CHAPTER - II
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REVIEW OF RELATED LITERATURE

Research scholar made very sincere efforts to locate both critical and allied literature pertaining to the present study. Relevant studies reviewed from the library of Lakshmibai National Institute of Physical Education, Gwalior and the National Institute of Sports, Patiala have been cited below:

Sprague\(^1\) investigated the ways of examining the relationship of swimming speed in all four competitive strokes to body measurements. The speed included times projected from the ratios of actual times to age group records, the age predicted residuals of those projected times, and the derived ratios themselves. In addition, the actual 100-yard freestyle times and the age predicted residuals of those times were used as dependent variables. Independent variables were entered in several ways and at least once as raw scores and the residuals of age related variables were also entered as independent variables. The Anthropometrical measurements taken were height, weight, sitting height, lower leg length, foot length, arm length, forearm length, waist girth, chest girth, hip girth, upper arm girth, thigh girth, wrist girth, ankle girth, hip width shoulder width and chest thickness.

The results of the study showed foot length and bicep size as the most consistent physical measures. Each was found significant in at least one analysis for each stroke. In each case longer feet were associated with slower times and larger biceps were associated with faster times.

Yachter et al. conducted a study on 25 male swimmers of varying ages to find out the value of power training and stroke training in determining the appropriate training procedures for competitive swimmers. Swimmers were tested on their strength, height, weight, segmental swimming and 50 yards swim. The required swimming velocity was acquired by measuring 5-yard interval the 50-yard sprints. Their swimming velocities were transferred into Fraud numbers so that the swimmers could be compared independent of their length (standing height from floor to fingertips).

The results of the study suggested that: strong-inefficient swimmers should emphasise more on stroke technique and not on further strength development, where as Weaker-inefficient swimmers should train a combination of stroke technique and strength development.

Scott studied 26 senior high school male swimmers who bettered or equalled the time of 56 seconds for 100 yards crawl stroke. They were tested

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for the flexibility of ankle, knee, hip, trunk, and shoulder followed by strength test of knee, hip, shoulder, and trunk. Upon completion of tests the swimmers were timed for 100-yard kick, pull and swim. It was concluded that certain flexibility measures were significantly related to swimming time. However, it was determined that knowledge of flexibility and strength measures could not be used to predict 100 yards crawl stroke time.

Carlin\textsuperscript{4} investigated the effect of body composition upon the efficiency of water treading. The subjects were 8 trained swimmers with their age ranging between 9-15 years. Cardio-pulmonary responses of treading water were compared to that of treadmill walking. Physical factors under analysis were body surface area, height, weight, body density, percentage fat, and lung capacity. Analysis indicated that efficiency of treading water was best related with their body height.

Manly\textsuperscript{5} conducted a study on 11 varsity swimmers of Virginia Polytechnic Institute and State University boys who were members of several Blacksburg and Virginia area AU Youth Group Swimming Teams, to determine the relationship of selected metabolic, pulmonary and


anthropometric factors to performance in 100 yards butterfly swimming event. It was concluded that maximal breathing capacity was the only predictor in the youth group swimming performance at the 0.05 level of confidence. The stepwise multiple regressions revealed that strength, somatotype index, bitrochantric, oxygen debt and maximum vital capacity are contributing factors to performance in 100 yards butterfly swimming event. Further, a high multiple-correlation, vital capacity, oxygen debt and strength performance in 100 yards butterfly swimming.

In order to study the effects of selected biological, psychological, and sociological factors on the learning rate of beginning swimming Vander stork conducted a study on 37 Negro male freshmen enrolled at North California Agricultural and Technical State University, Greensboro. The biological factors were limited to the floating ability of the subject as measured by the turtle-prone float combination. The sociological factors focused on the individual's level of aspiration and certain family and environmental background data. The psychological factor of general anxiety was measured by IPAT-8-Parallel Form Anxiety Battery and a ten-point fear rating scale, developed by the investigator for this study.

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An initial period was used for preliminary tests. Later there were five weeks of instruction during which front crawl was taught according to the American Red Cross Manual. The classes met twice a week for thirty minutes each. Performance improvement was recorded at the end of the third, fourth and fifth week by measuring the distance the subject could swim the front crawl.

Analyses of variance and correlation were the statistical techniques employed. The 0.05 level of confidence was accepted for indicating significance. A descriptive analysis was used to describe the sample in terms of sociological factors such as previous swimming experience, family background, and desire to learn to swim. A graphic presentation was included to show the relationship between selected sociological factors, as well as a pictorial presentation of the swimming improvement over the five weeks.

The findings of the study indicated no significant correlation between the floating ability and the rate of learning swimming. Differences in anxiety did not show a statistical significant effect upon the learning rate. Fear seemed to be an important aspect of the learning rate. As fear diminished, the swimming performance improved. Level of aspiration was found to be a highly significant indicator of quicker learning.
In a status study made by Rossen\textsuperscript{7} on 8 champion sprint swimmers at
the University of Oregon, all swimmers were found 6 feet tall, having
mesoectomorphic body build with narrow hips, wide squared shoulders, and
long but thin legs. They had poor flexibility in their shoulders and ankles but
had smooth and coordinated movements in the water. All of them were non-
buoyant having great strength and fast reactions. They had great confidence in
themselves and set higher goals than most.

For determining the learning rate of beginning swimmers and the
relationship of this learning rate with motor ability Scott\textsuperscript{8} conducted a study on
20 non-swimmers at the University of Iowa. The subjects were taught
swimming in small classes to facilitate very close records. Lessons were
carefully timed to 30 minutes. Students were asked to continue coming one
lessons beyond the required to pass the 15-minutes test and others were
permitted to continue to rest, if they chose the group. Lessons were terminated
at 12\textsuperscript{th} to 17\textsuperscript{th} lesson for the slower learners. On the lesson following the
passing of the test, five judges observed the swimmers and rated them on form,
which was considered a measure of competence in water. All swimmers not
completing the test were also rated at the end of the series of lessons. Motor
ability was measured by Scott Motor Ability Battery. The sum of the judge's

\textsuperscript{7} Don Van Rossen, "Developing a Sprinter", Swimming world 11 (December, 1970): 5.

\textsuperscript{8} M. Gladys Scott, "Learning Rate of Beginning Swimmers", Research Quarterly 25 (March, 1954):
91-99.
ratings was correlated with the motor ability scores. The author noted some
indication that motor ability was one factor determining learning rate, but it
was not sufficient to counteract all other influences. There was a great
individual variation in learning rate and majority of swimmers could be taught
sufficient swimming skills to pass the test in 15-16 lessons or less.

Dey et al., selected 12 athletes from Swimming, Basketball, Handball,
the Table Tennis, and all the selected athletes were from first four standing
teams of the National School Games and tested for different anthropometric
measurements. The result of the study showed that Basketball player had
higher values in height, arm length, leg length, thigh-girth and weight than
those of the Handball, Swimming and Table Tennis players.

A study by Komadell conducted on 45, fourteen-year old male
swimmers in Czech Sports School revealed that swimming performance was up
to 62 per cent determined by physical development. The body weight and body
size of the swimmers were above the average for untrained lads of the same
age. Accelerated growth, combined with regular training, influenced swimming
performance for more than the assumed talent (1975).

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Schroeder\textsuperscript{11} explained varied basic physical exercise and sports instruction i.e. required as a basis for the development of good performances in a sport discipline, further the young organisms needs varied growth stimuli. They considered that maximum development of the various physical factors determining performance is possible. Since this takes cannot be performed by a particular sport or discipline on its own. Other training methods, "so called general training methods" should be used in training in addition to the training methods specific to the sport or discipline.

Trog\textsuperscript{12} said that almost all our younger ones we train them all four strokes. We feel like, with all different body types and everything it's really had to tell what they are going to swim later on. We prefer they have pretty good basic in all four strokes. We will enter them in all four events we will really try to press them into swimming the IM especially around 13 for the girls, for the guys, 14-15, we encourage them to swim the 400 IM a couple of times a year, rest to give them a feel for it. We do weights three days a week and then basic exercises for abdominal three days a week.

Kurt\textsuperscript{13} emphasized that the muscles of the trunk are important to the integrity of all competitive strokes, but especially the font and back crawl


\textsuperscript{12} G. Trog, "Younger ones we train", Swimming Technique, Vol. 26, November 1989.

stroke, besides serving as fixators to the prime movers of the limbs, their importance in maintaining good body roll is essential. Explosive strength from the trunk is essential of the swimmer to fully realize the effort of the arms. Swimming like all skills, which emphasize trunk rotation, must initiate the production of momentum necessary from the body's centre of gravity, and sequentially, transfer this momentum outward to the extremities. Therefore, it appears advantageous for swim coaches to incorporate torso-twisting exercises into their strength-conditioning programme (Kurt, E.K. 1990).

Albrecht\textsuperscript{14} conducted the study and included 89 varsity swimmers from six different high schools in the South Sub-urban area as subjects. Measurements were taken of height, weight, upper-arm length, lower arm length torso length, bust height, arm spare chest normal, chest expanded chest deflated and foot area measurement, body surface area ankle flexion and hip flexion. Success was measured by a 'Coaches' rating and success (percentage) determined by the State record for the event divided by the time in the conference meet. In last no significant relationship was found between the swimming success and variables selected.

\textsuperscript{14} Robert C. Albrecht, "The Relationship Between certain Physique and Flexibility Measures and High School Swimming Success", Completed Research in Health, Physical Education, and Recreation 1 (Jan., 1959): 56.
Matheson\textsuperscript{15} studied the relationship between Swimming and selected physiological, anthropometric development and skill variables in 10-12 years old female competitive swimmers. Forty girls were tested and data were collected for selected Variables. Each subject completed 400 yards and 50 yards time trials and later classified into top and bottom level Groups. The Inter-correlation matrix indicated that best predictors of swimming performance were height, aerobic capacity, and stroke efficiency.

Councilman\textsuperscript{16} studied the force, which operated during swimming two types of crawl stroke. He used a test in which the subjects were pulled at various speeds while in a glide position during which they kicked their legs. He concluded that "when the swimmer was pulled at speed greater than five feet/sec., the kick did not contribute anything to the speed at which he was being towed but, in same instances, actually created an increased drag as a result of his kicking. "On the basis of his findings, he concluded that the kick contributed nothing to the propulsion created by the arms when persons swim at specified fast speeds. he contended that the principal role of the kick was to stabilize the body and keep the legs in a high position. This results in a more streamlined position in the water. Also, if the kick is coordinated with the

\textsuperscript{15} Zarilee Matheson, "Selected Physiological, Anthropometric and Skill Variables Contributing to Success in 10-12 Years Old Female Competitive Swimming", \textit{Completed Research in Health, Physical Education and Recreation} 20 (1978): 293.

corresponding arm acting, it acts as a neutralizing force in order to counteract 
the negative drag resulting from the hips being forced downward in the water.

Carter et al.\textsuperscript{17}, reviewed on the somatotype of 1039 male and female 
athletes. Their findings supported the hypothesis that physique is selective in 
champion performance; but somatotype patterns were found narrower in higher 
level of competition athletes when compared to each other, the endomor...}
characters were found in distance runners, and some wrestlers and weight 
lifter's i.e. tthey had rating of 1. As expected in regard to mesomorphy, athletes 
were rated higher. Gymnast had a rating of 6, but was not as high as weight 
lifters, track and field athletes, swimmers and golfers. The last component, 
ectomorphy, which depicted linearity, showed the greatest within most sports. 
Male gymnast has a rating 2 in this component. The highest ratings were 
usually found in distance runners. Among women, gymnasts were the least 
linear, and track and field sprinters and jumpers the most linear. Thus, on an 
average, the outstanding gymnast had of 2-6-2. Highly successful gymnasts 
were found more mesomorphic than less successful gymnasts.

Carter in another study related to Olympic Gymnasts, studied seven 
male groups and found mostly mesomorphic body of the males. Further, seven 
of the male groups are concentrated in narrow position between the 5 and 5½

\textsuperscript{17} L. Carter, D. Steet; G. Martin, "Somatotypes of Male Gymnasts", \textit{Journal of Sports Medicine} 11 
units in mesomorphy, while the lowest groups are the reference male,
basketball players and distance runners. He stated that gymnasts were
significantly more mesomorphic than all of the groups except divers and
canoeists. The canoeists were significantly more mesomorphic than the
remaining groups.

Between 1965 and 1970, Maas\textsuperscript{18} studied 23 top selected male gymnasts
and compared them with judokas/sportmen. He explored the area and
concluded on the basis of final results that the gymnasts distinguish themselves
clearly from the other groups. They were small and had a broad upper part of
the body with great circumstances. The width measurements below the waist
was not small for their stature. An important difference with the Judoka as a
more or less was the small circumference of the legs; both in the absolute and
relative numbers but they also differ from each other in relative trunk length.
Gymnasts have short upper legs and upper arms in cm as well as in
percentages.

Tanner\textsuperscript{19} collected somatotype data on 102 Track and Field Athletes
participated in the 1964 Rome Olympic Games. Only those athletes who had
achieved the 1960 Olympic standard in their event were included in the study.


\textsuperscript{19} J.M. Tanner, \textit{The Physique of the Olympic Athletes} (London: George Allen and Unwin Ltd.,
1964), pp. 21-4.
Additional data were obtained from Oxford University students, Royal Military Academy Cadets, and Physical Education Students.

The event wise grouping of Olympic athletes and the mean somatotype ratings for each group, as well as somatotype ratings were also classified. The following observations were made:

1. In track events there was a noticeable gradient of decreasing mesomorphy and increasing ectomorphy as the distance increased from 100 m and 200 m through 400 m to 800 m and the longer ones.

2. The endomorphic ratings for all track events were equal to 2.6.

3. Jumpers on the average were similar to sprinters and possessed high in mesomorphy and having the second highest rating ectomorphy.

4. Throwers were more mesomorphic and endomorphic, and less ectomorphy than the runners and jumpers.

5. University students could be considered as belonging the mediocre physique category, with a slightly higher rating in ectomorphy than in the endomorphic.
6. Military Cadets and Physical Education students were quite similar except that the former had a higher ectomorphy rating than the later.

7. On the whole, the Olympic Athletes were considerably different from the university students, military cadets, and physical education students.

Regression equations using physical traits and class commitment as predictors were developed by Atkinson\textsuperscript{20} for determining potential skill in beginning tennis, badminton, and handball for college men. The physical traits used were: agility, power, hand-eye coordination, and visual acuity. Skill level was determining during a round-robin tournament in each sport. Subjects were 140 college men enrolled in beginning classes for each sport and taught by the whole-part method. Control subjects included 138 students enrolled in other beginning classes and taught by the part method. Another purpose of the study was to determine if practice in the sport would significantly improve scores on the physical traits. A paired 't' test was used. A 't' was used to compare experimental and control groups. He concluded that the class commitment was probably an integral part of skill attainment in the sports studied; students taught tennis and badminton by the whole-part method experienced greater

gains in agility and hand-eye coordination; students taught tennis by the part
method experienced greater gains in shoulder girdle power.

In their investigation of human body dimensions applied hydrodynamics
and selection criteria for top swimmers, using 63 students from Academy of
Physical Education, Amsterdam and nine Dutch competitive Olympic
swimmers as subjects, Clarys and Associates\textsuperscript{21} concluded that shape,
composition and dimensions of the body exert little or no influence on the
hydrodynamic resistance (in independent crawl locomotion).

Everett\textsuperscript{22} tested thirty varsity Baseball players of the University of Iowa
on ability to throw for distance, running speed and agility (shuttle run); ability
to visualize spatial relationships (Thurstone's "S" Test); ability to make
decisions quickly (the blocks test) and motor capacity (the General Motor
capacity Scale). The subjects were rated according to playing ability by the
coach.

Product moment correlation, partial correlation and multiple correlation
were computed and the following conclusions were made: 1) the Sargent Jump
is the best single measure for selecting baseball talent, 2) the best economical

\textsuperscript{21} Jan P. Clarys et al., Abstracts: International Congress of Sports Sciences (Patiala: Netaji Subhas

\textsuperscript{22} Peter W. Everett, "The Prediction of Baseball Ability", Research Quarterly 23, (March 1952):L
15-19.
combination to predict baseball ability is the Sargent Jump, "S" test, and the blocks test.

\[ T_{\text{SCORE}} = 0.92 \text{ Sargent Jump (cm)} - 0.08 \]

"S" test (score) – 0.23, Blocks Test (Sec.) + 16.19

Bakker\(^{23}\) selected 28 members of the women's extramural Volleyball teams at Illinois State University as subjects. Two experienced volleyball coaches established the criterion by rating each player on her playing ability. The Variables measured were height, weight, leg extensor strength using the Multiple Angle Testing Unit, grip strength using an adjustable dynamometer, skin folds using the Lange Caliper jumping ability using the jump and reach test. Investigator apart from it used apparatus to measure reaction time and movement time. Through t-test and correlations it was found that jumping ability and reaction time were significantly related to success in Volleyball. A multiple correlation (R) of 0.718 was obtained between the nine variables and the criterion. An R of 0.53 was obtained between the criterion and reaction time plus jumping ability, and one of 0.52 between the criterion and jumping ability plus weight. The regression equation computed in this study could be used to predict success Volleyball playing.

A list of qualities, which was thought that a good gymnast would possess, was compiled by Wettstone\textsuperscript{24} and sent to twenty-five of the country's outstanding coaches and gymnasts. These authorities ranked the qualities according to importance. Tests for 15 of the highest-ranking qualities were obtained from a selected group of 22 gymnasts actively engaged in gymnastics at the University of Iowa. Eleven anthropometric measurements were taken. A test was constructed consisting of three elements, thigh circumference/height, strength test (consisting of chinning, dipping and thigh flexion), and the Burpee test which predicted potential ability in gymnastics with a multiple correlation of \( r = 0.79 \).

Relationship of selected physiological and psychological factors to the beginning swimmer's ability to perform the crawl stroke was determined by Crites\textsuperscript{25} who used 40 subjects from two beginning swimming classes. The beginning swimming classes met for 40 minutes twice a week. Prior to any swimming instruction, measurements were collected on shoulder rotation, shoulder extension strength, hip extension strength, body composition, swimming anxiety, and swimming ability as measured by the Fox Power Test (revised). After five weeks of crawl stroke instruction, measurements were

\textsuperscript{24} Eugene Wettstone, "Test for Predicting Potential in Gymnastics and Tumbling", \textit{Research Quarterly} 9 (December 1938): 115.

\textsuperscript{25} Jerry Keith Crites, "A Study of Selected Physiological and Psychological Factors to Determine their Relationship to the Performance of the Crawl Stroke by Beginning Swimmer", \textit{Dissertation Abstracts International} 36 (October 1975): 2084.
again collected on swimming anxiety and swimming ability. Pearson Product Moment correlation was used to analyse the data. It was found that: 1) shoulder rotation, should extension strength, hip extension strength and body composition were not significant factors in the performance of crawl stroke, and 2) a significant relationship was indicated between swimming anxiety and the ability to perform the crawl stroke.

Hoffman26 analysed the throwing techniques and reached to conclusions to predict performances of first, third and fifth grade boys and girls within the framework of a four-part taxonomy originally conceived by Fitts. Throwing performance was assessed under task conditions, which varied the motion states of the thrower's body and the target (stationary on moving) by use of a dual pendulum apparatus. (Accuracy scores were highest in a condition where both body and target were stationary and lowest where both body and target were moving. Task conditions requiring motion of only target of body were of inter-mediate difficulty, and scores from these tasks were not significantly different from each other. There was evidence of learning across trial blocks for all tasks, but no indication that states of acquisition differed for the task types. Likewise, significant effects were observed for age levels but no age X task type interactions were disclosed. Boys were more accurate than girls across task conditions, and most noticeable on the two most difficult tasks.

Comparison of subjects ability to predict, from stationary body position, the coincidence of the moving target with a standard reference point and their ability to predict the coincidence of their moving body with the same reference point revealed lower error scores on the former prediction task.

Umansky\textsuperscript{27} determined the relationship between selected prenatal factors and the perceptual motor performance of pre-school children. Children three to five years old from five pre-schools were administered the Frosty Developmental (Test of visual perception and developmental) checklists of perceptual motor and pre academic performance. Birth records were obtained for subjects to assess prenatal factors one and five minutes. Test scores, birth weight, length, head circum, chest circum, use of prenatal analgesia, and presence of delivery complications. Performing 'r' analyses assessed relationships between prenatal and pre-school variables. Significant negative relationships of low magnitude were found between head circumference and frosty DTVP and between birth complications and the perceptual motor scale. No other relationships between prenatal factors and pre-school perceptual motor performance were significant.

Admund and Florence\textsuperscript{28} took physiological and anthropometric measures of a group of young women, mean age 16.2 years, who had been training regularly by running approximately 50 miles per week for 2 years. Their mean \( \text{VO}_2 \text{ max} \) of 63.24 ml./kg. min\(^{-1}\) is among the highest ever recorded in a group of young women. Anthropometric measures included, selected segment lengths, diameter, skin folds, and circumferences. These young women appeared to be of average height, low in body weight, subcutaneous body fat, have a high component of ectomorphy and a smaller overall skeletal frame work than non-athletes.

Chapman\textsuperscript{29} determined what, if any, predictive qualities could be identified in a group of skilled women Field Hockey players. The subjects were 106 players who participated in the International selection and training camps sponsored by the U.S. Field Hockey Association during the summer of 1978. The study investigated anxiety, visual perception, manual dexterity, ball control and dynamic balance. Five tests were used to assess the predictor variables: a) sports competition anxiety test, b) Herkowitz's moving embedded figure test, c) Chapman ball control test, and Scott sideward leap test.

\textsuperscript{28} Burke J. Admund and Brush C. Florence, "Physiological and Anthropometric Assessment of Successful Teenage Female Distance Runners", \textit{Research Quarterly} 50: 2 (October 1979): 180.

Level of camp participation determined by player selection based on subjective evaluation of field hockey playing ability, served as the criterion measures in the study. A stepwise discriminating function analysis determined that the three discriminating variables – dynamic balance, ball control and anxiety could predict correct group membership 78.95% of the time.

Robert\textsuperscript{10} attempted to predict potential of 67 football players from their scores on a football potential test. The test battery consisted of motor items as well as football skill items. Substantial correlations were obtained between most test items and the test criterion – the sum of T scores. Size, as depicted by McCloy's Classification Index (C.I.), had a negative non-significant correlation with the criterion. The discriminative power of the battery was evidenced by highly significant correlation between the tests. It was concluded that athletic potential in football could be predicted by testing. In second part of the body, football teams from three different strata of competition were evaluated on the basis of the test battery. The battery substantiated a stepwise progression between the teams on most items, with significant differences being noted. The test showed validity, in that the test criterion (the sum of T scores) was significantly different between the teams.

Beiter\textsuperscript{31} selected forty-six players for the construction of a football prediction test using general and specific motor performance tests, included strength, power, speed, agility and body composition. Multiple regression analysis selected the top four tests to estimate the sum of eighteen T scores. Neither of the 18-item profile significantly predicted starters in the opening game. Multiple regression to predict coaches rating (Mean for 5 coaches) produced an $R = 0.66$ using 1-RM bench press, power clean, 7 skin folds, blocking RT and Margaria-Kalamen anaerobic power. Contrary to results of other studies to predict success in Football, the test battery developed in this study did not distinguish between starter and non-starters. It was conducted that possession of speed, strength, and size does not guarantee success in highly skilled game such as football.

Deshaises\textsuperscript{32} developed predictive equation of Junior Ice Hockey. One hundred and sixteen Quebec Junior Major League Hockey players were measured on 14 variables falling in biological, psychological and specific motor skill categories. These variables were included in a stepwise regression analysis with the ice hockey playing ability as the criterion variable. A predictive equation was obtained (P 0.05) which included the following four

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variables: forward speed skating, motivation, visual perceptual speed, and anaerobic power. The correlation co-efficient obtained was 0.74. The 55% of the variance in Ice Hockey playing ability accounted for by the psychological profile was larger than that observed individually for either the biological (17%) psychological (20%) or the specific skill profile (33%).

Keller\textsuperscript{33} carried out an investigation to determine nature of the relationship between "quickness of bodily movement" and success in athletics. Measurements were taken of 755 men and boys in the University of Minnesota; Columbia Heights, Minnesota, High School; and the University of Minnesota High School. All subjects were placed under two categories namely athletes and non-athletes. "Total Bodily Movement" was measured by a test consisting of a quick action of one arm, one foot, and the trunk combined into one movement, either to the left to the right, or forward. A test was devised to measure "total body quickness" because none of the existing tests and techniques was found to be adequate for measuring it. A 't' test and chi-square was used to statistically analyse the data and the following conclusions were drawn: there is a positive relationship between the ability to move the body quickly and success in athletic activities, 2) the requirement in quickness of bodily movement are not the same for all sports.

\textsuperscript{33} Louis F. Keller, "The Relation of 'Quickness of bodily Movement to Success in Athletics", \textit{Research Quarterly} (May 1942): 146-155.
Kansal\textsuperscript{34} studied 246 male students ranging in age from 11 to 17 years to develop scientific criteria for the selection of budding athletes based on their morphological status. Their height, weight, bi-acromial, humerus, bycondylas, chest and calf circumferences, and performance in 100 m. running shot put, and standing broad jump were examined. He concluded that the measurements showed significant degree of relationship with individual performance tests.

Park\textsuperscript{35} determined whether there is any relationship between physical fitness and success in physical education activities in a normal school department. For the purpose of this study 25 men and 25 women were selected at random from the physical education freshman class. The activities used were those required of all major in physical education activities at the State Normal School Cortland, New York. Sixty-five subjects were selected at random. The activities were swimming, any relationship between physical fitness and success in physical education activities in a normal school department. For the purpose of this study 25 men and 25 women were selected at random from the physical education freshman class. The activities used were those required of all major in physical education activities at the State Normal School Cortland, New York. Sixty-five subjects were selected at random. The activities were


\textsuperscript{35} Bessie L. Park, "Relationship Between Physical Fitness and Success in Physical Education Activities", Research Quarterly 6 (March 1935): 263.
swimming, gymnastics, dancing, play games and athletics. The researcher found low correlation in all five activities. There were lack of correlation between physical fitness index and athletic award. It was concluded that athletic success for men depends on mere strength than physical fitness.

Vickery\textsuperscript{36} studied the effects of race and musculoskeletal development on the prediction of body density from the skinfolds in young males. Three hundred nineteen male subjects, aged 18 to 30 years, were placed into three groups representing different degrees of musculoskeletal development based on the health Carter Anthropometric Somatototype Mesomorphy rating.

Measurements of skinfold thickness at eight sites (chest, mid-auxiliary, triceps, sub scapula, abdomen, supra-iliac, thigh and calf), body diameters at two sites (humors and femur), ad body circumferences at four locations (waists, forearm, upper arm and calf) were taken on each subject. Body density was measured by hydrostatic weighing. Measured body density and body density predicted from skinfold measures and age were compared among the groups varying in musculoskeletal development and between the blacks and whites. It was found that both race and muscular skeletal development significantly affect the prediction of body density from skinfolds and age in young men. It was

\textsuperscript{36} Susan Rebecca Vickery, "Effects of Race and Musculoskeletal Development on the Prediction of Young Males", Dissertation Abstracts International 47 (July 1986): 120-A
concluded that equations for predicting body density should include race and an indicator of musculoskeletal development as independent variables.

Dubey\(^{37}\) studied the relationship of selected anthropometric measurements, physiological variables and arm and leg speed to front crawl swim speed. Thirty swimmers of national level were the subjects of this study.

The dependent variables of 50 meters and 100 metres were selected to take front crawl swimming performance. The independent variables selected for the study were anthropometric, physiological, arm alone, and leg alone speed variables. The anthropometric variables included: weight, height arm length, thigh length, foreleg length, leg length and body composition. The physiological variables included vital capacity, maximum expiratory pressure, maximum breath holding capacity, Peak flow, pulse rate and blood pressure.

Pearson's product moment correlation was used to assess the relationship between front crawl swim speed and each of the independent variables. In order to predict the crawl stroke swimming speed ability on the basis of most contributing anthropometric, physiological and arm, leg speed and all variables combined regression equations were developed. Height, weight, arm length, thigh length, fore leg length, leg length, body composition,

vital capacity, maximum expiratory pressure, peak flow, arm speed were significantly related with 50 meters front crawl swim speed.

Shondell\textsuperscript{38} conducted a study to identify the physical and anthropometric traits possessed by successful volleyball players and upon determination, develop a physical performance test battery that would prove valid, reliable and practical, when used to identify potentially successful collegiate volleyball players.

An initial group of 23 tests and measurements was selected to measure the characteristics of a successful player. Ninety-three subjects completed all 23 items. Statistical techniques utilization provided inter-correlation coefficient of the independent variables, correlation coefficient between the independent variable and the dependent variable, stepwise regression coefficient and constants and the square of the multiple correlation coefficient for the regression equation each step. Findings were as follows:

Reliability coefficients ranged from 0.994 to 0.496.

Validity coefficients ranged from 0.585 to 0.13.

Power appeared to be the most significant factor in successful volleyball performance. Strength did not seem to be a factor in successful volleyball

\textsuperscript{38} Donald Stuart Shondell, "The Relationship of Selected Motor Performance and Anthropometric Traits to Successful Volleyball Performance", \textit{Dissertation Abstract International} 32 (March 1972): 5026-A.
performance. He concluded that the cross-validation procedures employed supported the validity of the sixteen batteries as a predictor of expected volleyball performance.

Childress\textsuperscript{39} conducted a study to identify the components of high school basketball playing ability, and to construct an evaluative tool for classifying high school basketball players into populations' identified as successful and unsuccessful.

Twenty-four items were selected and administered to 106 high school basketball players. Seven factors were isolated and six were identified as agility speed, relative muscular endurance, basketball speed manipulation, gross muscular strength, total body movement time, and manual dexterity. One factor was unidentifiable in terms of common test items with high factor loadings.

Two test batteries were constructed, the first consisting of the seven test items loading highest on the isolated factors; the second was composed of ten test items, which were selected through a combination of statistical techniques. The first battery when utilized in a discriminant function analyses, effectively classified the 1-6 subjects into successful and unsuccessful basketball players. The first and the second discriminated between the two groups.

\textsuperscript{39} James Thomas Childress, "A Factor and Discriminant Analysis to Identify and Determine the Effectiveness of Selected Physical Variables in Predicting a Successful Basketball Performer", Dissertation Abstracts International 33 (November 1972): 2146-A.
The results of the study indicated that the components of basketball ability could be isolated, measure, and utilized to construct an evaluative tool for classifying players into two population identified as successful and unsuccessful.

Albrecht\textsuperscript{40} studied 89 high school level swimmers in order to investigate the relationship between certain physique and flexibility measure and swimming success and did not find significant relationship between physique measures and swimming success.

Israel \& Burhl\textsuperscript{41} (1980) emphasised that young swimmer's training up to the eleventh year includes primarily teaching of technique. Improvement of basic swimming endurance, reaction time, short-term acceleration, all round coordination and flexibility. It should not be forgotten that at this age, the muscular strength of all parts of the body should be uniformly promoted by general strengthening exercises and other sports. The increase in strength at this age is based mainly on improved co-ordination within the individual muscles and between various muscles. The flexibility of the muscles should also be increased by regularly performed stretching exercises. Only with a very good neuromuscular coordination and excellent flexibility is the transition between

\textsuperscript{40} Robert C. Albrecht, "The Relationship between Certain Physique and Flexibility Measures and High School Swimming Success," Completed Research in Health, Physical Education and Recreation 1 (1959): 56.

tensing and relaxing the driving muscles guaranteed, which is crucial for economical execution of swimming movements, which have to be continuously repeated over long distances.

In a comparative study Bharadwaj and associates\textsuperscript{42} concluded that presence of longer lower extremities in basketball players appears to be the effect of selection. Shorter but muscular legs in footballers were better suited to provide powerful kick. Longer legs would perhaps cause earlier fatigue of the thigh muscles. Longer arms were found advantageous for basketballers and wrestlers were found with lowest leg proportions.