Chapter II
Review of Related Literature

To understand the research topic in depth the researcher has made every effort to review literature related to the problem in the game of volleyball. For this purpose, maximum possible efforts by spending considerable time in the major libraries pertaining to the literature on physical education and sports. The researcher had access to the libraries of Chandrasekhar Agashe College of Physical Education, Department of Physical Education, Pune University, NSNIS, Patiala, Government College of physical education, Gwalior. A brief review of the studies relevant to the problem has been presented in this chapter. The literature pertaining to it has been abstracted in this chapter to provide the back ground material so as to evaluate the study well as to interpret its findings. The abstracts of the reviewed studies are given below. The reviews in this chapter, divided into categories are:

2.1 Review related to Volleyball research
2.2 Review related to Morphological Variables
2.3 Reviews related to Fitness and Performance
2.4 Reviews related to Norms
2.5 Review related to Norms of Different Sports- Skill Test

2.1 Review related to Volleyball research:
Lidor, R and Ziv, G.¹ (2010) conducted a research Physical and physiological attributes of female volleyball players-a review. The main objective of this article was to review a series of studies \( (n = 31) \) on physical attributes, physiological attributes, and on-court performances of female volleyball players. Empirical and practical knowledge emerging from studies on training-related issues in volleyball, such as body mass, fat-free mass, aerobic profile, strength, and agility and speed, should be integrated and applied when planning annual training programs for volleyball players. Based on our review, it was found that (a) players of a higher skill level are taller, somewhat heavier, and have higher vertical jump values than players of a lower level; (b) the aerobic profile of female volleyball players is similar to that

of female basketball players; (c) ballistic resistance training can increase vertical jump values in female volleyball players; and (d) preseason conditioning should be conducted to prevent fatigue and reduced performance at the beginning of the season. Among the research concerns discussed in the article are that there is a lack data for on-court performance and time-motion analysis in female volleyball players and that more experimental/manipulative studies are needed to examine the effectiveness of different training programs on physiological attributes of female volleyball players. Two practical implications are suggested for volleyball and strength and conditioning coaches: (a) functional and nonfunctional overreaching should be carefully monitored when planning strength and conditioning programs, and (b) volleyball programs should include ballistic-type training.

M. H. Kumara² (2000) conducted study on, to find out the relationship of selected volleyball skills with the selected variables. They evaluated 24 women volleyball players belonging to national team of Cuba, Russia, Italy and Korea. From 3rd Leg of world volleyball grand prix held in 1988. With the help of 24 sets video filming and Volleyball Information system, investigator and qualified volleyball coaches rated the volleyball playing ability of the selected volleyball players in relation to age and experience in international competition. The result of the study was, as follows, there is highly significant relationship between attack success with spike jump reach and block jump reach, Service success with block jump reach, Age with experience, Stature with weight and Block jump reach with spike jumps reach.

Cox³ (1985) study was relationship between performance in women’s volleyball and selected psychological measures. The subjects for this research were 157 female volleyball players who participated in a 16-team invitational collegiate volleyball tournament. The batteries of selected psychological tests were administered to all athletes at least two hours prior to their first match on second day of the tournament. Volleyball performance was measured throughout the tournament. Data were analyzed using multiple correlation and stepwise regression procedures. The results of the investigation varied greatly depending on the nature of the dependent variable. The best model for predicting volleyball performance was obtained when psychological measures were correlated with a composite score of volleyball

³ Cox, R. H. (1985) Relationship between performance in women’s volleyball and selected psychological measures. Abstract research paper, AAPHERD Convention, pp. 139.
performance. It was concluded that, relationship between an athletes’ psychological profile and volleyball performance is relatively high, accounting for 41 percent of the variability.

Jäger, J. M. and Schöllhorn, W. I., (2007) conducted a study titled Situation-orientated recognition of tactical patterns in volleyball. The aims of this study were to develop a classification of offensive and defensive behaviors and to identify team-specific tactical patterns in international women's volleyball. Both the classification and identification of tactical patterns is done by means of a hierarchical cluster analysis. Clusters are formed on the basis of similarities in the players' positions on the court. Time continuous data of the movements, including the start and end points during a pass from the setter, are analyzed. Results show team-specific patterns of defensive moves with assessment rates of up to 80%. Furthermore, the recognition of match situations illustrates a clear classification of attack and defense situations and even within different defense conditions (100%). Thus, this approach to team tactical analysis yields classifications of selected offensive and defensive strategies as well as an identification of tactical patterns of different national teams in standardized situations. The results lead us to question training concepts that assume a team-independent optimal strategy with respect to the players' positions in team sports.

Murugesan G. (1981) established the relationship of height, agility, and vertical jump in spiking in volleyball. the researcher conducted tests on 30 male students of L.N.C.P.E., Gwalior and concluded that the vertical jump is most reliable single variable in judging spiking ability of men volleyball players; combination of height and vertical jump provide to be the most reliable of assessing the spiking ability of male volleyball players. The combination of three variables, ie. height, agility and vertical jump, was found valid and reliable for predicting spiking ability of male volleyball players. The most valid combination in predicting spiking ability consisted of height, agility and vertical jump.

Narain J. (1985) conducted a study on different levels of 77 volleyball players and 10 physical performance tests. The results seated that than the other groups. The

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control group with a persistent descending gradient in most of the variables like height and weight. The volleyball player showed poor muscular development. In ectomorphic component volleyball players were thinner and leaner than the control group and average value of the state players were more than lean. In performance test (block jump, approach jump and three successive jump, 20 m dash, 6-3-6-3-9 agility basketball throw, sit-ups, forward and backward bend, 2.4 km run), the state players best followed by those of the university and districts levels. The control group has descending gradient of performance, in overall performance state players were better than other groups.

Dyba W.\(^7\) (1982) conducted a study on 11 subjects who were junior men’s provincial volleyball team members. They undertook a series of laboratory tests to determine selected motor performance and anthropometric and physiological characteristics. The motor performance tests were 20 meters sport, 3 long jump, sargment jump, block jump, running, spiking jump, push-ups, 90 m run shuttle run, rolls and sit-ups. The findings were:

- The game of volleyball as played at this level is a moderately stressful aerobic sports, game heart rates average 144 beats per minute. Game blood Lactic Acid concentration averaged 32.5 mg%.
- Significant difference in action component profiles were observed among the players. Blocking action had the greatest frequency. Setters performed a significantly greater number of volleys.
- Difference in time characteristics were not significant during the various game of each match. Rally duration averaged 7.0 seconds while the tests of duration averaged 13.3 seconds. Average game length was 18 minutes and 33 seconds.
- The predominance of play ends with the first net encounters, the more stressful the rally.

Buligin M. A.\(^8\) (1981) proposed model of physical preparation for volleyball players for combination of various physical qualities and checked the improvement in the players. His model was prepared and checked out over a period of several years in volleyball improvement groups in pedagogical institute where planning the training

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and checking of progress is done with the use of eight indicates. The speed of movement was tested with shuttle run, Muscle strength by throwing medicine ball, speed of arm movement by throwing a tennis ball against the wall (rebound) and the strength of the extremities by executing the maximum number of repetitions (push and squat thrust). In second the model directs the combination of the various qualities of a volleyball player. The conclusions of this study were:

- The constructed model allows for effective planning for improvement in the physical qualities of a player by taking in to consideration their individual characteristics.
- The proposed model makes it easier to evaluate the capabilities of the players for selection.

**Adhikari C. S.** (1983) conducted a study on 30 college boys to find out the comparative relationship of power, agility and selected speed characteristics of power, agility and selected speed characteristics to block jump and three stride jump in volleyball. A set of test squat thrust, etc., were used to measure different components and their relationship to each other. The results show that:

- Power of an individual contributed much to performance of block jump and showed positive relationship to each other.
- Agility which was a require factor in performance vertical jump co-relates significantly with block jump and three stride jump.
- Speed, reaction time and speed of movement did not contribute much in performance of block jump and three stride jump.
- Power and Agility played an equal role in the performance of block jump as well as three - stride jump because there was no significance difference between the “r” of power and agility to the performance at block jump and three stride jump.

**Phipps F. J.** (1983) inferred that the game of volleyball requires quickness, endurance and co-ordination and suggested that a player was to be evaluated through the skill test, physical components general ability test and specific test. In his study he first gave the general test of ability test, successive long jump, vertical jumps, rolling tests, seven - second run bend bench basketball throw, Illinois agility run shuttle run,

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push up and ball roll. The vertical run seven - second run and shuttle run, had the highest correlation to performance. He conducted that the specific ability and sports skill were more specific and general, especially at senior high school levels , such as blocking test, approach spiking, bump test, repeated volleys test for setting, switching and digging, and accuracy server test. The approach spiking test, bump test and test for passing had the highest correlation to the criterion. He further suggested that if general and specific abilities were combined for evaluation, it could be better predictor of playing abilities.

Devi B.\textsuperscript{11} (1985) made a study on 80 college level volleyball players to determine the relationship of depth perception, agility and speed of movement. Her findings reveal that depth perception, agility and speed of movement contribute to volleyball playing ability. The significant correlation of agility and speed of movement may be expected in the game of volleyball as it demands a quick acceleration rate along with performing movements in any direction. The results showed a significant relationship with speed of movement and agility.

Kumar R.\textsuperscript{12} (1995) conducted a study regarding the interrelationship among leg power tests spiking and blocking skills on 32 volleyball players at N.I.S. Patiala. The tests were vertical jump without approach and with approach, block jump, three consecutive long jumps with both legs and with left and right leg, standing broad jump half squat, shuttle run (9-3-6-3-9) forward and back bending of body, 20 m and 40 m sprints, and 60 m, run spiking and blocking. He concluded that spiking and blocking skills were not inter-correlated with each other. Sprint tests showed a significant correlation with jump tests. The test of flexibility was correlated with agility only. Blocking was highly correlated with consecutive jumps it had a high correlation with the approach and without approach jump.

Sandhu S.\textsuperscript{13} (1987) evaluated kin anthropometric potential of junior level volleyball players of 16 to 18 years of age. The results revealed that the wing volleyball players were significantly taller than the non-wing players. The 18 years of age players heavier than the those of 16 years. The non-wing volleyballers showed significant


\textsuperscript{12}Kumar R. (1995) \textit{Inter relationship among leg power tests, spiking and blocking skills in volleyball} Unpublished dissertation of Master’s in sports , N.I.S., Patiala.

improvement in tests or explosive strength from 18 to 16 years. The wing players showed higher level of performance than non-wing volleyballers and showed better performance in basketball throw. Both groups showed improvement in speed (20 mt dash) but wing players better than the control group showed improvement from those of 16 to 18 years of age. The magnitude of improvement was less in wing players than in non-wing players. The test of aerobic endurance in case of non-wing volleyball players showed significant improvement of 16 to 18 years of age.

**Rajan K.**¹⁴ (1980) evaluated the effect of selected weight training exercise (half squats, bench press, sit ups with weight, leg press, wrist curl) and specific exercise (Medicine ball throw, jump and throw, lift ball target throw, hurdle leap and other individual movement) on volleyball playing ability. There were 60 subjects in all who belonged to 10th and 11th classes and were divided in three groups. His result revealed that volleyball ability could be improved significantly by administering a programmed of weight training and specific exercises in addition to regular practice of volleyball and also playing volleyball alone. Weight training exercises and specific given in addition to regular practice of volleyball were found superior to regular practice of volleyball alone for developing performance in Russell Lunge volleyball test.

**Devi S.**¹⁵ (1985) tested 24 volleyball players of Laxmibai National College of Physical Education, Gwalior, in order to study the relationship of selected strength and flexibility measures by using Roger’s formula sit-ups. Legs dynamometer, wrist flexion and extension and extension by goniometer, trunk flexibility by sit and rich test, shoulder flexibility metric scale, to volleyball playing ability. to playing ability in volleyball. Shoulder flexibility also contributed significantly to the playing ability, grip strength did not however, correlate significantly to playing ability, wrist flexibility and ankle flexibility, and it had an insignificant relationship to playing ability. Trunk flexion also showed an insignificant correlation to laying ability in volleyball.

**Bhola V.**¹⁶ (1984) conducted on 25 volleyball players to assess the relationship of absolute leg length, foot length, dynamic power, and ankle flexibility to jumping

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ability in volleyball, using three stride rhythm. The tests included the 50 meter run, side step and Sarjent jump. He concluded that:

- Foot length and dynamic power showed a significant relationship with jumping ability in volleyball using three stride rhythm.
- Right and left ankle flexibility also showed significant relationship to jumping ability.
- Agility too was closely related to jumping ability.
- The variables of absolute leg length, fore leg length and thigh leg length showed an insignificant relationship to jumping ability.

**Joseph K.** (1983) conducted a study to determine the relationship of agility, shoulder flexibility, arm length and, leg length to volleyball playing ability. For this purpose, he selected 80 volleyball players. He administrated the test of sarjent jump, 40 m shuttle run, shoulder flexibility, arm length and leg length and round that power was the most reliable variable followed by arm length and leg length in predicting volleyball playing ability. It was also concluded that agility and flexibility sis not correlate significantly with volleyball playing ability.

**Spence D. W.** (1980) developed a descriptive profile on 15 members of the United States women national volleyball team, who were highly skilled. The data were obtained from anthropometric, strong physiological and motor performance domains consisting of jump and reach, triple hop, agility run, and 20 meter dash within group comparisons were made between the six women who were selected for the pan American team and the nine who were not selected. The pan American selected players were taller and heavier and demonstrated better motor ability than the non-selected players. Strength measurements do not indicate consistent differences between the two sub-groups. The non-selected had greater VO2 max than those selected, between group comparisons on selected variables were made between the team player and other women volleyball players. The training team subjects were taller heavier the comparative groups. The training team group demonstrated a lower heart rate Max (180 beats/min) than their VO2 Max (43.2 ml/ kg/min) was within the range of comparative groups.

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Puhl J.\(^{19}\) (1982) examined the absolute and relative physical physiological characteristics of elite men and women volleyball players. Height male and 14 female subjects were put under study, by measuring the body fact, Vo2 max post-exercise blood lactic acid, vertical jump peak isokinetic torque for knee flexion and extension, shoulder extension and planter flexion. The results indicate that:

- Men were taller, heavier, had a higher body sensity, lean body weight and lower body fat.
- Men achieved greater absolute height for jump and reach.
- Men had a greater Vo2 max maximal exercise heart rates, post exercise blood lactic acid value were similar between the groups.
- Torque production decreased with velocity of movement and sex differences in absolute torque disappeared as velocity increased. The differences in muscle mass were apparently due to the sex differences.

2.2 Review related to Morphological Variables:

Popovskil\(^{20}\) (1981) stated that, along with the fitness factors, a player’s body height and reach height have an additional advantage in Volleyball. Traditionally, this criterion has become a trend to select player’s fort the top level competition even in the Olympic Games. This has become our common experience that reach-height has significant impacting spiking and blocking. Popovskil (1981) also indicates that average body-height for women and men in the XXII Olympic Games was 176.90cm and 190.40cm respectively. Similar studies on anthropometric measures and somatic aspects of the players of different games have revealed that performance in any sport is significantly related with the status of the athlete where body weight must be proportional (Garbin, 1988: 15-20, Narain, 1985: 125-130).

Shondell D.\(^{21}\) (1972) investigated the relationship of the selected motor performance and anthropometric traits to successful volleyball performance. 23 tests and measurements were administered to 93 college students. Multiple ‘r’ techniques were employed and regression coefficients determined. A two phase cross validation


procedure determined the test battery used to predict volleyball potential using 45 Ss. Phase 2 of the cross validation utilized 2 divergent group to determine weather the test battery discriminated between highly skilled and beginning players. A four item battery consisting of the medicine ball toss, 30 yard dash, zigzag run, wall catch, vertical jump, and weight was also a reliable battery for predicting volleyball potential of the college men at Ball state university.

In a study Miloslav E. (1988), the samples were 86 game-volleyball-players of Czechoslovak top league men’s teams. Anthropometric data was measured according to Martin, whereas performance parameters were attack hit, block serve and serve reception as recorded in 4 qualitative grades each. Well-trained personnel performed measurements and observation. Matrices of Pearson’s correlation coefficients were further elaborated by factor analysis using method of principal axes and Kaiser’s orthogonal rotation. Factorization of all players’ matrix resulted in extraction of 8 factors, while factor structures corresponding to samples of respective special playing functions- speakers, blockers and setters were created by 7, 8, and 7 factors respectively. 5 of these factors: power of lower limbs, lankiness attack, playing experiences and locomotion abilities were common to all player’s functions, even though with different weight in each structure.

Singh S. (1994) aims at comparing the attackers and set-uppers in volleyball with regard to motor abilities. 44 male volleyball players (22 attackers and 22 set-uppers) of university and state level were volunteered as the subjects. Ten motor ability tests were conducted on the subjects to compare the motor abilities along with age, body weight, and standing reach of the subjects. The findings indicate that attackers are significantly younger, heavier and taller than the set-uppers the attackers and set-uppers do not differ significant in the test except basketball throw. On the whole, attackers are better in 40m sprint, vertical jump, and vertical jump with approach, basketball throw, three consecutive long jumps, 9-3-6-3-9m agility test and 2.4 km run. On the other hand, set-uppers are better in block jump, forward bend and reach, and bent knee sit up (60 sec).

The anthropometrical characteristics and body composition of Greek woman volleyball players (age: 23.8 +/- 5.1 years) were examined by Papadopoulou (2000) from the national team (NT, n= 29) and A1 division (AD, n= 63). The measurements recorded were ht, wt, segment lengths, diameters, circumferences and body fat percentage. The mean height was 179 +/- 62 cm and the mean weight 70.7 +/- 7.8 kg. The NT players had significant longer upper limb, forearm, bi-trochanteric diameter and wrist and calf circumferences (p<0.05). There were no significant differences in body fat percentage between NT (22.4 +/- 4.7 %) and AD (21.3 +/- 5.5%) players, as well as fat free mass (56.1 +/- 5.7 kg and 54.6 +/- 4.7 kg for NT and AD, respectively). Some anthropometrical characteristics differ between NT and AD players and these characteristics could possibly affect the performance. In both NT and AD players relatively high body fat percentage is a negative factor in athletes’ top performance and must be decreased.

Matsumoto D. (2000) examined the relationship between performance and not only weight, but also lean body mass (LBM), muscle mass (MM), and total body fat (TBF) (as a negative factor) and also examined differences between selected competitive athletes and club members. One hundred and thirty six judo players from the all Japan University team Championships and all Japan elite judo athletes were separated into two groups, one involving competitive athletes (n1=40), and the other involving club members (n2=96). Body composition was measured using a Tanita TBF-305, which produced data on LBM and TBF. The results indicated that: 1) competitive athletes differed from club members on back strength, vertical jump, and push ups with claps. 2) Competitive athletes had significantly higher scores than the club members on LBM and MM; club members had significantly higher scores on the limiting factors of TBF and TBW. These results help to understand the importance of body composition in a competitive sports such as judo, and the importance of reducing body fat, increasing muscle mass, and improving basic physical fitness. Obviously, the findings are helpful for success in Handball also.

The investigators Ashok & Babu\textsuperscript{26} (2000) undertaken this study at the south west intervarsity men tennis tournament held at Ayya Nadar Janki Ammal College (Autonomous), Sivakashi, Tamilnadu. Fifteen players were randomly selected and their anthropometric variables such as height and arm length were measured with the help of standardized devices. The accuracy was founded by seeing the percentage of getting success in the first serve during the competition. The collected data was statistically analyzed by using Pearson’s product moment correlation. The findings drawn after the statistical treatment revealed that there was – 1) very low negative correlation between the height and accuracy in the first serve. 2) Very low negative correlation between the arm length and accuracy in the first serve. 3) Very less positive correlation between the height and arm length of university Tennis players.

Brown-Miner K.\textsuperscript{27} (1989) investigated relationship of physical characteristics, physiological capabilities, and nutritional habits to female basketball team selection. 27 female from the University of Wisconsin-La Crosse participated in this study. Nutritionally, diets were analyzed. Physiological parameters examined were % body fat, lean body mass, VO2 max, anaerobic power, and vertical jumping distance. Physical parameters including age, height, weight was measure. It was concluded that, at the University of Wisconsin-La Crosse, physiological capabilities, and nutritional habits were not a major factor in team member selection.

Richardson W.\textsuperscript{28} (1977) studied the relationships between grip strength, wrist flexion, arm length and the velocity of a thrown baseball in male high school varsity baseball players. The purpose of this study was to determine if grip strength had significant relationship to throwing velocity etc. Ss were 31 high school varsity baseball players, currently in regular season play. Grip strength was measured with dynamometer. Data obtained were then analyzed by a multiple linear regression. The study concluded that grip strength had a significantly positive relationship to baseball throwing velocity.


Muzumdaar I. and Edwin M.\textsuperscript{29} (2000) selected male basketball players (n=180) in mini, youth, and junior category of Bombay region. Standard tests for testing the variables viz., vertical jump for leg power, 30m dash for running speed, agility, 12min run and walk for C.V.endurance were administered in the players. The basketball playing ability was graded (out of 10 points) by a panel of three qualified judges during the competition and the average of three judges was considered as the subjects playing ability. The relationship of physical fitness variables and playing ability was established by computing Pearson’s product moment correlation coefficient. Using ‘t’ test did comparison for mini, youth, and junior playing ability group. The result reveals that - 1) There was positive relationship between 30m dash and under basket shooting for the junior group. 2) Relationships between other physical fitness variables and basketball playing ability for the three groups were not significant 3) Mini group has a significant higher relationship between playing ability and 30m dash than the youth group. 4) The youth group has a significant higher relationship playing ability and endurance than the mini group.

Takeuchi M.\textsuperscript{30} (1988) compared physique and physical fitness of the national handball team players of Japanese national team (JH, n=17 men) with Yugoslavia (YH, n=15 men) (ranked first in Los Angeles Olympic) and West Germany (GH, n=15 men) (ranked second in Los Angeles Olympic) in Japan. Seven physique indices were measured: height, weight, girth of chest, upper arm(extended and bent), forearm, thigh, and calf. The functional indices of back strength, grip strength, and vital capacity were also measured. For height, weight, and girth of chest, upper arm (extended and bent) and of forearm JH players showed significantly lower values than YH and GH ones. As for the girth of thigh or of calf, all three team players showed about same values. For back strength JH and YH players showed almost the same values, which were significantly higher than those of GH. For vital capacity, YH and GH players showed significantly higher values than JH ones. The study concluded that in all physique indices, the players of JH evidently showed the values lower than those of the players of YH and GH, with two exceptions of the girth of thigh and of


calf. For **vital capacity**, JH players showed also apparently lower values compared those of the YH and GH players. It is thus clear that the JH players should first of all improve in the **body size** by training, or it might be necessary to collect big players in order to level up the great of the performance of the handball game, in comparison of the YH and GH players.

The study of **Housh T.**\(^{31}\) (**1990**) determines the effects of age and body weight on anthropometric estimations of minimal wrestling weight (MWW) in high school male wrestlers \((n=522, \text{ age: } 16.45\pm1.03 \text{ years})\). The total sample \((N=522)\) was dichotomized by age \((<16 \text{ years, } n=171; >16 \text{ years, } n=351)\) and body weight \((<62.60kg, n=252; >62.60kg n=270)\). Cross validation analysis included examination of the constant error (ce), \(r\), and total error (te). The result indicated that the quadratic skin fold equation of Lohman most accurately estimated MWU in each group. Furthermore, it was recommended that MWW be calculated.

The contribution of physique and associated variables to competition performance in sub-junior female gymnasts has been evaluated by **Debnath and Bawa**\(^{32}\) (**1995**) Thirty four \((n=34)\) national level female gymnasts were divided, on the basis of their competition performance scores in competition, into three groups i.e. HPG (high **performance group**), MPG (mediocre **performance group**), and LPG (low **performance group**). Age, wt, ht, arm length, leg length, arm length / height ratio, leg length / height ratio, upper arm and thigh circumferences, biceps, triceps, sub scapula, suprailliac, thigh, calf and total six skin folds were obtained on each subject. ANOVA was applied to compute significance of differences in various variables among the three groups. Scheffe’s post-hoc test was applied in those variables where ‘F ‘ ratio found were significant, to determine the significance of differences in various variables between the group. It has been observed that both the HPG and MPG are significantly older, heavier, taller, and possess significantly greater arm and thigh circumferences than the LPG. HPG has found to possess stronger physique than both the other groups which may be one of the reasons of the better competition performance of the HPG when compared with the MPG and LPG.


Kaur R.33 (2002) explores that the development of an athlete is governed largely by the constitutional factors. The data of the present study were collected through various published studies done in India and Olympic level sportsmen. Somototype characteristics of Indian sportsmen (national top level) belonging to track and field events, cycling, basketball, boxing football, gymnastics, hockey, swimming, weight lifting, and wrestling were compared with the Olympians and top-level athletes of other countries. The results of this study suggest that top-level athletes in most sports are more mesomorphic and less endomorphic. On the other hand, Indian athletes are found to be high in endomorphy, which is considered to be negatively associated with physical performance.

Sodhi34 (1991) took anthropometric measurements on 116 athletes during the national games held in New Delhi, in November 1985. Anthropometrics measurements taken on each subject were those used by Heath and Carter for evaluating a somototype of an individual. The data of the present sample have been compared with previous studies and also with those hockey players who participated in at Montreal (n=47), in basketball at Mexico (n = 63) and volleyball at Montreal (n=130) Olympic games. In each group, the players have been compared with the Olympians as well as the Indian players reported already. In about a decade the results of the study showed a trend of improvement in the body size of Indian players were still shorter in size, relatively lighter in weight and power in the development of mesomorphic comment of somatotype. Further, greater predominance of ectomorphic component was still persistent in these Indian sports.

Bose K.35 (1987) selected forty one (n=41) high school champion footballers between 14-17 yrs old by using purposive sampling technique. Among these, 13 were from Pannalal School, Kalyani, Nadia (District level players), 16 from lake view high school, Madhya gram, 24-Parganas (state & national champion & winner of Subrato Mukerjee cup in 1985). Thirty six below par school –footballers were randomly selected from Nadia district & from these only 12 were again randomly selected as control group. Morphological characteristics viz., standing height, weight, length of

lower extremities, chest, thigh & calf circumference were considered and standard procedures were adopted for the purpose. Reliability of data was assessed which is statistically accepted. The score of all 6 morphological profiles were analyzed by multivariate one-way system & for testing significance differences (non-parametric) chi–square test was conducted. From the result, it appears that all the 6 variables jointly responsible for the difference in morphological profile between state and district level footballers. Thus, morphological profiles probably play a vital roll for achieving high-performance level along with skill status being a vital factor.

Karir36 (1988) have collected data on heights and weights of seven soccer teams during interuniversity championship held at Calcutta in October 1987. The teams belonged to four zones viz: North, South, East, and West comprising of the universities viz., Burdwan, Guru Nanak Dev, Jiwaji, Punjab, Jodhpur, and Gandhiji respectively. The mean age of the winning team is 20.83 years, which is the minimum of all the teams. Similarly the players of the winning teams are the lightest and are so short in stature. The defenders and the strikers of all the seven teams are not too much different from each other. However, in most of the cases the goalkeepers are tall and heavier. While comparing the winning team players with the Olympians and Asian junior, it has been found that they are much shorter and lighter and also younger in age. Ponderal index has also been studied.

A sample of Indian hockey players (n = 206 from different states of India and organizations affiliated to Indian hockey federation) during national hockey championship 1987 was examined by Richardson37 (1977) studied the relationships between grip strength, wrist flexion, arm length and the velocity of a thrown baseball in male high school varsity baseball players. The purpose of this study was to determine if grip strength had significant relationship to throwing velocity etc. Ss were 31 high school varsity baseball players, currently in regular season play. Grip strength was measured with dynamometer. Data obtained were then analyzed by a multiple linear regression. The study concluded that grip strength had a significantly positive relationship to baseball throwing velocity.

2.3 Review related to Fitness and Performance:

Bera\textsuperscript{38} (1988) revealed that muscular power of limbs and flexibility of spine contributes to exhibits better performance in volleyball. Many sports scientists are in agreement that jumping ability of volleyball players and their ability to spike contribute more than 44\% of the game’s success (Berger 1963: 64). In fact, this is the outcome of muscular power of extremities. Rivet\textsuperscript{1978: 183-192} analyzed the fitness ability of volleyball players and recorded that 62.3\% jumps are performed while blocking ang 37.7\% during spiking. It has been further revealed that a player performance in the range of 42 to 134 jumps and the average jump by each player is 87 approximately. The success in Volleyball lies with a player’s jumping ability has been admitted by Singh (1982: 8) who started that along with reaction time, the jumping ability is indispensable during spiking and blocking in volleyball and it is the complex manifestation of the explosive power of muscles of the lower extremities.

Sandhu\textsuperscript{39} (1987) conducted a similar study to know if a higher degree of running maneuverability and agility accelerates a player’s performance to take correct stance and immediate body position in the volleyball court for acquiring a firm self-defense. This, in fact, accelerates fast sprinting ability in actual game situation and gives an additional advantage, while attacking and counter-attacking. Physiology responses of volleyball players greatly depend upon a high level of endurance as the game involves continuous bouts of play fast rate over a long duration. The aerobic as well as anaerobic functioning ability of muscles of the limbs and physiological contributes the performance ability.

Gionet\textsuperscript{40} (1978) studied the Performance in skills during jump (e.g. spiking, blocking, jump pass, dive pass) when the contact with the ground is lost demand a high level of agility and accuracy in spatial movements. In volleyball, skill is relatively more important and it’s level deteriorates while a player experiences fatigue. In fact a high level fo fitness delays the onset of fatigue and enables the player to maintain his level of skill for a longer duration to win the game. Many investigators are in opinion that

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\end{itemize}
along with the attributes if fitness, volleyball players need a good level of skill (Gill, 1976:51; Toyoda, 1971: 151; Kumar, 1985: 78).

Canadian volleyball Association \(^{41}(1981)\), studied on the involvement of a series of perceptual motor skills involving complex mental process with only the end result being “motor” in nature. The performance of any of these skills is a perceptual motor performance, and may or may not reflect the true skill of an athlete. This is not because the present level of an athlete can fluctuate as function of such factors as motivation, fatigue, attitude, and so on. However, when a coach attempts to evaluate an athlete’s progress, he tries to measure perceptual motor learning. This is achieved by observing performance and present performance. The learning, which occurs, is observed through a permanent change in the performance of an athlete in the direction of improved skill.

Lawrence W. \(^{42}(2007)\) conducted a study Relationship of Jumping and Agility Performance in Female Volleyball Athletes. Court sports often require more frequent changes of direction (COD) than field sports. Most court sports require 180\(^{\circ}\) turns over a small distance, so COD in such sports might be best evaluated with an agility test involving short sprints and sharp turns. The purposes of this study were to (a) quantify vertical and horizontal force during a COD task, (b) identify possible predictors of court-sport-specific agility performance, and (c) examine performance difference between National Collegiate Athletic Association Division I, II, and III athletes. Twenty-nine collegiate female volleyball players completed a novel agility test, countermovement (CM) and drop jump tests, and an isometric leg extensor test. The number of athletes by division was as follows: I (n = 9), II (n = 11), and III (n = 9). The agility test consisted of 4 5-meter sprints with 3 180\(^{\circ}\) turns, including 1 on a multiaxial force platform so that the kinetic properties of the COD could be identified. One-way analysis of variance revealed that Division I athletes had significantly greater countermovement jump heights than Division III, and the effect size comparisons (Cohen's d) showed large-magnitude differences between Division I and both Divisions II and III for jump height. No other differences in performance variables were noted between divisions, although effect sizes reached moderate values for some comparisons. Regression analysis revealed that CM displacement was a


\(^{42}\) Lawrence W. (2007), Relationship of Jumping and Agility Performance in Female Volleyball Athletes. National Strength and Conditioning Association
significant predictor of agility performance, explaining approximately 34% of the variance. Vertical force was found to account for much of the total force exerted during the contact phase of the COD task, suggesting that performance in the vertical domain may limit the COD task used herein. This study indicates that individuals with greater CM performance also have quicker agility times and suggests that training predominantly in the vertical domain may also yield improvements in certain types of agility performance. This may hold true even if such agility performance requires a horizontal component.

Sheppard, J. (2007)\textsuperscript{43} conducted a study ‘Twelve-Month Training-Induced Changes in Elite International Volleyball Players’ The purpose of this investigation was to examine the strength, power, and anthropometric contributors to vertical jump performances that are considered specific to volleyball success, including countermovement vertical jump (CMVJ) and spike jump (SPJ), by examining changes across 12 months in elite volleyball players. Anthropometry (height, mass, $\Sigma$7 skinfolds), vertical jump ability (CMVJ, SPJ, and depth jumps from 35 cm), kinetic and kinematic data from an unloaded and loaded (body mass + 50%) jump squat were assessed before and after 12 months of training in 20 elite male volleyball players. To examine the association between the change in each of the strength, power, and anthropometric variables with the changes in CMVJ and SPJ, a correlation analysis of the percent change of each variable with the percent change in CMVJ and SPJ was performed. A significant correlation ($r = 0.47; p = 0.04$) was observed between changes in CMVJ and SPJ. Significant ($p = 0.006$-$0.02$) improvements in CMVJ were associated with increased peak force in the unloaded ($r = 0.61$) and loaded jump squat ($r = 0.59$) and greater relative power and peak velocity in the loaded jump squat ($r = 0.49$ and 0.51, respectively). The significant increase in CMVJ was strongly associated ($r = 0.865; p < 0.001$) with an improved depth-jump ability. Significant ($p = 0.003$-$0.03$) increases in SPJ were related to increases in relative power ($r = 0.64$), peak force ($r = 0.46$), and peak velocity ($r = 0.49$) in the loaded jump and improved depth-jumping ability ($r = 0.591$). This study demonstrates that, in an elite population of volleyball players, stretch-shortening cycle performance and the ability to tolerate high stretch loads, as in the depth jump, are critical to improving jumping performance.

\textsuperscript{43} Sheppard, J.(2009)\textsuperscript{43} Twelve-Month Training-Induced Changes in Elite International Volleyball Players. Journal of research NSCA.
Johnson, T. M, (2010)\textsuperscript{44} conducted a study Effect of four different starting stances on sprint time in collegiate volleyball players. Starting stance plays an important role in influencing short-distance sprint speed and, therefore, the ability to reach a ball during sport play. The purpose of this study was to evaluate 4 different starting stances on sprint time. Twenty-six male and female collegiate volleyball players volunteered to participate in 1 testing session. Each subject performed 3 15-ft sprint trials at each of 4 different starting stances (P-parallel, FS-false step, S-staggered, and SFS-staggered false step) in random order. Analysis of variance revealed that there was no significant interaction of sex by stance, but there were main effects for sex (men were faster than women) and stance. The FS (1.18 ± 0.10 seconds), S (1.16 ± 0.07 seconds), and SFS (1.14 ± 0.06 seconds) stances were faster than the P (1.25 ± 0.09 seconds) stance, and the SFS stance was faster than the FS stance. This indicates that starting with a staggered stance (regardless of stepping back) produced the greatest sprinting velocity over the initial 15 feet. Although taking a staggered stance seems counterproductive, the resultant stretch-shortening cycle action and forward body lean likely increase force production of the push-off phase and place the total body center of mass ahead of the contacting foot, thereby, decreasing sprint time. 

Larson,\textsuperscript{45} (1967) with the institute International Council of Health, Physical Education and Recreation i.e. ICHPER, undertook an International research programmed for the standardization of physical fitness tests. A committee on the standardization of physical fitness test ICHPER was appointed to set u standards and to construct instruments for the measurements of physical fitness in 1964 at Tokyo. A survey was conducted and a report on the tentative standard was distributed to all members of the committee for review. The comments and recommendations received were discussed at the meeting held in Maaglingen, Switzerland in august, 1967. The performance tests items were developed in two parts. The basic combination of tests items includes endurance run (100 meters run-walk, 800 meters run- walk).50 mts sprint, pull-ups, (pull ups and the fixed arm hang), standing broad jump and grip strength. The following additional items for application under special circumstances are also involved: 50 meters sprint (2 min), sit-ups (25-20), repetition bench presses


\textsuperscript{45}Larson, L. (1967). An American research programme for the standardization of physical fitness tests. Canada: ICHPER, 10\textsuperscript{th} International Congress.
(15 kg press). One min trunk curl, vertical jump, 50 meters shuttle run, back strength, leg strength with belt and arm flexion strength.

**Marques, M. C. (2008)** conducted a study Changes in Strength and Power Performance in Elite Senior Female Professional Volleyball Players During the In-Season. It is often recommended that in-season training programs aim to maintain muscular strength and power developed during the off-season. However, improvements in performance may be possible with a well-designed training regimen. The purpose of this case report is to describe the changes in physical performance after an in-season training regimen in professional female volleyball players in order to determine whether muscular strength and power might be improved. Apart from normal practice sessions, 10 elite female volleyball players completed 2 training sessions per week, which included both resistance training and plyometric exercises. Over the 12-week season, the athletes performed 3-4 sets of 3-8 repetitions for resistance and plyometric exercises during each training session. All sessions were supervised by one of the investigators as well as by the team head coach. Muscular strength and power were assessed before and after the 12-week training program using 4 repetition maximum bench press and parallel squat tests, an overhead medicine ball throw (BTd), as well as unloaded and loaded countermovement jumps (CMJs). Strength improved by 15% and 11.5% in the bench press and parallel squat, respectively ($p < 0.0001$). Distance in the BTd improved by 11.8% ($p < 0.0001$), whereas unloaded and loaded CMJ height increased between 3.8 and 11.2%. The current findings suggest that elite female volleyball players can improve strength and power during the competition season by implementing a well-designed training program that includes both resistance and plyometric exercises.

**Brandao (2000)** conducted their study to identify the degree of relationship between team final standing and individual technical skills in youth basketball players. They have selected the samples of 246 Basketball players, 12 to 14 years of age belonging to 21 teams. They played

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in official Competitions of Porto Basketball Association in 1988-99. Teams were presented in 4 series of competition (A, B, C, & D) of different performance level according to their standing in a preview tournament. Technical skills were evaluated according to basketball test battery from AAPHERD. Pearson correlation and ANOVA were used as data analysis technique. ANOVA showed significant difference between series A, B, C and D; Pass (F=34.426, p=0.000), Dribbling (F=6.131, p=0.000). Scheffe’s post hoc test confirmed the previous difference among the competing groups. Pearson correlation between indicators and team final standings were: (r=0.741, p=0.000, r2=55%), dribbling (r=0.641, p=0.001, r2=41%), Shooting (r=0.722, p=0.000, r2=52%), and Different movements (r=0.219, p=0.341, r2=48%). The study revealed that there is strong relationship between offensive technical indicators (pass dribbling and shooting) and team final standings. The result presents important criterion-referenced values for pre-selection purposes in this age group.

2.4. Review related to Norms

Hornak\textsuperscript{48} (1972) evaluated the physical fitness of the 1972 Olympic men’s Team of Czechoslovakia to know the level of fitness. The test battery consisted on age, weight, height, fat percentage, reach height, 3kg. Medicine ball throw put by both hands first, with right then left hand, 350 gram ball throw with run up and without run up, broad jump, triple jump, touching the basketball board by jumping, sprint 60 mts, 1000 mts, run, step test and bicycle ergometer test. He found that these items were significantly related to their performance.

Haag and Singer\textsuperscript{49} (1979) developed a test to measure motor fitness for boys and girls representing the school in the age groups 10 to 20 years. The study was conducted with the objective to the help the children in schools and clubs to learn and develop complex motor skill by achieving basic fitness level students from grade five and eight were tested (n=580) – in order to calculate the major test criteria. The objectivity of the test was 0.999, the reliability of the test was 0.902, the validity obtained through comparison items: i) Figure – 8 run, ii) Sit-up, iii) Jumping, iv) Push-up, v) Shuttle Run and vi) Ball throw.


Thomas\textsuperscript{50} (2000) undertook construction and standardization of specific physical fitness test for soccer players. His study was confined to District level Soccer players of the age 17 to 21 years from different Districts of Kerala State. The test items were push-up, bent keen sit-up, burpee jump, standing broad jump, vertical jump, kicking for distance (football), 12 minutes run/walk, one mile run, 800 meters run, 30 meters run, 50 meters run, 70 meters run, shuttle run. Illion agility test, special agility test, bridge-up test, trunk extension test, sit and reach test, from raw score a significant difference in the means was found to exist between the test variables when applied to the successful and unsuccessful soccer players.

Rampu\textsuperscript{ty51} (1998) constructed norms in selected fitness test items for girls of age group 2-16 years in Gwalior Districts. She administrated the test on 650 students of Kendriya Vidyalaya and public schools of Gwalior Districts. The test items were flexed armed hang, curl up, sit and reach shuttle m-run, one minute run/walk 50 yard dash, standing broad jump. The data obtained was correlated following the product moment correlation method.

John\textsuperscript{52} (1965), prepared national norms for the one minute Basketball throw for goal, Pull-ups, Potato race, Standing broad jump, Standing hop step, Push-ups, and Softball target throw, items of the Y.M.C.A. National Athletic Achievement Program. Different centers of Y. M. C.A. tested 2000 boys in each age group of 8, 9, 10 years throughout the United States.

Box\textsuperscript{53} (1967) prepares percentiles norms and tales selected measures of strength, power, agility, body composition, cardiovascular and muscular endurance from data collected in five schools of the Unity Christian School system of Hudson Ville.

Veeraswami\textsuperscript{54} (1973) conducted a study to evolve physical fitness norms for higher secondary schools of Greater Gwalior. 212 male Students from four higher secondary schools and 793 male students from remaining 23 schools were selected and AAHPER Youth fitness and ICHPER physical fitness Test were administrated on


\textsuperscript{52} Mistkawi J. (1965) “Norms for eight, Nine and Ten Years Old Boys on Y. M. C. A. Athletic Achievement test,” Completed Research in Health, Physical Education and Recreation 8: 101.

\textsuperscript{53} Box.D. (1967) “Physical ability Testing male Students in Grades Four Through Twelve,” Completed Research in Health, Physical Education and Recreation 9 :77

them respectively. The percentile norms for each test items were evolve for the boys of age group 13-17 years. It was also concluded that in all items except pull-ups of the AAHPER Youth Fitness, the mean scores of Indian boys in al age groups were lower than the 50th percentile of American Norms. There was a positive, But low order of relationship between physical fitness and participation I physical activities. There was a positive correlation though low \( r=0.13 \) between physical fitness and academic achievements.

Physical fitness norms for Nigerian Boys and girls of 11 to 18 years of age were constructed by Anyanwu\(^55\) (1977). The test items were Shuttle-run, Push-ups, Chair Push-ups for girls, Flexed knee, Sit-ups, 45 meters, Dash, Standing long jump, Pull-ups for boys Flexed arms for girls, 9min run, for subject 11 to 12 years and 12 min run for subjects 13-18 years. A comparison for the mean scores of the United States of the Nigerian Youth showed that of the upper age levels, the United States Youth had a better physical fitness status than their Nigerian counter parts, where as the lower level there was not much difference.

Backford\(^56\) (1976) conducted a research to evaluate the physical fitness level of Navajo girls through AHPER Youth Fitness Test. The Navajo girls of 14 to 16 years were selected from seven schools to measure physical fitness level. Also percentile norms were established on the basis of score obtained from test result. These norms were compared to national norms found in the manual accompanying the AAPHER Youth Fitness Test. The results gave an indication of the overall fitness level of 14, 15 and 16 years old Navajo girls of the seven test items. The navajo norms were found to be below the national norms on 5 items and above on the softball throw and 600 yard run/walk.

Sassi, R. H.\(^57\) (2009) conducted a study Relative and Absolute Reliability of a Modified Agility T-test and Its Relationship with Vertical Jump and Straight Sprint. The aims of this study were to evaluate the reliability of a modified agility T-test (MAT) and to examine its relationship to the free countermovement jump (FCMJ) and

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\(^{56}\) Backford.A.P, (1976), 'A Normative Study of the Physical Fitness of 14, 15 and 16 Years Old Navajo Girls Using AAPHER Youth Fitness Test,' Completed Research in Health Physical Education and research 14 : 159.

the 10-m straight sprint (10mSS). In this new version, we preserved the same nature of displacement of the T-test but we reduced the total distance to cover. A total of 86 subjects (34 women: age = 22.6 ± 1.4 years; weight = 63.7 ± 10.2 kg; height = 1.65 ± 0.05 m; body mass index = 23.3 ± 3.3 kg·m⁻² and 52 men: age = 22.4 ± 1.5 years; weight = 68.7 ± 8.0 kg; height = 1.77 ± 0.06 m; body mass index = 22.0 ± 2.0 kg·m⁻²) performed MAT, T-test, FCMJ, and 10mSS. Our results showed no difference between test-retest MAT scores. Intra class reliability of the MAT was greater than 0.90 across the trials (0.92 and 0.95 for women and men, respectively). The mean difference (bias) ± the 95% limits of agreement was 0.03 ± 0.37 seconds for women and 0.03 ± 0.33 seconds for men. MAT was correlated to the T-test \((r = 0.79, p < 0.001\) and \(r = 0.75, p < 0.001\) for women and men, respectively). Significant correlations were found between both MAT and FCMJ, and MAT and 10mSS for women \((r = -0.47, p < 0.01\) and \(r = 0.34, p < 0.05\), respectively). No significant correlations were found between MAT and all other tests for men. These results indicate that MAT is a reliable test to assess agility. The weak relationship between MAT and strength and straight speed suggests that agility requires other determinants of performance as coordination. Considering that field sports generally include sprints with change direction over short distance, MAT seems to be more specific than the T-test when assessing agility.

Singh\(^{58}\) (1988) undertook a normative study of the physical fitness of male Teenagers of the state of Jammu and Kashmir in the ages 13 through 19 years. The variables considered were, pull-ups (arm and shoulder girdle strength),, bent knee sit-ups (abdominal strength), shuttle run (agility), and 600 mts run walk test (cardio-vascular endurance). He concluded that the subjects belonging to age group 16 through 19 years showed better performance in all variables over the other age group of 13 through 15 years.

Chaouachi, A\(^{59}\) (2010) conducted a study Reliability and Validity of a New Repeated Agility Test as a Measure of Anaerobic and Explosive Power. The aim of this study was to evaluate the reliability and validity of a repeated modified agility test (RMAT) to assess anaerobic power and explosiveness. Twenty-seven subjects (age:

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20.2 ± 0.9 years, body mass: 66.1 ± 6.0 kg, height: 176 ± 6 cm, and body fat: 11.4 ± 2.6%) participated in this study. After familiarization, subjects completed the RMAT consisting of 10 × 20-m maximal running performances (moving in forward, lateral, and backward) with ~25-second recovery between each run. Ten subjects performed the RMAT twice separated by at least 48 hours to evaluate relative and absolute reliability and usefulness of the test. The criterion validity of the RMAT was determined by examining the relationship between RMAT indices and the Wingate anaerobic test (WAT) performances and both vertical and horizontal jumps. Reliability of the total time (TT) and peak time (PT) of the RMAT was very good, with intra-class correlation coefficient > 0.90 and SEM < 5% and low bias. The usefulness of TT and PT of the RMAT was rated as “good” and “OK,” respectively. The TT of the RMAT had significant correlations with the WAT (peak power: $r = -0.44$; mean power: $r = -0.72$), vertical jumps (squat jump: $r = -0.50$; countermovement jump: $r = -0.61$; drop jump (DJ): $r = -0.55$; DJ with dominant leg: $r = -0.72$; DJ with non-dominant leg: $r = -0.53$) and 5 jump test ($r = -0.56$). These findings suggest that the RMAT is a reliable and valid test for assessing anaerobic power and explosiveness in multi-sprint sport athletes. Consequently, the RMAT is an easily applied, inexpensive field test and can provide coaches and strength and conditioning professionals with relevant information concerning the choice and the efficacy of training programs.

Sreedevi\textsuperscript{60} (1984) constructed norms using the AAPHER fitness test for girl in secondary schools. Her subjects were eight girl students of VII th and IXth standard studying in Kendriya Vidyalaya, Gwalior. McCann M. R. and Flanagan, S. P.\textsuperscript{61} (2010) conducted a research The Effects of Exercise Selection and Rest Interval on Postactivation Potentiation of Vertical Jump Performance. The purpose of this study was to determine if a power exercise would lead to greater postactivation potentiation (PAP) than a strength exercise, if a 4- or 5-minute rest interval led to greater PAP, the extent to which PAP was an individual phenomenon, and the effect of PAP on the ground reaction force (GRF) during a vertical jump (VJ). Subjects included 16 volleyball athletes (8 men and 8 women)


from a Division I university. Participants were instructed to complete a pre-exercise countermovement jump for height. After the VJ, subjects performed 5 repetitions of either the back squat or hang clean (midthigh) with a load equal to their 5 repetition maximum (5RM). After the 5RM resistance exercise, countermovement jumps were completed at 4 or 5 minutes after the back squat or hang clean. Ground reaction force was measured using a force platform embedded in the ground, whereas VJ height was assessed using a Vertec jump apparatus. Data were analyzed using a factorial analysis of variance with repeated measures. Results revealed that there was no consistent rest interval or exercise that produced the largest increase in VJ height for all subjects, and there were no apparent differences because of gender. The condition that produced the largest increase in VJ height for each individual resulted in an average increase of 5.7% (2.72 ± 1.21 cm; p < 0.001). There was no significant difference (p > 0.05) in peak GRF, and no significant correlation (r = −0.110, p = 0.707) between the increase in VJ height and increase in peak GRF. Results suggest that individually determining complex training variables will increase VJ height, thus acutely enhancing athletic performance.

Monga (1984) constructed a Physical Fitness test battery for girls student (age: 10 to 14 years) of Delhi. Norms were established on a sample of 5000 girls belonging to different socioeconomic groups, age range physical standards. Both T-scale and Percentile norms were established. Validity (face validity, criterion related validity and factorial validity) and reliability of the test revealed acceptable values. The reports indicate that the test battery was found to be easily usable in school as per available facilities and equipments.

Gabbett, T. J. (2010) conducted a research on influence of closed skill and open skill warm-ups on the performance of speed, change of direction speed, vertical jump, and reactive agility in team sports athletes. In this study, we evaluated the efficacy of two different dynamic warm-up conditions, one that was inclusive of open skills (i.e., reactive movements) and one that included only preplanned dynamic activities (i.e., closed skills) on the performance of speed, change of direction speed, vertical jump,

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and reactive agility in team sport athletes. Fourteen (six male, eight female) junior (mean ± SD age, 16.3 ± 0.7 year) basketball players participated in this study. Testing was conducted on 2 separate days using a within-subjects cross-over study design. Each athlete performed a standardized 7-minute warm-up consisting of general dynamic movements and stretching. After the general warm-up, athletes were randomly allocated into one of two groups that performed a dynamic 15-minute warm-up consisting entirely of open or closed skills. Each of the warm-up conditions consisted of five activities of 3 minute duration. At the completion of the warm-up protocol, players completed assessments of reactive agility, speed (5-, 10-, and 20-m sprints), change of direction speed (T-test), and vertical jump. No significant differences (p > 0.05) were detected among warm-up conditions for speed, vertical jump, change of direction speed, and reactive agility performances. The results of this study demonstrate that either open skill or closed skill warm-ups can be used effectively for team sport athletes without compromising performance on open skill and closed skill tasks.

Das (1980) prepared norms for evaluating performances in physical fitness for classes IX, X and XI in the Government Higher Secondary Schools of the union territory of Delhi. Twenty percent of the schools in rural and urban areas in the same population were taken for this study. In each school ten percent of students were tested on the items of AAPHER youth fitness test and NPFP battery “A”. The items of NPFP were the same as included in the syllabus of central board of secondary education. Norms were prepared for the boys IX, X and XI classes and was statistically analyzed it was concluded that a comparison of the obtained data with the data of American students show that the Indian student classes IX, X and XI seems to be very poor in abdominal strength. The performance of student of class IX in all items of youth fitness tests was poor and there was a remarkable spurt of performance in classes X and XI through still than of students in the United States of America except on pull-up measuring shoulder girdle strength.

Knudson, D.V. (2008) conducted a research correcting the use of the term power in the strength and conditioning literature. Many strength and conditioning papers have incorrectly adopted the colloquial use of the term power as a measure of short-term, high-intensity muscular performance despite a long history of research and editorials critical of this practice. This has lead to confusion, incorrect interpretations, and conflicting results in the literature. This paper summarizes the scientific evidence on external mechanical power as a short-term, high-intensity neuromuscular (anaerobic) performance or training variable. Many problems in the measurement and use of power in strength and conditioning research were identified, as well as problems in the use of the vertical jump as a field test of power. A critical review of the biomechanics, measurement, and training research does not support this colloquial use of the term power. More research is needed that improves our understanding of the domains of muscular strength or neuromuscular performance, as well as partial correlation and multiple regression analyses to document the unique associations between these domains, biomechanical variables, training effects, and sport performance. Strength and conditioning research should limit the use of the term power to the true mechanical definition and provide several specific and measurement details on this measurement.

Singh (1986) prepared physical fitness norms for the high school boys and Punjab state. Data were collected on 5000 subjects from various schools in the state. The test that was administrated consisted on eight items, viz, standing broad jump, sit and reach test, agility run, sit-ups bent knee, 50 meter dash, push ups (chair), cricket ball throw and 600 meters run and walk. The percentile norms for physical fitness tests were found to be valid and suitable to assess the physical fitness level of the high school boys in the age group of 12 through 15 years.

Humphrey (1983) conducted a study to investigate the physical fitness of third grade pupils taught by specialists and non-specialists, 100 specialists and 100 non-specialists were randomly selected from 20 schools in Greenly, Colorado. The AAPHER youth was administrated consisting of following items: Sit – Ups, Sit and

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Reach, Skin Fold, One Mile Run and Walk. Comparison was made with the test result, between all subjects taught by specialists and those taught by non-specialists and between female taught by specialists and non-specialists. The two group “T” tests were used to make the comparison. Analysis revealed that the specialists group had significantly higher scores. The specialist males scored significantly higher on sit-ups and reach, skin fold measurement and one mile run and walk when compared with non-specialists. The specialist female scored significantly higher on the skinfold measurement then the non-specialists females.

**Jensen, Johansen, & Liwendahl** (1999) tested thirty-two players belonging to the national youth teams (Y: 17-18 or U: 19-20 years), age: 18.4±0.7 years, height: 188±6 cm and weight: 83.7±8.4 kg (mean±SD), at least twice for physical performance in February 1997, 1998 or 1999. Team Y was placed 6 in the European championship in 1998, while Team U won the world and European championship in 1997 and 1998, respectively. Physical performance parameters were measured during maximal treadmill running: oxygen uptake ($V_{O2max}$), running time ($T_{max}$), blood lactate ($Bl_{max}$) and heart rate ($HR_{max}$). Furthermore, sprint time over 5 and 30 m ($T_{5m}$ and $T_{30m}$), counter-movement jump without load and loaded with half the bodyweight (CMJ and $CMJ_{\frac{1}{2}BW}$), shooting velocity in 3 shots: standing, after 3 steps and after a jump ($S_{ST}$, $S_{3S}$ and $S_{JU}$), and a 30 m shuttle run with increasing speeds between markers until exhaustion ($30m_{shuttle}$) were performed. Strength was evaluated as one repetition maximum (1RM) in power clean, squat and bench press. No difference was seen in Body fat, $V_{O2max}$, $Bl_{max}$, $HR_{max}$, $T_{5m}$, $T_{30m}$, CMJ, $S_{ST}$, $S_{3S}$ and $S_{JU}$ (P>0.05), while body weight and fat free mass increased by 1.6 and 2.0 kg or 1.9 and 2.9%, respectively (P<0.01). $T_{max}$, and $30m_{shuttle}$ increased 22 sec and 354 m or 4.9 and 8.6%, respectively (P<0.05). $CMJ_{\frac{1}{2}BW}$ increased by 1.4 cm or 9.9% (P<0.001). 1RM increased by 8, 14 and 7 kg or 11, 14 and 9% in power clean, squat and bench press, respectively (P<0.001). Accordingly, after one year of training the players increase body weight and fat free mass and variables related to strength such as $CMJ_{\frac{1}{2}BW}$ and 1RM in strength exercises. Time to exhaustion in maximal treadmill run and distance covered during shuttle run also increase. However, no changes are seen in functional exercises as 30 m sprint and different shots. Aerobic work capacity per kg body

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68 Jensen, K., Johansen, L and Larsson, B. (31 Oct.-5 Nov., 1999). *Physical performance in Danish elite team handball players.* 5th IOC World Congress on Sport Sciences with the Annual Conference of Science and Medicine in Sport, Sydney, Australia.
weight is maintained although body weight increases. It is concluded that successful players competing at international level in team handball is depending more on changes in variables alluding to strength properties rather than on variables related to aerobic capacity.

Singh\(^69\) (1997) assessed the performance and fitness of 11-14 years old swimmers according to German standards. Data was collected on 160 swimmers (80 boys and 80 girls) by conducting a battery of tests (50m free style, 50m back stroke, 50m breast stroke, 50m butter fly, 60sec chin up, 60sec sit up, 30sec jumping sideways over the bench, 60sec push up, 60sec upper body lift, 60m dash, and 2000m run) used in Germany. The results revealed that Indian swimmers are much inferior to their German counterparts and swimming performance of Indian girls is very poor. On the whole the study indicates that the training and competition system for young swimmers needs comprehensive revaluation and change.

Singh\(^70\) 1994 aims at comparing the attackers and set-uppers in volleyball with regard to motor 7abilities. 44 male volleyball players (22 attackers and 22 set-uppers) of university and state level were volunteered as the subjects. Ten motor ability tests were conducted on the subjects to compare the motor abilities along with age, body weight, and standing reach of the subjects. The findings indicate that attackers are significantly younger, heavier and taller than the set-uppers the attackers and set-uppers do not differ significant in the test except basketball throw. On the whole, attackers are better in 40m sprint, vertical jump, and vertical jump with approach, basketball throw, three consecutive long jumps, 9-3-6-3-9m agility test and 2.4 km run. On the other hand, set-uppers are better in block jump, forward bend and reach, and bent knee sit up (60 sec).

Shondell\(^71\) (1972) investigated the relationship of the selected motor performance and anthropometric traits to successful volleyball performance. 23 tests and measurements were administered to 93 college students. Multiple ‘r’ techniques were employed and regression coefficients determined. A two phase cross validation procedure determined the test battery used to predict volleyball potential using 45 Ss. Phase 2 of

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the cross validation utilized 2 divergent group to determine weather the test battery discriminated between highly skilled and beginning players. A four item battery consisting of the medicine ball toss, 30 yard dash, zigzag run, wall catch, vertical jump, and weight was also a reliable battery for predicting volleyball potential of the college men at Ball state university.

Stanley (1999) made a comparison of different fitness components between state level (n=13, age=16.23 yrs) and district level (n=10, age=17.10 yrs) female tennis players. The fitness components measured included: maximal aerobic capacity (graded treadmill test to volitional exhaustion with direct oxygen analysis), strength (grip strength), power (vertical jump), speed (20 yard dash), muscular endurance (60second sit-up), agility (spider test), flexibility (sit and reach) and body composition (restricted anthropometric profile). A questionnaire was also administered to determine fitness training habits and attitudes to fitness. A series of unpaired t-tests found no significant differences between the groups on any of the body composition or fitness variables. The only significant difference occurred with the subjects playing age where the state group had been playing tennis for a significantly longer time (8.46 yrs) than the district group (6.55 yrs).

The purpose of this investigation Fedotova (2000) was to study the age trends in development of physique and fitness of young female athletes practicing field hockey and to detect the significant differences between both age groups and field position groups. Data were collected on 135 subjects aged between 10 and 18, practicing hockey in special sport schools of Olympic reserve in Moscow. All of them have been studied for height, weight, lengths, breadths, girths, skin folds, body composition, physical work capacity (PWC170), respiratory performance (vital capacity), grip strength, and explosive strength were collected .It was found that hockey players of all age groups have higher values of humeral breadth, % muscle mass, grip strength, explosive strength, PWC170, and lower value of % fat and pelvic breadth than non athletic girls of similar age groups. Compiling the results of intrasportive differences in physique and fitness of young female hockey players it is found that the different

72 Stanley, M. (31 Oct.-5 Nov., 1999). Fitness profiling and comparisons between different standards of competitive junior female tennis players. 5th IOC World Congress on Sport Sciences with the Annual Conference of Science and Medicine in Sport, Sydney, Australia.

categories of players (forwards, halves, backs, and goalkeepers) are significantly
differ in some of parameters studied only from the age of 15-1+ (after 6-7 years of
practicing in hockey). The findings are useful to coaches who are working with young
female hockey players. It can also be used or sport selection and for controlling the
effects of practice.

**Uppal and Datta** (1988) identified motor fitness components, which can help in
prediction of performance in hockey. Male hockey players (n=74), studying in
different universities of India were exposed to motor fitness components: Speed (50-
yard dash), strength (right and left hand grip), Power (standing broad jump), Agility
(dodge run), Dynamic balance (Johnson modification of Bass test), Flexibility (trunk
and shoulder) and kinesthetic perception (a test of horizontal distance). The criterion
measures were playing ability in hockey, which was based on the Strait field hockey
tuning scale. The analysis of data using zero order and multiple correlations revealed
that playing ability in hockey is significantly related to speed (r=-0.29), right grip
strength (r=0.29), left grip strength (r=0.47), agility (r=0.30), balance (r=0.27), and
kinesthetic perception (r=0.29). Playing ability in hockey is not found to be
significantly related to power (r=-0.19), flexibility (r=-0.10), and shoulder flexibility
(r=-0.16). The analysis of data further revealed that the combined contribution of left
grip strength, balance and speed to playing ability in hockey is significant at 0.05
level of confidence. Conclusion: 1) the motor components, namely speed, grip
strength, agility, balance, and kinesthetic perception contribute to playing ability in
hockey where as power and flexibility do not underlie performance in this game. 2)
Speed, left grip strength and balance taken together, contribute most to the playing
ability in hockey. 3) It is possible to predict playing ability in hockey based on
performance in selected motor fitness components.

**Shergill** (1992) established the importance of a set of specific physical fitness
components as contributors in hockey playing ability. On the basis of available
literature, 22 relevant test items were selected to measure fitness components. The
sample consisted of 100 female hockey players, from 4 universities of Punjab. The
age of player’s ranged between 18 to 24 years. The stepwise regression was applied to

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performance.* Book of Abstracts: Pre-Olympic Congress, 2000, Brisbaen, Australia:
International Congress on Sport Science, Sports Medicine, and Physical Education, pp. 58.

**Shergill, H. et al., (1992).** *Identifying specific physical fitness predictors of hockey playing ability.*
assess the importance of different variables in predicting hockey playing ability. The result of ‘t’ ratio suggested that endurance run test, standing broad jump, grip strength (LH), vertical jump, wrist flexion, age, height, and weight were significantly important in evaluating the hockey performance. Also, the results failed to find support for speed as an important predictor of hockey playing ability. The result of this analysis again stresses the positive role of physical fitness components in hockey playing ability.

Calderia and Mastudo76 (1988) analyze the changes on the physical fitness variables in elite volleyball players. The athletes from the 1987 national Brazilian team were submitted to a battery of tests. Data from each athlete included: weight, height, skin fold thickness, arm and calf circumference, predicted VO2 max I (min)-1 and ml. (kg min)-1 (ml), 40 sec run test, 50 m run test, vertical jump with and without the help of arms, long jump and shuttle run. Data were compared to the national volleyball team who had participated in the 1980 Olympic games in Moscow. The results showed a better situation of the 1984 Brazilian Olympic team in muscle mass; velocity (50m); aerobic (VO2) and anaerobic (40 sec) power.

2.5 Review Related to Norms of Different Sports – skill Tests:

Hewitt77 (1966), Dyer78 (1935), Aloia79 (1975), Digennaro80 (1969) all these researchers have done researches on various variables. Hewitt used test retest method to established reliability. Reliability was 0.75. Dyer has been designed to measure ability in tennis classification purpose. Validity was determine by two methods correlating the test score with the judgment of three experts and correlating the last score with standing of the subjects in a number of round robin tournament reliability was computed by the test retest method. Digennaro construct forehand service test male volunteers N=64 at the beginning level test retest method used for reliability.

Broerd miller devised a test of tennis ability with college women he used criteria of judges ratting. Miller\(^{81}\) (1950), French & Stalter\(^{82}\) (1941), Bobrich\(^{83}\) (1972) constructed wall volley test for the game of badminton. Three 30 sec. trial will given with 30 sec. for college girls criterion of tournament play validity reliability reported .83 .94 respectively. French constructed short serve test in badminton to measure ability to serve accurately and low. The reliability was 0.96 reliability will not hold up well for beginner players Bobrich developed Badminton observational rating scale validity was estimate on test retest basic using three qualified judges. French and Stalter constructed test of footwork wrist action and smash in ability to supplement the previously validated French tests items and from a battery of skill test in badminton to measure playing ability. French constructed a short serve test in badminton to measure ability to serve accurately and low. Validity and reliability was not hold up well for beginning players. Bobrich development badminton observation rating scale to measure total skill development as double badminton game reliability was estimate test retest method with three qualified judges.

Singh & Durehe\(^{84}\) (1985), Nirmala\(^{85}\) (1985) constructed skill test on hockey Singh constructed 2 items test in field hockey test were correlate with expert rating by the Pearson product moment method. Dureha constructed objective skill test in hockey. Objectivity was established by administrating the test in the survey manner with help of experts. Validity was found comparing the test result with expert opinion in playing situation.

Marcelino, R., Mesquina, I., Afonso, J.,\(^{86}\) (2006) conducted a study titled the weight of terminal actions in Volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005 the purpose of this paper was to study performance levels in scoring skills in the Volleyball World League 2005, and to

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relate the results to the teams' final ranking in the tournament. The sample consisted in 33745 actions, distributed by serve (n=12434), block (n=7200), and spike (n=14111), having been recorded during 72 World League 2005 matches. Both absolute (number of successful and unsuccessful executions) and relative (coefficient of performance, percentage of successful executions and percentage of unsuccessful executions) variables have been considered for the three dimensions (spike, serve, and block). Team ranking has been calculated for each variable. Also, each team's final ranking in the tournament has been considered. The results permit us to conclude that the spike is the best indicator of success in high level volleyball, but only when considering relative measures. Simultaneously, the number of block points per game proved to be a good indicator of success in volleyball. Finally, the number of serve errors and the percentage of serve points are associated with the team's tournament ranking. That is, the best teams fail a higher number of serves, but also win more points with this action.

Hopkins87 (1974) investigated development of a wall volley test for skilled male lacrosse players. The Ss (n=39) for this study were college varsity lacrosse players with two or four years of experience from four N. E. teams. All Ss were administered a test of stick handling ability. Each Ss score was based upon accuracy as well as the number of times the ball hit the wall. Six trails were given. The reliability of the test was 0.97, and rho was found to be 0.65. the t test was focus to be significant (p<0.01) indicating a difference in test performance between the two groups.

Sandhu88 (1987) constructed Motor fitness battery for female volleyball players. The subject of her study were 300 volleyball players. The subjects representing different colleges o the State of Punjab. They were from different universities of Punjab and their age was ranged from 17 to 21 years. Factors analysis were used to construct motor fitness test. The subjects were tested on 27 different items of motor fitness test through the factor analysis technique. 10 factors were expected after an orthogonal rotation of maximum loading were selected for test battery, which consisted of seven test namely, spike jump, W. M. run, W. M. Agility, Push-ups, 20 meters run, the stick test and bend and reach test. The scientific authenticity of the test was establishing by computing reliability, objectivity, validity and specificity. For preparation of the

norms 300 female volleyball players were selected. The Hull-Scale and T-Scale were used to prepare the norms for different test items for college female playing volleyball.

Kowert⁸⁹ (1962) constructed a badminton ability test battery for men. The judges rating scale yielded reliability co-efficient of 0.38 when correlated with the class rankings of the subject’s playing ability. An ‘r’ of 0.97 was obtained for the reliability of the Judges’ rating scale as determined by the interclass correlation between the sum of the three judges rating and the scores obtained for the diagonal run. Millar’s Wrist Volley and French’s Long Service Tst, was 0.84. it was found that the Badminton playing ability of the male college students (N=46) could bne successfully measured by the multiple refresh ion equation containing the variables of the diagonal run test. French’s Long Service test and Miller’s Wrist Volley test.

Corner and Cureton⁹⁰ (1945) developed a motor fitness test for high school girls. The test consisted of two forms- a single period test of 6 items and a double period test of 12 items. The test comprised of following paired items Foot and toe balanced and Dizziness recovery, trunk extension and trunk flexion, kneeling and jump and Illinois agility run, sit-ups and kneeling push-ups, basketball throw and standing broad jump and squat thrust (30 second) and Brouka step test. Test items correlation with the composite items scores ranged from .39 to 62 Percentile norms based on a limited sample were available.

Shore Jr.⁹¹ (1972) constructed a test battery for assessing motor fitness for boys in the lower elementary grades. Seven factors were revealed and two test batteries were formed. Test batteries included were Clarke’s Strength Composite, McCloys Endurance Ratio, Well’s Sit and reach Test, Leg Flexion-Extension etc. the battery two was made of three hundred yard run balance on stick, flexibility test modified push-ups etc. both the motor fitness test batteries for elementary grades were highly valid.

⁸⁹ Kowert, (1962) “Construction on badminton ability Test Battery for the Men” Completed Research in Health, Physical Education and Recreation. 11 : 211.
Patrick (1972) constructed a motor fitness test battery for the girls in lower elementary grades. The following items were included in these tests. Clark’s strength composite, McCloy’s endurance ratio, Leg extension and flexion, Well’s sit and reach, Dodging run, bass length wire-stick balance and vertical jump. The test measured the essential components of motor fitness such as muscular strength, muscular endurance, cardiovascular endurance, flexibility, agility, balance and power.

Sharma (1987) constructed and standardized specific physical fitness test for Badminton Players. He used factor analysis technique on the data of 100 Inter College District badminton players of north India, as many as 7 factors specific physical fitness were obtained, out of which, 5 were considered as meaningful to select test items from each factor 1 test items having the highest loading as included in the test battery, from each factor. The test items thus derived were applied on 500 badminton players to develop the norms. The selected five factors were Trunk Strength, Flexibility Badminton agility, Badminton endurance and Arm-leg explosive strength and the test items selected endurance specific physical fitness test for the badminton players were Sit-ups, Court agility Trunk Flexion six corners endurance and softball throw. Factors analysis technique was used to select the test items out of twenty variables.

Thomos (1995) constructed a specific test battery of motor fitness for Hockey players. He took forty-five Intercollegiate Hockey Players of Jiwaji University Gwalior. The multiple correlations yielded five specific motor tests, namely Speed, Endurance, Power, Flexibility and Agility are deemed to be meaningful in representing the specific motor fitness of Hockey Players. All the Five test (20m run, Six Point run, Two hand medicine ball throw, Trunk Flexion and Court Agility) showed high significant relationship with the ability to predict the specific motor of Hockey players.

Shohei\(^{95}\) (1988) established the performance probability curve of some skill in athletics. In their study large sample (N=295) have been collected on athlete on short distance run, jumping and throwing events. Data were arranged by time series in each athlete, and measure of central tendencies and variability were calculated with every successive data based upon normal distribution. Probability of records around mean was calculated with given SD. These probabilities were collected in each record, and tried to fit logistic function to them. Standard error of estimate was evaluated for each compared between the athlete of some event. The study calculated that 1) Proper application of logistic function was of 35 cases among 152 athletes who had enough data to apply logistic function. These curves did not cross each other, and the intervals between the curves were almost same. 2) Standard error of estimate for proper application was about 0.05. 3) Error was greater in record which had only low probability. 4) Development constant, Denominator involved in logistic function was different significantly among the athlete to the same event. 5) It was supported that the maximal slope of the curve was one of the indices representing ones own athletic ability of each athlete.

Doed\(^{96}\) (1991) investigated a factor structure of selected beginning-level racquetball skills in the domain of human motor performance to identify the robust factors in that domain. A battery of ten experimental variables was administered to 230 male and female university beginning level racquetball players. Results of the study showed that there was a difference in the factor structure for male and female. It was recommended that racquetball skills tests with higher reliability be developed be used as similar study be replicated on intermediate and/ or advanced level players. Finally, it was recommended that stricter guidelines be developed to differentiate between beginning-level and experienced players.

Gregory\(^{97}\) (1978) developed of a skill achievement test for beginning skiers on an artificial surface. 73 randomly selected beginning skiers were tested with a 16-item test battery, which was composed of suggestion form selected expert skiers. Rs between the subjects’ scores on the 16-item test battery and the total test scores

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resulted in the highest values. 6 items were selected from a cluster analysis as representative of the most divergent skills of the items constituted the final test battery. Test reliability was determined by test-retest of the initial Ss. Additional Ss (N=208) were evaluated with the final battery to essential norms. Test validity was determined comparing the expert evaluation of 87 Ss with final test battery score. The X2 test indicated “a goodness of fit” between the 5 final test items and corresponding items on the preliminary test.

Relationship between selected fundamental skills and team success in intramural junior college basketball was studied by Won\textsuperscript{98} (1988) studied the relative contribution of physical fitness and skill domain according to different skill level of handball players. Thirty three physical fitness and handball skill measures chosen from physique (6 items), muscular strength (5 items), muscular endurance (3 items), muscular power (5 items), agility (3 items), balance (3 items), flexibility (3 items), cardio respiratory (2 items), and handball skills (4 items) domain were tested on national representative (N= 21), University (N= 34), high school (N= 30) handball players. In order to investigate the relative contribution, communalities of 9 physical fitness and handball skill domains were evaluated for each different skill level group. The result indicated that degree of contribution of total variance were increasing tendency from 44.17 % to 57.08 % as the handball skill level increased. It implies that higher skill level groups are more explainable from 33 measures chosen than the lower skill level groups. In mean contribution to total variance for each 9 physical fitness and handball skill domain; physique, flexibility, cardio-respiratory endurance and handball skill domain were relatively high (11.50 % to 14.45 %), agility, muscular strength and endurance domains were moderate (10.65 % to 11.50 %), muscular power and balance domain were relatively low (8.88 % to 9.70 %). But these tendencies not always same each different skill level group.

Gabbett, T., Georgieff, B., Domrow, N.,\textsuperscript{99} (2007) studied the use of physiological, anthropometric, and skill data to predict selection in a talent-identified junior volleyball squad the aim of this study was to determine whether physiological,


anthropometric, and skill test results could discriminate between junior volleyball
players of varying ability. Twenty-eight junior volleyball players competed for
selection in a talent-identification volleyball program. Participants underwent
measurements of stature, standing reach stature, body mass, skin fold thickness,
overhead medicine ball throw, vertical jump, spike jump, 5-m and 10-m speed, "T"
test agility, maximal aerobic power, and passing, setting, serving, and spiking
technique and accuracy. A discriminant analysis was conducted on the selected and
non-selected groups to obtain a regression equation that could be used to predict
selection in junior volleyball squads based on the dependent variables. Passing and
serving technique were the only significant variables included in the discriminate
analysis. Cross-validation results showed that 17 of 19 selected players (89.5%) and 5
of 9 non-selected players (55.6%) were correctly classified into selected and non-
selected groups, respectively, providing an overall predictive accuracy of 78.6%. The
results of this study demonstrate that selected skill test results (i.e. subjective coach
evaluations of passing technique and serving technique), but not physiological and
anthropometric data, discriminate between successful and unsuccessful talent-
identified junior volleyball players. These results demonstrate the importance of
developing passing and serving technique in talent-identified junior volleyball
players.

Michalopoulou, M., Papadimitriou, K., Lignos, N., Taxildaris, K., Antoniou,
P.,100 (2005) conducted a study named Computer analysis of the technical and tactical
effectiveness in Greek Beach Volleyball. The aim of the present study was to assess
the effectiveness of the technical and the tactical elements in Greek Beach Volleyball
by evaluating differences between the winning and the defeated teams. The sample in
this study included 3416 game phases that compose all the games (34 games) played
by the 10 higher-ranking teams in the Men's Greek Beach Volleyball League for the
year 2000. Data collection was performed with the use of Assess. The following
performance parameters were being recorded: 1) final game outcome, 2) serve
effectiveness, 3) reception effectiveness, 4) set effective, 5) attack effectiveness, 6)
block effectiveness 7) fake-block effectiveness, 8) defense effectiveness, 9) free-ball
effectiveness, 10) effectiveness of defense without block, 11) effectiveness of set for

100 Michalopoulou, M. Papadimitriou K. Lignos. N. Taxidaris (2005) Computer analysis of the technical
and tactical effectiveness in Greek Beach Volleyball. Journal of Sports Science, Volume 25,
Number 12, October 2007., pp. 1345-1353 (9).
counter attack and 12) counter attack effectiveness. A 4-point scale was used for the serve effectiveness and the attack effectiveness performance parameters and a 3-point scale was used for the rest. The statistical analysis of the data included one-way ANOVA, Frequency analysis and Chi – square (NPAR TEST). According to the results of this study effectiveness in serve and attack were the two technical – tactical elements that were significantly higher for the winning when compared to the defeated teams. Significant differences in effectiveness between the winning and the defeated team were revealed for the variables of lost serves resulting directly in lost points and successful attacks resulting directly in gaining points.

Zavetan\textsuperscript{101} (1988) developed a semi–automatic system for registering actions of playing. The data were sent for correlation, discriminative and factor analysis. The game efficiency of top world basketball players during Olympic Games was seen. By means of computer analysis of large statistics information, the correlative and factor structure of basketball game has been established the main factor of game efficiency has been calculated, the discriminative functions of attack and defense in basketball have been calculated. Mathematical models gave been established for evaluating the individual actions of the players. An overall scientifically based system for control and evolution of game efficiency has been offered by widely applying the multiple statistical analysis and computer technique.

Gabril\textsuperscript{102} (1988) examined the utility of several objective measures to predict which girls were selected for one of six junior high school basketball teams. Linear discriminate models of six coaches’ team selection were constructed from measures of basketball and athletic skills, strength, physical measures, and competition anxiety obtained during the first week of practice. These models provided greater than chance agreement with coaches’ player selection for each team (87%-93% correct classification). A cross modeling procedure revealed that the six coaches selections could be modeled in terms of one of three approaches to selection: 1) Select the aspirants who possess the best basketball skills (3 teams). 2) Select the aspirants with greatest size and strength and least competition anxiety (2 teams). 3) Select only the


aspirants with both types of attributes (1 team). The results indicate that it may be
difficult to identify a single set of measures to select skillful or potentially skillful
basketball players, because of differences in how coaches might choose to define
these terms.

Christian\textsuperscript{103} (1980) constructed and evaluated of a soccer skill test. The purpose of
this study was to construct a valid, reliable, and objective test battery to measure the
soccer skills of passing, shooting, and heading. Forty-five male students were
administered the soccer test battery. Fifteen subjects were selected randomly from
each of the following sub-groups: The Appalachian State University (A. S. U.) varsity
soccer team, A. S. U. intramural divisional championship teams, and A. S. U. physical
education soccer classes. The criterion measures were judge’s ratings according to
subject’s performance in passing, shooting, and heading during actual games played
at A. S. U. The rater agreement (R=0.85) was determined with an intra class
correlation coefficient using ANOVA techniques. The reliability and objectivity
coefficient, which were determined with an intra class correlation coefficient using
ANOVA techniques ranged from 0.90 to 1.00. Construct validity for each test was
established using ANOVA for the known differences among performance groups.
Resulting F ratios were significant at the 0.01 level for each test performance when
broken down by groups. The contrasted mean score differences obtained for the three
distinct groups supports the assumed constructs of passing, shooting, and heading as
logical and statistically valid measures for men’s soccer playing ability. Therefore, the
score test battery appears to be a valid, reliable and objective assessment of passing
shooting, and heading skills for men’s soccer.

Hensley\textsuperscript{104} (1982) studied characteristics of selected tennis skill tests. The purpose of
this study was to investigate gender differences in performance on selected tennis skill
tests and to identify underlying components of tennis playing ability. Fourteen tennis
skill tests purporting to measure the fundamental skills required of a beginning level
tennis player, were administered to 36 males and 44 females enrolled in a beginning
tennis class at the collegiate level. The were then analyzed by the following factor-
analytic techniques for each sex groups and for the combined sample: alpha factor
analysis, canonical factor analysis, and maximum-like hood factor analysis. It may be

\textsuperscript{103} Christian, V. (1985). The construction and evaluation of a soccer skill test. Abstract Research Paper,
AAPHERD convention, pp.167.

\textsuperscript{104} Hensley, L. D. (1982). Characteristics of selected tennis skill tests. Abstract Research Paper,
AAPHERD convention, pp.98.
concluded that the tests selected in this study were measuring the same skill components and consequently, were not sex biased.

**Chapman**\(^{105}\) (1980) investigated the development of a basketball battery for middle school students. This study was undertaken to devise a standardized and utilitarian battery of test items that could be used as an aid in selecting players, equating teams, grading, and measuring progress or for motivational purposes. Male 9\(^{th}\) grade students (n=58) at a SHS were tested on a battery of 8 test items and measured on certain anthropometric items, the results from which were correlated with a subjective rating by coaches of the Ss ability to play basketball in the game type situation. A 0.73 correlation between the composite 8 items battery scores and subjective rating found. Therefore 8 items test battery be used as standardized basketball battery. Factor of age, and weight were relatively unimportant to the criteria.

**Maccormack**\(^{106}\) (1977) established the relationship of selected hockey skills to success in ice hockey. A battery of selected basic skills in ice hockey was administered to 60 members of the St. Lawrence university hockey school, representing two age levels, 11-13 years and 14-16 years. Data were collected at the end of both the 1\(^{st}\) and 2\(^{nd}\) week the hockey school. Objective rating of the Ss on the skill test were then compared to the subjective rating made by qualified coaches as a measure of playing ability. Final multiple correlation of coefficients for the 11-13 yrs old boys (r=0.71) and for the 14-16 yrs old boys (r=0.74) were determined variables added significantly to the regression equation (p<0.01). It was concluded that an ice hockey skill test battery was found to be reliable and valid measure of ice hockey playing ability.

**Battles**\(^{107}\) (1980) investigated the prediction equation for selection of intercollegiate basketball team members. Subjects for this investigation were 33 females who were participating in women’s basketball at three colleges in Florida; all were members of the FAIAW. Each subject completed a personal data form, the AMI, the Knox basketball test, Sargent jump test, and the field goal speed test. Selected anthropometric measurements were also obtained from each subject. Results of step-


wise multiple regressions indicated that players ranked high by head coaches tended to score high on a combination of physical and psychological variables.

Brar\textsuperscript{108} (1988) established a prediction equation for Basketball playing ability at University and national level in India. He tested fifty four (n1 = 54) University level female players and fifty one (n2=51) National level female players. The basketball playing ability of the selected player was rated by appointing a panel of three judges the AAPHER Basketball Skill test items, selected motor fitness components and Eysenk Personality Inventory were administrated to subjects. Correlation matrix for the playing ability and selected variables was prepared. Multiple correlations were calculated with the help of Wherry-Doclittle method and prediction equation was computed. The result revealed as R of 0.981 for University level players between playing ability and push for accuracy, under basketball shot, foul shot, speed test and cardiovascular endurance. An R of 0.988 was achieved for National level players between playing ability and double push pass for accuracy, front shot and power test.

Man-Won\textsuperscript{109} (1988) investigated relative contribution of physical fitness and skill domain according to the different skill level of Handball players. The investigator selected some physical fitness and handball skill measures from physique (5 items), muscular strength (3 items), muscular power (5 items), ability(3 items), balance (2 items) and handball skill (4 items) domain were tested on national representative (n1 = 21), university (n2=34) and high school(n3=30) handball players. Product movements correlations between 33 measures were computed separately for each group and principal component factor analysis and normal varimax criterion procedure of the orthogonal rotation were applied in order to investigation the relative contribution, communalities of 9 physical fitness and handball skill domains were evaluated for each different skill level group. The result indicated that degree of contribution to total variance were increasing tendency from 17% as the handball skill level increased. It implies that higher skill level groups are more explainable from 33 measure chosen than the lower level groups. In mean contribution to total variance for physical fitness was relatively high (11.5% to 14.45%) than the handball skill domain.


Luhtanen\textsuperscript{110} (1988) studied individual skills, understanding of the game and team skills of 138 Finnish national level junior soccer players (Age: 8-19 yrs). The terms in different age categories played six matches, which were recorded by video and coded for off-line computer software. All actions with ball were analyzed using different classified scales related to skill maneuvers. Selected technical skills, physical abilities, decision-making velocity and understanding of the rules and game were measured. The total amount of actions with ball in this study was 4800. On the average in one game with their own rules the players executed 29 passes, tried 34 recoveries of ball, executed 5 dribbling, 2 shooting for goal, tried 20 interceptions, and executed 4 dead balls. A goal executed on average 13 savings. Relatively players succeeded in their attempts as follows: passing 50%, recovery of ball 69%, dribbling 38%, shooting technically 66%, scoring 8%, interceptions 59%, dead balls 58%, and goalkeepers saving 82%. The average duration of actions with the ball was only 0.9 seconds. The mean distance covered in one action (pass and dribble) was 15 meter. The correlation coefficients between total technical skill tests were as follows: bouncing the ball 0.938, combined dribbling-wall- passing-shooting 0.889, passing0.877, and heading 0.501. The age was in more significant relationship between the successful skill maneuvers and understanding of the game than the years to play and practice. A combined dribbling-wall- passing-shooting test had the highest correlation ($r=0.504$) to the amount of successful pass in the game. The starting velocity in sprinting and dribbling test explained most of the success in the passes and dribbling. In conclusion, it could be stated that the players with tests are starting and decision making velocity and better ball control might have more time in the game to read the game and to execute the purposeful decisions for the existing situation than the players with lower corresponding velocities and skills.

McDonald\textsuperscript{111} (1969) investigated the development of skill test for the badminton high clear. Test for measuring success on the high clear was established using measures of height and 7 of distance. College women (N=119) at 2 levels were tested. Test reliability for 12 methods of scoring for the whole group ranged from 0.73 to 0.83. F ratios indicated a highly significant difference between the 2 groups on all 12


variables. Scores on the test were correlated with results on a bigger tournament and ranged from 0.63 to 0.74

Cox (1974) established the relationship between selected volleyball skill components and team performance of men’s Northwest “AA” volleyball teams. A purposive sample of 107 games between the best “AA” men’s teams in each of 9 northwest volleyball tournaments was charted. The results of the study indicated that; consider together, the volleyball skills studied was significantly related to team performance. Further analysis of nature of the relationship revealed that the order of the volleyball skills most influential in predicting team success.

In a doctoral research Wangwad (2001) assessed and evaluated the morphological variables (i.e. height and weight), physical fitness (i.e. speed, leg power and agility), and skills of volleyball, establish a standardized norms for selection of junior volleyball team of state level. The male volleyball players (n = 272) below the age of 18 years participated in Maharashtra state volleyball championship in 1998 were the subjects of this doctoral study. This ensures that 100 % population was covered in this study. Standard procedure was followed to conduct test items for the collection of data. Standing body height (cm), body weight (kg), fifty-meter dash (speed), 4x10m shuttle run (agility), jump and reach (leg power), and volleyball skills (i.e. under hand pass, upper hand pass, serving, reception and service, set for spike and smash) were measured by using standard tests. The selection criteria as developed and standardized in this investigation is a reliable and valid, tests that can be objectively assess the efficiency of volleyball players to get entry in state level junior volleyball team. The norms of the selection criteria were easy to grade that can discriminate talented volleyball players with optimum accuracy so as to constitute a standard junior volleyball team.

From the above studies it is clear that various researches on volleyball regarding test construction, physical fitness testing have been done at international level. But the researcher finds that no similar study was done on Indian/Maharashtra state. Considering the popularity and status of volleyball game in Maharashtra state a study on related to volleyball in connection with regarding norms is essential. Hence the


study titled Development of norms for selection of senior volleyball players in Maharashtra undertaken. The following chapter describes the methodology used for the current study.