Chapter – II

REVIEW OF RELATED LITERATURE

Research Scholar made sincere attempt to locate literature by going through the various. Some of the important review of literature has been cited below.

Greenlie\(^1\). Conducted a study on the relationship of selected measures of strength, balance and kinesthesia, and bowling performance. Tests of leg strength, grip strength, arm & shoulder girdle strength, static and dynamic balance and various measures of kinesthesia including wrist – extension, rotatory positioning of the fore-arm and forward weight shift were administered on 122 beginning bowlers during the last two weeks of an eight week bowling course. These test results were correlated with an average of six games bowled. A significant positive relationship was found between the dynamic balance and bowling performance.

Sabol\(^2\) conducted a study to determine the validity of subjective ratings of the ability to handle a given weight ball, as a criterion measures of bowling ability and to investigate the relationship among anthropometrics performance data were collected to each subject on

\(^1\) Gereldine Greenlie, “Relationship of Selected Measures of Strength, Balance & Kinesthesia & Bowling Performance” Completed Research in Health, Physical Education & Recreation, 2 (1960) : 42

height, weight, arm length, grip, pull-ups, push-ups, three finger bowling, grip velocity of fast ball, average and game score. All groups were significantly different in all variables on one or five percent level when an analysis of variance was computed. The Duncan Multiple Range tests was used to determine significant difference between pair of means.

Delores\(^3\) found out the effects of the strength and flexibility to free running speed. He took women college students and tested them in toe strength, ankle strength and leg strength, toe flexibility, ankle flexibility and free running speed prior to and immediately following a four week's exercise programme designed to increase the toe strength tests and running speed and significant loss in leg strength, toe and ankle flexibility.

Tipton\(^4\) suggested that flexibility aids in gaining a long stride in running. Great flexibility in the ankles, hip and trunk may over some of the disadvantages of possessing legs which are not extremely long. Short legs and inflexible joints are a poor combination for running performance. Keeping the rate of leg movements constant the speed of running can be increased by lengthening the strides.

Johnson\(^5\) conducted a study on the relationship of balance, speed, strength, height, arm and leg length to success in collegiate wrestling, The

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\(^3\) Mann Delores, "The Relationship of Toe Strength and Flexibility to Force Running Speed" *Completed Research in Health, Physical Education and Recreation*, 37 : 10 (March 1967) : 96

\(^4\) Tipton, *Track and Field Athletics*, p. 58

\(^5\) Johnson, *Completed Research in Health, Physical Education and Recreation*, 68.
subjects (N=208) for the investigation were collegiate wrestlers with at least two years variety experience, who had wrestled at least 50 percent in their teams matches during the average of successful according to their win-loses percentage. All subjects were measured for height, arm length, leg length and tested for MT-RT static elbow flexion, strength, explosive strength and dynamic balance. Treatment of data by ANOVA table showed no difference among the wrestlers in three-weight division in dynamic balance, explosive leg strength and RT in elbow flexion strength and the middle-weight were faster in MT RT heavy weight. The successful wrestlers had better balance than the unsuccessful wrestlers. The unsuccessful wrestlers had long legs than the average and successful wrestlers. The analysis by multiple R and Regression showed that no contribution of the independent variable was useful in predicting success.

Joseph⁶ studied the relationship of power, agility, flexibility, measurement of selected body segments to volleyball playing ability taking thirty volleyball players and found that power was the most reliable single variable in predicting playing in volleyball. Arm length and leg length also were reliable. Flexibility and agility had insignificant relationship to the playing ability.

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Scott\(^7\) conducted study on male swimmers (N=26) bettered on equaled a time of 56 seconds, for the 100 yards crawl stroke testing for flexibility of ankle, knee, hip, trunk and shoulders in an open competition of these the students were timed for a 100 kick pull and swim. It was concluded that certain flexibility measures were volleyball serve. 14 female students in seven randomly selected SHS in districts 111 of W.S. Inter-scholastic Athletic Association were taken as subjects. Multiple Regression were used to analyse the data and indicate the relationship between arm and wrist strength and open overhand volleyball serve velocity (P.05)

Richardson\(^8\) concluded a study to determine if grip strength had a significant relationship to throwing velocity, range of wrist flexion had a significant relationship to throwing velocity, length of the throwing arm had a significant relationship to throwing velocity and if there was a predictive value to any of the three resulting relationships. Subjects were 31 varsity baseball players currently in regular season play. Grip strength was measured with a dynamometer, wrist flexion with a goniometer and velocity with hand held radar unit data obtained were then analyzed by a multiple liner regression and stepwise multiple linear regression. It was concluded that grip strength had throwing significant relation to velocity

\(^7\) Guilford, J. Scott, "Relationship of Selected Flexibility and Strength Measures to Time in 100 Yards Crawal Stroke," *Completed Research in Health, Physical Education and Recreation*, 20 (1978): 304.

whereas wrist flexion had significant relationship to throwing velocity, which can be moderately predicted (36 percent shared variance) from grip strength.

Marjorie⁹ conducted a study on the relationship of forward hip rotation velocity, magnitude of forward hip rotation and composite arm shoulder strength to the flat tennis serve ball at velocity subjects (N=27) for this study were advanced female tennis players who were measured for velocity of the tennis serve hip mechanics and strength of the arm, wrist and shoulders. The two velocity variables were measured cinematographically while strength was assessed with a tensiometer. Analysis of the Data led to conclusions that there is a relationship between the velocity of hip rotation and the velocity of the tennis serve but no relationship between forward hip rotation and the velocity of tennis serve. Composite arm, wrist and shoulder strength is related to the velocity of the tennis serve.

Hoffman¹⁰ in his study aimed to look for the best relations between the leg strength and frequency of a sprinter’s strides, taking into account the length of his legs. The measurements were taken exclusively during

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competition. The results showed that the leg length is connected more with the athletes running ability than is height.

Spiroduco\textsuperscript{11} studied the relationship between strength and speed as affected by limb length, conducted tests on 114 college men to determine relationship between speed of movement and strength in thighs a lower legs extension and to determine whether this was affected by limb length. Persons product moment relationship between strength and speed were negligible (0.14 or Less) with no appreciable change in partial relationship when holding limb length (things and / or lower leg) constant.

Rasch\textsuperscript{12} in a relationship study correlated the length, strength and weight of the arm with the maximum speed of voluntary movements of the arm. From the experimental findings recorded there is no statistically significant correlation between the voluntary movements of the hand, forearm and the weight length and strength of the arm and its segments.

Greenlee\textsuperscript{13} Administered test of grip strength, leg strength, arm and shoulder girdle strength, static and dynamic balance and various measures of kinesthesis including wrist extension, rotation, position of forearm and forward weight shift, to 12 beginning bowlers significant

\textsuperscript{11} Craig Denvico, Spiroduco, "Relationship Between Strength and Speed as Affected by Limb Length" \textit{Completed Research in Health, Physical Education and Recreation}, 15 (1973): 139.

\textsuperscript{12} Phillip, J. Rasch, "Relationship of Arm Strength, Weight and Length to Speed of Arm Movement" \textit{Research Quarterly}, 25 (October 1954) : 328-332.

positive relationship was found between dynamic balance and bowling performance and strength and bowling performance.

Bowne\textsuperscript{14} studied the relationship of selected measures of acting body levers to ball throwing velocity achieved in the overhand and underhand throws. Motion picture data were obtained from the throwing performance of 42 High School Girls, arranged in three groups on the basis of difference in initial throwing velocity achieved, arm measures of acting body levers for trunk rotation, medial rotation, flexion of the arm and flexion of the wrist were studied. A similar relationship between structure length measured and over hand throwing velocity. Result with understand throws indicated that neither length of the body segments nor the position of the action lever at the moment of release of the ball was critical factor in determining the velocity of throws.

Linford\textsuperscript{15} studied the effect of Knee angle on the measurement of leg strength of college males. This study was designed to determine the effect of variations in knee angle upon static leg strength of adult males when tested in the semi-erect position maximum strength reading were taken at five knee angles which were varied in a Latin Square sequence in the range of $115^\circ$-$164^\circ$. Application of a type II mixed analysis of variance design and a Scheffe multiple comparison test revealed no

\textsuperscript{14} Mary E. Bowne, "Relationship of Selected Measures of Acting Body Levers to Ball Throwing Velocity" \textit{Research Quarterly}, 31 (May 1960) : 392.

significant difference in performance (p<.1) where the knee angles were between 135\(^0\)-164\(^0\). Knee angles between 115\(^0\)-134\(^0\) gave significantly lower leg strength scores (p<.1).

McCrown\(^{16}\) studied that throwing ability and certain selected anthropometrics measurement of the arm, ability to throw, a baseball for the distance were correlated with age and weight, with grip, wrist and shoulder medical rotation strength and with the length of the hand, lower arm and upper arm as a proportion of total arm length.

Thomas\(^{17}\) conducted a study on the relationship of motor fitness components and anthropometrics variables to the velocity of basketball throw taking 25 college professional male players as subject. He concluded that wrist strength, back strength, arm strength, upper arm length, total arm length had a significant relationship to the velocity of basketball throw.

Mary\(^{18}\), studied the velocity and angles of projection for the tennis serve. The purpose of this study to determine the minimum and maximum velocity of the tennis ball for selected heights of contact and angles of projection and wall impact points during the tennis serve. By use of


ballistics formula, a number of variables which determine the trajectory of the tennis ball were programmed for the computer. Tables were tabulated and are available for all data gathered. Angles of projection from the horizontal were selected to range from 50 to 150 in increment, of 10 velocity of the serve ranged from a low of 30ft. per second to high of 176ft. per second. Finally, the height of the contact point ranged from a low of 6.0 ft. to high of 9.0 ft. in increments of 5 ft. height of the ball when crossing the net (impact point on the practice court) ranged from a low of 3.01 ft. to high of 8.47 ft. The minimum height at crossing was achieved at 6.5 ft. Service height a-30 angle of projection and time from baseline of 30 Sec. This is a relatively high velocity serve. In contrast the maximum height over the net of 8.47Ft. was achieved at an 8.5 ft. Service height, a 150 angle of projection and time of 0.79 Sec. To point of impact. These data indicate that at higher service heights and slower velocities, a ball can hit the impact area as much as 8.47 ft. from the floor, 4.47 ft. above the net and still remain in the service court.

Selin\(^{19}\) analysed the aerodynamic of pitched Baseball. The purpose of this study was to analyses the trajectories of pitched base balls and to determine the courses of particular type of trajectories. More than 200 pitches, made by 14 pitchers of baseball team in the Western (Big Ten) conference, were photographed by means of two high-speed cameras.

The films upon which were recorded the complete trajectories of pitches were analysed in terms of velocity and rate of rotation, axis of rotation vertical deviation. Horizontal deviation, vertical forces, and horizontal forces. It arrived on following conclusion.

i) Each pitch in each category showed either vertical deviation or horizontal deviation or both. None of the pitches followed the course that would be followed by a freely falling body.

ii) Within the ranges of the measured rates of rotation and velocities of the pitched ball in this study, the amount of deviation of a pitched ball is determined primarily by the vertical angle.

iii) In general the forces that in one plane. (i.e. vertical or horizontal) act upon the ball are inversely related to the forces that in the other plane (i.e. horizontal or vertical) act upon the ball.

iv) The relation of air-flow to the seams of the ball affects the magnitude of the deviation of the pitch.

Slaugther\(^\text{20}\) studied the arm movements. The purpose of this study was to observe the contractions of the particular muscles involved in prescribed movements of the arms. The particular muscles studied were the long and short heads of the biceps bra-chill the long head of the

triceps bra-chi and pronator teres. By means of electromyography the contraction of the biarticular muscles were studied. The long head of the biceps bra-chi, the short head of the biceps bra-chill the long head of the triceps bra-chi and the pronator teres. Electromyograms were recorded from four subjects by a model III – D Grass electroenccephalograph. Surface electrodes were used for all electromyograms that were recorded. Results of the study revealed that both head of the biceps bra-chi aid the movements that require arm extension and forearm flexion. Weak action potentials were recorded from both heads of the biceps bra-chi in the movement in which a contraction of these muscle parts would aid flexion of the arm and hinder extension of the forearm. The pronator teres aids the movement of forearm flexion and hand pronation as well a the movement of forearm in flexion of hand and supination. The action potentials recorded from this muscle are much large in forearm flexion with the hand being pronated than are the action potentials in forearm flexion with the hand being supinated.

Sondell\textsuperscript{2} established the relationship of selected motor performance and anthropometrics trials in successful Volleyball player.

He used a slice items battery of this purpose. He found out the power appeared to be the most significant factor in successes volleyball performance.

\textsuperscript{21} Donald Stuart (Shondell) "Relationship of Selected Motor Performance and Anthropometric Measurement Traits to Successful Volleyball Performance", \textit{Dissertation Abstracts International}, (April 1975) : 6496-A.
Atwater\textsuperscript{22} used five fastest right handed throwers from a university basketball team and photographed while performing three trials of a maximum velocity. Initial ball velocities ranged from 110 to 125 ft./sec. The 16 mm. Kodak cine special cameras, operating at 64 frames/sec. were used to record simultaneously the side, rear, and over head views of each throw. One trial of each subject was selected for analysis. The basic measures consisted of x, y and z coordinates of the balls position in each film frames during the 0.04 Sec. preceding release and immediately following release. Form these measures the three dimensional displacement, velocity and acceleration of the ball in space were determined. A descriptive analysis was then undertaken of the joint actions which occurred and were associated with the displacement and resultant velocity of the ball prior to and at release. On the basis of result obtained following conclusions were drawn.

1. Distinct phase of rapid acceleration and deceleration of the ball preceded final acceleration of the ball toward release in all five subjects. In the brief time interval of 0.07 to 0.12 seconds before release, all subjects accelerated the ball from a velocity of less than 20 ft./sec. to the velocity measured at release.

2. The early increase in resultant ball velocity occurred as the right shoulder adducted and laterally rotated to move the ball upward in its backward swing. The subsequent decrease in ball

velocity, during which time the ball lagged briefly behind the head and shoulders, was associated with the increase speed of forward trunk rotation and shoulder lateral rotation with the elbow flexed 90 degrees. The on going but deceleration forward trunk rotation, and the joint actions of right elbow extension, shoulder medial rotation, and forearm pronation contributed to the final acceleration of the ball during the 0.07 to 0.12 seconds before release.

Hopkins\textsuperscript{23} filmed six member of the Springfield College varsity tennis team while serving the flat, slice and top spin tennis serves. Three trials were used for each type of serve. A cine eight model SP-1 camera with a 25 mm. lens was used to photograph the serves and subsequent ball flights: frame rate was 100 frames per second. Thirty-nine correlations were computed based upon film measurements. Only the correlation between ball velocity and recoiling distance on the slice serve (r = -.884) was found to be significant (P<.05).

Guenzler\textsuperscript{24} filmed five skilled male pitchers (side view 200 frames per second) throwing a minimum of three trials each of the three most frequently thrown pitches in the Tucson AAA softball league: riseball,


dropball and changed of pace where as stride length, ball path prior to release and selected events in the delivery remained consistent within subjects for the three types of pitches, variances among the three types of pitches existed in grip, release position, arm actions just prior to release, and ball trajectory. The riseballs were characterized by a tucked index finger grip, ulnar deviation just prior to release, a ‘x’ speed of 66.0 m.p.h., and a vertical target landing point (45 ft. from the pitches rubber) that was higher than predicted for a normal parabolic flight. Dropball pitches exhibited a 2 or 3 finger grip across the same, r – u supination at release, a ‘x’ speed of 68 m.p.h., and a target landing point lower than predicted or a normal parabolic flight. Changed of pitches demonstrated either a loose of tight grip simultaneous extension of the fingers at release, and a ‘x’ speed of 43.5 m.p.h.

Patrish\textsuperscript{25} examined the three dimensional resultant linear velocities of the ball, right elbow joint center and right shoulder joint center; the three dimensional components, velocities of the ball; three angular displacement and the velocity of the right elbow joint; and the body position at release, four adult female subjects, who were or had been college varsity softball players performed both over arm and side arm softball throws. They were filmed using two high speed motion picture cameras aligned so their optical axes inter selected at 90 degree. The film

data were then reduced to three dimensional coordinates by mean of the susanka vector approach. It was concluded that there were more similarities between the over arm and side arm throwing patterns than there were differences. The two throws were similar in the ball velocities, rate, sequence, and timing of joint center velocities and degree of elbow extension. Differences were round in the Y (lateral) and Z (vertical) component ball velocities, and in the trunk position at release as seen from a rear view. However, the difference between the two throws were felt to be significant enough to warrant separate learning experiences for each type of throw.

Finch\textsuperscript{26} studied the kinematics and kinetics of the arm swing and shoulder action during the bowling delivery. Twenty four college male students were selected as subjects for this study. The subjects were screened by arm length and met intermediate bowling average requirements of 135±12 pins in order to control body parameters variability and provide more consistent deliveries. The ball velocities were determined using information provided by a pair of lesser timing gates. The average velocity of the five trials was used to categorize the subjects as high and slow speed bowlers. The bowlers' average velocity served as his criterion, or target velocity to be approximated in the following trials. The bowlers rolled six trials for each of the three ball weights (13, 15

and 17 pounds). The subject trial to trial alternation in ball speed and constant errors from their criterion velocity was determined by the timing gates. Cinematography records were taken of the fourth, fifth and sixth trials but only the trial with the smallest constant error was analyzed for each ball weight. Six data point making the shoulder joint, wrist joint, geometric center of the ball, and three reference markers were digitized using a numonics 1224 digitizer. The filmed horizontal and vertical coordinates of the data points were scaled to real distances and digital filtering was used to smooth the coordinates of the end points employing a four Hertz frequency cut off. Then linear and angular displacements velocities and accelerations were calculated using the real distances. Also shoulder torques, shoulder impulses, and timing information were calculated for the three phases of the bowling delivery. A three dimensional factorial analysis with repeated measures on ball weights and trial factors was employed to analyze the alteration in ball speed and constant error from the criterion velocity. It was concluded that the position of the ball with respect to the shoulder influence the shoulder height during the approach. High Speed bowlers developed greater horizontal ball velocity at release by walking faster during their approach. The bowlers horizontal ball velocity a release was significantly affected when the ball weight was varied more than two pounds. Non zero torques were applied at the shoulder during the arm swing which indicated that a free swinging delivery. Therefore, a muscually accelerated pendulum
model should be developed to ensure a more valid teaching model for the arm action during the bowling delivery.

Kimura\textsuperscript{27} selected mechanical factors exhibited in fosbury flop high jump technique of a female using three dimensional photography with subsequent biomechanical analysis were investigated. Locam and photosonic high speed camera, each equipped with angencause zoom lenses, were used with frame rates of 200 frames per second and a 1/3 shutter fraction. The subject was filmed from side and front. A 90° angle separated the camera's optical axis. There trials were analyzed at every five frames by digitalizing the joint center with a Numanics graphics calculator interfaced with a Dec System 20/50 computer. Digitized result from both camera views were analyzed using MLAB a computer modeling programme, and by computer programme in the computer library. The mechanics involved in the velocities and position of the lead knee, the arm action, the velocity of approach, the vertical angle of lift, the placement of the C.G. The time of take-off, the flexion of the knee of the lead and plant leg compared favourable with the literature. It was concluded that these can be used to describe efficient fosbury flop technique.