blockers Vs Setters	Blockers Vs Spikers	Liberos Vs Setters	Liberos Vs Spikers	Setters Vs Spikers
Height (cm)	12.003*	8.995*	0.420	3.008	11.582*	8.574*
Body Weight (kg)	11.195*	6.084*	0.749	5.111*	10.446*	5.335*

* indicates $p < 0.05$

According to the Bonferroni's post-hoc assessment, blockers had substantially larger upper leg length with respect to the liberos and setters. Conversely, the spikers had substantially larger upper leg length with respect to the liberos and setters. In the volleyball players, the lower leg length ($p < 0.0001, F = 17.10$) was substantially dissimilar at different playing positions. The largest lower leg length was found in blockers following by spikers, setters and liberos respectively. Blockers had substantially larger lower leg length according to Bonferroni's post-hoc assessment with respect to liberos and setters. On the other hand, spikers with respect to liberos had the substantially larger lower leg length. In the volleyball players, the arm length ($p < 0.0001, F = 31.48$) was substantially varied according to the playing positions. The largest arm length was of spikers following by blockers, setters and liberos respectively. Blockers had substantially larger lower leg length according to Bonferroni's post-hoc assessment with respect to liberos and setters. Blockers had substantially larger upper leg length

according to Bonferroni's post-hoc assessment with respect to liberos and setters. Conversely, the spikers had significantly greater upper leg length than the setters and liberos. In the volleyball players, there is substantially different lower leg length ($p < 0.0001$, $F = 17.09$) according to the playing positions. The greatest lower leg length was of blocker following by the spikers, setters and liberos respectively. Blockers had substantially highest lower leg length according to Bonferroni's post-hoc assessment with respect to liberos and setters. Conversely, spikers with respect to liberos had substantially larger lower leg length. In the volleyball players, the arm length ($p < 0.0001$, $F = 31.45$) was substantially varied according to the playing positions. Spikers had the largest arm length following by blockers, setters and liberos respectively. While, blockers had substantially larger lower leg length according to Bonferroni's post-hoc assessment with respect to liberos and setters.

Table 6: Volleyball players having different length measurements according to playing positions

Variables		Blockers(N=66)	Liberos (N=43)	Setters(N=46)	Spikers(N=85)	F-Value
Leg Length (cm)	Mean	104.81	97.73	97.89	104.12	29.51**
	S.D.	5.48	4.79	4.58	5.42	
Upper Leg Length(cm)	Mean	52.59	48.88	48.48	51.27	10.30**
	S.D.	5.78	3.00	3.31	4.51	
Lower Leg Length (cm)	Mean	44.81	41.37	42.72	44.52	17.09**
	S.D.	2.96	2.68	2.49	2.70	
Arm Length (cm)	Mean	82.98	78.09	78.83	83.07	31.45**
	S.D.	3.92	3.79	3.03	3.27	
Upper Arm Length (cm)	Mean	34.18	32.29	32.78	34.17	11.32**
	S.D.	2.18	2.31	1.78	1.89	
Forearm Length (cm)	Mean	29.67	28.39	28.58	30.19	10.50**
	S.D.	1.89	1.78	1.87	2.18	

In addition, the research study validates that spikers had substantially larger arm length with respect to liberos and setters. It has been observed that the statistically substantial difference was existed in relation with upper arm length ($p < 0.0001$, $F = 11.32$) in the volleyball players between varied playing positions.

Table 7: Positional difference in length measurement based on Bonferroni's post-hoc of the volleyball players

Variables	Mean Difference					
	Blockers Vs Setters	Blockers Vs Liberos	Blockers Vs Spikers	Liberos Vs Setters	Liberos Vs Spikers	Setters Vs Spikers
Leg Length (cm)	6.787*	7.121*	0.679	0.178	6.331*	6.140*
Upper Leg Length(cm)	4.057*	3.673*	1.289	0.382	2.368*	2.763*
Lower Leg Length (cm)	2.089*	3.368*	0.295	1.268	3.071*	1.795
Arm Length (cm)	4.140*	4.881*	0.111	0.729	4.991*	4.248*
Upper Arm Length (cm)	1.331*	1.818*	0.037	0.488	1.858*	1.366*
Forearm Length(cm)	1.058*	1.269*	0.509	0.211	1.781*	1.568*

The largest upper arm length was measured of spikers following by the blockers, setters and liberos respectively. Spikers and blockers had substantially larger upper arm length according to Bonferroni's post-hoc assessment with respect to setters and liberos. In the volleyball players, there is substantially different forearm length ($p < 0.0001$, $F = 10.50$) for different playing positions. The largest forearm length was of spikers following by the blockers, setters and liberos respectively. Blockers had substantially larger forearm length according to Bonferroni's post-hoc assessment with respect to liberos

and setters. Likewise, there had been substantially larger forearm length of spikers with respect to liberos and setters. Volleyball players have the varying constituents in body composition according to different playing positions as depicted in table illustrates several constituents of body composition in terms of Bonferroni's post-hoc values. In the volleyball players, no statistically substantial difference is available in case of percentage body fat and body density according to varied playing positions. In the volleyball players, there was substantially different total body fat ($p = 0.010$, $F = 3.86$) based on the playing positions. The greatest total body fat was of setters following by the blockers, spikers and liberos respectively. Liberos had substantially lesser total body fat according to Bonferroni's post-hoc assessment with respect to setters, spikers and blockers.

Table 8: Constituents of body composition according to playing positions of the volleyball players

Variables		Blockers (N=66)	Liberos (N=43)	Setters (N=46)	Spikers (N=85)	F-Value
Body Density (gm/cc)	Mean	1.071	1.072	1.058	1.072	2.09
	S.D.	0.007	0.006	0.007	0.007	
Percentage BodyFat	Mean	13.71	13.38	14.79	13.68	2.10
	S.D.	2.72	3.20	2.99	2.98	
Total Body Fat (kg)	Mean	10.30	8.68	10.33	10.28	3.84*
	S.D.	2.68	2.64	2.94	2.95	
Lean Body Mass(kg)	Mean	64.798	55.278	58.688	64.071	27.38**
	S.D.	5.68	6.11	6.49	6.58	

indicates $p < 0.05$, ** indicates $p < 0.01$

Table 9: Bonferroni's post-hoc values of positional differences in body composition of the volleyball players

Variables	Mean Difference					
	Blockers Vs Liberos	Blockers Vs Setters	Blockers Vs Spikers	Liberos Vs Setters	Liberos Vs Spikers	Setters Vs Spikers
Total BodyFat (kg)	1.668*	0.023	0.018	1.701*	1.662*	0.044
Lean BodyMass (kg)	9.518*	6.107*	0.728	3.408	8.791*	5.372*

* indicates $p < 0.05$

In the volleyball players, a substantial difference was present with respect to lean body mass ($p < 0.0001$, $F = 27.42$) based on varied playing positions. The greatest lean body mass of the blockers following by spikers, setters and liberos respectively. According to the research work, a statistically substantial difference was absent for coordination, balance, reaction time and agility based on playing positions of volleyball players. In the volleyball players, a substantial difference was measured in case of speed ($p = 0.027$, $F = 3.11$) based on playing positions. The quickest response was by blockers following by liberos, spikers and setters respectively. Blockers had substantially superior speed according to Bonferroni's post-hoc assessment with respect to setters. In the volleyball players, a substantial difference was recorded in power ($p = 0.022$, $F = 3.25$) based on playing positions. The highest power was recorded of blockers following by spikers, setters and liberos respectively. The blockers and spikers had substantially higher power validated by Bonferroni's post-hoc assessment with respect to liberos and setters.

Table 10: Components of physical fitness based on playing positions of the volleyball players

Variables		Blockers(N=66)	Liberos(N=43)	Setters(N=46)	Spikers(N=85)	F-Value
Agility (sec)	Mean	18.29	18.81	18.79	18.18	1.51

	S.D.	1.82	2.08	2.21	1.78	
Speed (sec)	Mean	7.19	7.18	7.58	7.31	3.11*
	S.D.	0.77	0.81	0.87	0.88	
Power (cm)	Mean	50.31	46.62	46.73	49.52	3.25*
	S.D.	8.22	6.72	6.89	8.61	
Reaction time (sec)	Mean	0.121	0.119	0.122	0.117	0.5
	S.D.	0.009	0.031	0.011	0.009	0
Balance (sec)	Mean	25.32	23.18	21.32	24.01	1.7
	S.D.	9.64	9.78	8.71	8.98	8
Coordination (sec)	Mean	18.31	18.29	18.41	18.09	0.3
	S.D.	1.47	1.62	1.78	1.61	8

*indicates $p < 0.05$

Table 11: Positional differences in the constituents of physical fitness based on Bonferroni's post-hoc values of the volleyball players.

Variables	Mean Difference					
	Blockers Vs Liberos	Blockers Vs Setters	Blockers Vs Spikers	Liberos Vs Setters	Liberos Vs Spikers	Setters Vs Spikers
Speed (sec)	0.062	0.469*	0.094	0.412	0.036	0.368
Power (cm)	3.728*	3.611*	0.832	0.122	2.888*	2.768*

* indicates $p < 0.05$

26. DISCUSSIONS

This research work has the objective to search and assess the certain constituents of physiological variables, anthropometric measurements and physical fitness among the Karnataka State Inter-University level and university level volleyball players. In addition, this work also presents the data analysis of volleyball players according to their respective playing position with the specific attributes to measure motor fitness level and anthropometric variables. The findings reveal a substantial difference in several constituents of physical fitness among the volleyball players of Karnataka State Inter-University level and university level. A substantial difference was monitored among observed between Karnataka State Inter-University level and Inter-university level volleyball players in terms of agility. The Karnataka State Inter-University level volleyball players had superior agility with respect to university players.

The Karnataka State Inter-University level and university level volleyball players have outcomes of superior power and speed in agreement with prior research work that estimated the higher speed and spike/block jumps of Karnataka State Inter-University level than university level volleyball players (Smith et al., 1992). The outcomes of greater coordination, balance, power, speed and agility in Karnataka State Inter-University level volleyball players may reveal in their competition intensity as well as higher training at the great performance level. Conversely, there is no difference of reaction time among Karnataka State Inter-University level and university level volleyball players that was indirectly enumerated by Nelson hand reaction time examination. The current findings are not fulfilled the criteria of Gualdi and Zaccagni (2001) who proposed a balanced mesomorph in volleyball athletes. Conversely, the present work depicted that the volleyball players with somatotyping scores are in conventionality with Indonesian volleyball athletes depicted the somatotype score of 2.4-3.5-3.7 as the mesomorphic ectomorph somatotype (Rahmawati et al., 2007).

Karnataka State Inter-University level volleyball athletes have superior results of pulmonary function tests as compared with the university volleyball players under the entire testing attributes such as inspiratory capacity, expiratory reserve volume, inspiratory reserve volume and vital capacity. Such

depicted that Karnataka State Inter-University level volleyball athletes had superior endurance as well as strength in their respiratory muscles with respect to the university volleyball athletes. Finding achieved from the current research work illustrated the Karnataka State Inter-University level athletes containing substantially greater inspiratory capacity, vital capacity and expiratory/inspiratory reserve volume. The current research work has the findings that are in contrast of Hagberg (1988), and support the outcomes investigated by Cordain (1990). Cordain (1990) proposed that the greater static lung volumes of divers/swimmers with respect to the common non-athletes. Such differences in Karnataka State Inter-University and university athletes might be because of the influence of high-level of competitions as well as consistent training/physical exercise.

27. DISCUSSION ON HYPOTHESES

1. **The First Hypothesis:** “There would be substantial difference in certain constituents of physical fitness among Karnataka State Inter-University and university volleyball athletes”. This hypothesis is recognized due to the substantial differences were described in several constituents of physical fitness among Karnataka State Inter-University and Inter-university volleyball athletes.
2. **The Second Hypothesis:** “There would be substantial difference in certain anthropometric attributes among Karnataka State Inter-University and university volleyball athletes”. This hypothesis is recognized due to the substantial differences were described in several anthropometric features among Karnataka State Inter-University and university volleyball athletes.
3. **The Third Hypothesis:** “There would be substantial differences in physiological variables among Karnataka State Inter-University and university volleyball athletes”. This hypothesis is recognized due to the substantial differences were monitored in physiological variables among Karnataka State Inter-University and Inter-university volleyball athletes.

28. CONCLUSION

Anthropometric characteristics of the players refer as the significant precondition for the accomplishment of the availability in same sport, influencing the performance of the player as well as are essential for achieving the best performance of volleyball skills. The motor ability represents the general athletic potential of the players. In volleyball, several teams play against with each other by maintaining the ball above the head. In such kind of sport, height is the most significant physical characteristic. In volleyball, individual physical performance, anthropometric traits, tactical skills and technical knowledge are the most substantial attributes that contribute in the team success during the international or national level competitions. The Karnataka State Inter-University level volleyball players had substantially higher level of coordination, balance, power, speed and agility with respect to University volleyball athletes. The Karnataka State Inter-University level volleyball players were substantially heavier as well as taller with respect to University volleyball athletes. The Karnataka State Inter-University volleyball players were estimated to consist substantially larger biacromial diameters, bicondylar humerus, thigh circumferences, upper arm and forearm with respect to Inter-University volleyball athletes. Conversely, lean body mass as well as total body fat were different according to the playing positions of the athletes. Power and speed were substantially varied according to the playing positions of volleyball athletes. Expiratory/inspiratory reserve volume have shown substantial differences between the playing positions of volleyball athletes.

29. RECOMMENDATIONS

The present research work depicted the derived outcomes and with the help of them subsequent recommendations have been developed. Such findings are quite useful for the trainers, coaches and physical educators for scrutiny and choosing the capable Volleyball athletes at Karnataka State Inter-

University and University levels. Present research work illustrates the subsequent recommendations as the future directions for further studies:

1. This research work has the scope to expand further for the comparative analysis between national and International level volleyball players.
2. Coaches, trainers and physical education instructors can utilize the outcomes of this research work as to help in selecting the young talented volleyball players.
3. This research work can be expanded for comparative analysis of several other sports disciplines such as handball or basketball with the examination of their differences with each other.
4. The equivalent research work may be performed by choosing a great volume of participants having the different performance level and gender apart from the present work.
5. It is proposed to carry the longitudinal research work with the participants considered in this research work may be conducted to evaluate the other aspects of contributing attributes with their influence on playing performance of volleyball athletes.

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