Chapter II

REVIEW OF RELATED LITERATURE

The research scholar had gone through different source materials and searched different websites for availing related review of literature. The research scholar has given deep thinking to those studies and has gained valuable literature from their findings which are of great help in providing scientific input to the research work. A brief review of related literature is presented in this chapter.

Gill (1985)\(^{22}\) had undertaken a study on assessment of predictive variables of gymnastics performance. The purpose of the study was to investigate the relationship of selected physical and physiological variables to performance in gymnastic and to find out the combined contribution of physical and physiological variables to gymnastic performance besides developing a multiple regression equation for the prediction of performance in gymnastic. The subjects were eighty male gymnasts who had participated in the 27th National Gymnastic Championship. The dependent variables were gymnastic performance which was evaluated by panel of five

qualified judges of Gymnastics Federation of India and independent variables were selected physical and physiological variables. In order to study the individual relationship of selected physical and physiological variables to gymnastic performance, Pearson product moment correlation were computed and to study the combined effect of these variables on gymnastic performance multiple correlation was calculated. The level of significance was set at .05. The Analysis of data revealed a significant relationship of gymnastic performance to right grip strength, dynamic balance, squat thrust, shoulder flexibility and spine flexibility, arm strength, abdominal strength, left grip strength, explosive strength, cardiovascular endurance, reaction time and speed of movement. The relationship between speed, agility, two hand coordination, kinesthetic perception, crural index, pondral index, body density and hymon index to gymnastic performance were not found significant at 0.05 level of significance. Multiple correlations were computed to determine these physical and physiological variables which contributed the most to gymnastic performance. The results of the study showed that right grip strength, dynamic balance, squat thrust, shoulder flexibility and spine flexibility contributed most to gymnastic performance (Rc. 12345 = .7766) among physical
variables. The cardio-vascular endurance, reaction time, speed of movement contributed significantly to gymnastics performance (Rc. 123.694) from among the physiological variables.

**Janette (1978)** conducted a study on relationship of arm and wrist strength to the velocity of an open overhead Volleyball serve. Arm and wrist strength and the open Volleyball serve velocity were determined for 44 female subjects in the seven randomly selected senior high schools district of the Wisconsin Interscholastic Athletic association. Cable sensitometer and cinematography techniques were used to determine the subject’s strength and serving velocity respectively. Multiple correlation was used to analyze the data. The results indicated the relationship between arm and wrist strength and open overhead Volleyball serve velocity.

**Saha (1996)** had undertaken a study on predictive variables of fast bowling in cricket. The purpose of this study was to find out the predictive variable of fast bowlers who were selected as subjects by purposive sampling. All subjects participated at all India Inter

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University Ranji Trophy competition. The height, weight, fore leg length, thigh length, Leg length, upper arm length, fore arm length, ponderal index, crural ratio, arm length, hand length, upper arm girth, fore arm girth, wrist circumstance shoulder width, chest girth, thigh girth and calf girth were the anthropometric measurements. The arm and shoulder strength, back strength, leg strength, speed, arm power, agility, balance, wrist flexibility, shoulder flexibility, spin flexibility were selected as physical variables and vital capacity, resting heart rate, body composition, anaerobic power/ weight, anaerobic power mass, cardiovascular endurance were the selected physiological variables. The data was collected by using standard procedure as available in literature. For measuring velocity of the ball, three time keepers were assigned. Correlation was applied to analyze the relationship of anthropometric, physical and physiological to fast bowling performance. To analysis combined contribution of independent variables (anthropometric, physical and physiological variables) to dependent variable (velocity of the ball), multiple correlations was computed by using Wherry-Doolittle method. Regression equation for prediction was also developed. The analysis of the data revealed
that height, leg strength, shoulder width and wrist circumstance contributed significantly to fast bowling performance.

Dutta (1984) had undertaken study on investigation of selected physical, physiological and psychological assessments as predictors in hockey performance. The purpose of the study was to investigate the relationship of physical, physiological and psychological variables to performance in hockey and to find out the combined contribution of physical and physiological variables to hockey playing ability besides developing a multiple regression equation for prediction of hockey performance. Seventy four male hockey players who had participated in the selection trials for combined university hockey team (men senior) in November 1983 were selected as the subjects. The dependent variable was hockey playing ability and independent variables were physical, physiological and psychological variables. Hockey performance was determined by taking the average of subjective grading by three experts who based their judgment on the strait field hockey rating scale. Physical variables including speed, grip strength, power, agility, dynamic balance, flexibility and kinesthetic perception

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which were measured by standard tests. Physiological variables including cardiovascular endurance, resting pulse rate, reaction time, movement time, response time and body composition was measured by a standard test. Psychological variables including anxiety and intelligent which were by IPAT anxiety scale and culture fair test respectively. It was found that physical variable namely speed, grip strength, agility balance and kinesthetic perception are significantly related to hockey playing ability. In case of physiological variables namely cardiovascular endurance, resting heart rate, hand reaction time, speed of movement, response time and body composition were significantly related to hockey playing ability. Among psychological variables anxiety was found to be significantly related to hockey playing ability.

Stuelcken (2007) had undertaken a study on anthropometric characteristics of elite cricket fast bowlers. The aims of this study were to describe the current anthropometric profiles of elite Australian female and male cricket fast bowlers and establish a set of reference values useful for future investigations on player selection, talent identification, and training programme.

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development. The participants were 26 female (mean age 22.5 years, s = 4.5; height 1.71 m, s = 0.05; body mass 66.2 kg, s = 7.5) and 26 male (mean age 23.9 years, s = 3.5; height 1.88 m, s = 0.05; body mass 87.9 kg, s = 8.2). The anthropometric profiles included the measurement of skinfolds, and segment lengths, breadths, and girths. A series of derived variables assessing the distribution of subcutaneous adipose tissue, the bivariate overlap zone relative body size and proportionality, and somatotype were also calculated. The male bowlers had larger length, breadth, and girth measurements than their female counterparts. There were differences in proportionality between the sexes, with only the male bowlers exhibiting characteristics that could be considered "large" relative to height. The female bowlers had a higher sum of seven skinfolds (P < 0.001), were more endomorphic (F (1, 50) 30.18, P < 0.001), and less mesomorphic (F (1, 50) 10.85, P < 0.01) than the male bowlers.

**Portus and Sinclair (2000)**\(^{27}\) undertook a study on cricket fast bowling performance and technique and the influence of selected physical factors during an 8-over spell. The aims of this

study were to determine the influence of an 8 over spell on cricket fast bowling technique and performance (speed and accuracy), and to establish the relationship of selected physical capacities with technique and performance during an 8-over spell. Fourteen first-grade fast bowlers with a mean age of 23 years participated in the study. Physical capacities assessed were abdominal strength, trunk stability, selected girth and skinfold measure. During the delivery stride of bowlers were filmed from an overhead and lateral perspective (50 Hz) to obtain two-dimensional data for transverse plane shoulder alignment and sagittal plane knee joint angle respectively. Ball speed was measured by a radar gun and accuracy by the impact point of each delivery on a zoned scoring target at the batter's stumps. Shoulder counter-rotation did not change significantly between over's 2 and 8 for all bowlers, but was significantly related to a more front-on shoulder orientation at back foot impact. When the front-on fast bowlers (n = 5) were isolated for analysis, shoulder counter-rotation increased significantly between over’s 2 and 8. Ball speed remained constant while accuracy showed some non-significant variation during the spell. Shoulder counter-rotation was significantly related to accuracy scores during the second half of the 8-over spell. Chest girth and body
composition were significantly related to ball release speed at various times during the spell.

Perkins (2003) had undertaken a study on physiological profiles and performance predictors of a women's NCAA rowing team. He described the physiological profiles of rowers (N=16; age = 20.1 +/- 1.4 years, weight = 78.6 +/- 9.5 kg, height = 177.5 +/- 3.1 cm) of the top 2 varsity boats on an NCAA women's crew and determined whether physiological measures predict boat assignment as determined by the head coach. Eight participants were members of the top varsity boat (1V) and 8 competed at a lower level (2V). Expired gases were collected while subjects completed the U.S. National Team VO2 max (3-minute stages) and 2 kilometer (2K) time trial rowing ergo-meter protocols. Heart rates (HR) blood lactates were measured before, during, and after each test. The VO2 max and blood lactate at stage 2 of the VO2 max test were used. Average (+/-SD) VO2 max was 3.86 +/- 0.40 L. min (-1). The 2K times averaged 453.0 +/- 10.5 seconds. The subjects used approximately 96% of VO2 max and 98% of HR (max) during the 2K. Neither VO2 max nor sub maximal lactate was related to boat

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assignment. The VO₂ values during the 2K trial indicated that rowing economy differed among athletes. The results of physiological measures and time trials should help the coach to individualize workouts of top performers.

Szymanski (2010) investigated the relation between anthropometric and physiological variables to linear bat swing velocity (BV) of 2 groups of high-school baseball players before and after completing a 12-week periodized resistance exercise program. Participants were randomly assigned to 1 of 2 training groups using a stratified sampling technique. Group 1 (n 24) and group 2 (n 25) both performed a stepwise periodized resistance exercise program and took 100 swings a day, 3 d-wk-1, for 12 weeks with their normal game bat. Group 2 performed additional rotational and full-body medicine ball exercises 3 d wk-1 for 12 weeks. Fourteen variables were measured or calculated before and after 12 weeks of training. Anthropometric and physiological variables tested were height, body mass, percent body fat, lean body mass (LBM), dominant torso rotational strength (DTRS) and non-dominant torso rotational strength (NDTRS), sequential hip-torso-

arm rotational strength measured by a medicine ball hitter's throw (MBHT), estimated I repetition maximum parallel squat (PS) and bench press (BP) vertical jump (VJ), estimated peak power, angular hip velocity (AHV), and angular shoulder velocity (ASV). The baseball-specific skill of linear BV was also measured. Statistical analysis indicated a significant moderately high positive relationship (p < 0.05) between pre-linear BV and pre-NDTRS for group 1, pre-LBM, DTRS, NDTRS, peak power, and ASV for group 2; moderate positive relationship between pre-linear BV and pre-height, LBM, DTRS, peak power, BP, PS, and ASV for group 1, pre-height, body mass, MBHT, BP, and PS for group 2. Significantly high positive relationships were indicated between post-linear BV and post-NDTRS for group 1, post-DTRS and NDTRS for group 2; moderately high positive relationships between post-linear BV and post-LBM, DTRS, peak power, BP, and PS for group 1, post-height, LBM, VJ, peak power for group 2; moderate positive relationships between post-linear BV and post-height, body mass, MBHT, and VJ for group 1, post-body mass, MBHT, BP, PS, and ASV for group 2. Significantly low positive relationships were indicated between pre-linear BV and pre-body mass, MBHT, and VJ for group 1, pre-VJ and AHV for group 2; post-linear BV and post-AHV for group 2.
These data show that significant relationships do exist between height, body mass, LBM, rotational power, rotational strength, lower body power, upper and lower body strength, AHV, and ASV to linear BV of high-school baseball players.

**Lidor and Ziv (2010)** took study on 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

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conducted to prevent fatigue and reduced performance at the beginning of the season.

**Visnapuu and Jurimae (2007)** had undertaken a study on handgrip strength and hand dimensions in young handball and basketball players. In handball and basketball the longer the finger length the better the accuracy of the shot or throw. All shots and throws are finished with the wrist and fingers. It can be proposed that athletes with longer fingers and greater hand surface parameters also probably have greater grip strength. The aim of this study was to investigate the influence of general body and hand-specific anthropometric dimensions on handgrip strength in boys participating in handball and basketball training. In total, 193 boys aged 10-17 years participated in this study. They were divided into 6 groups: 10-, 11-, 12-, 13-, 14-15-, and 16-17-year olds. The body height and body mass were measured and body mass index was calculated as general anthropometric parameters. The outlines of the hands of the boys were drawn on paper with a thin marker. Three groups of hand anthropometric parameters were measured: 5 finger spans, 5 finger lengths, and 5 perimeters of the hand.

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Handgrip strength was measured on the dominant hand with a Lafayette dynamometer. As a rule, general anthropometric parameters determined the maximal handgrip strength more accurately than did specific hand anthropometric parameters. From the specific hand anthropometric parameters, finger lengths and perimeters of the hand significantly correlated with the maximal handgrip strength. In summary, fingers are the smallest, lightest parts of the motor apparatus, and, therefore, they represent the parts most easily deflected by force from the ball, but at the same time, finger control is especially important for the accuracy of different shots, both in handball and Thus, it is especially necessary to measure finger length and perimeters of the hand for practical reasons.

Rawat (1988) had undertaken a study on physical, physiological and motor skill determination in male state level school volleyball players. The purpose of the study was to investigate the relationship of physical, physiological and motor skill variables to volleyball playing ability and to find out combined contribution of physical, physiological variables and motor skill

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variable separately to volleyball playing ability. The subjects were one hundred thirty five male school volleyball players who participated in the male state level school volleyball tournament held at district Bilaspur. The dependent variable was volleyball playing ability and independent variables were physical, physiological and motor skill variables. Volleyball playing ability was determined by taking the average of subjective grading by three experts who based their judgment on five pointing scale. Physical variables included speed, arm strength, explosive power, dynamic balance, agility, wrist flexibility, ankle flexibility, age, height and weight which were recorded with the help of standard test. Physiological variables included pulse rate systolic blood pressure, diastolic blood pressure, pulse pressure, body fat, lean body weight and cardiovascular endurance which were measured by standard test. Motor skill variables were volleying, serving, passing and set up which were measured by AAHPER Volleyball Playing Ability Test. Correlation was applied to find out the relationship of physical, physiological and motor skill variables to volleyball playing ability. To find out combined contribution of independent variables (physical, physiological and motor skill variables) to dependent variable (volleyball playing ability) multiple correlations
was computed. The physical variables namely speed, arm strength, explosive power, dynamic balance, agility, wrist flexibility, ankle flexibility, trunk hyper extension, shoulder flexibility, age, height and weight are significantly related to volleyball playing ability. Physiological variables pulse rate, body fit, lean body eight and cardiovascular endurance are significantly related to volleyball playing ability. Among motor skill variable volleying, serving passing and overhead pass are significantly related to volley ball playing ability.

**Kovaleski and Haitman (2003)** had undertaken a study on upper and lower body strength in relation to ball speed during a serve by male collegiate tennis players. The relation of leg, shoulder, and grip strength to ball speed in the tennis serve was investigated. For 15 collegiate male tennis players, leg and shoulder strength were measured using a Lido Active iso-kinetic dynamometer, grip strength with a handgrip dynamometer, and ball speed with a radar gun. Regression analysis showed no significant (p < .05) relationship among the strength variables and ball speed. The results were explained in terms of strength not

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33JE Kovaleski and RJ Heitman., "Upper and lower body Strength in Relation to Ball Speed during a Serve by Male Collegiate Tennis Players", *Perceptual and Motor Skills.* 2003 Dec; 97(3 Pt 1) pp: 867-72
being the only factor involved in producing ball speed during the tennis serve.

**Pugh (2003)** had undertaken a study on upper and lower body strength in relation to ball speed during a serve by male collegiate tennis players. 15 collegiate male tennis players were selected; leg and shoulder strength were measured using a Lido Active iso-kinetic dynamometer, grip strength with a handgrip dynamometer, and ball speed with a radar gun. Regression analysis showed no significant (p< 05) relationship among the strength variables and ball speed. The results revealed that strength is not only factor involved in producing ball speed during the tennis serve.

**Vinson et.al. (2013)** conducted a study on penalty corner routines in elite women indoor field hockey-prediction of outcomes based in tactical decision. Indoor hockey is a highly competitive international sport, yet no research to date has investigated the key actions within this sport. All 36 matches of the round-robin phase of the 2010-2011 England Hockey League Women's Premier

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34 SF Pugh, “Upper and Lower Body Strength in Relation to Ball Speed During a Serve by Male Tennis Players”, *Perceptual Motor Skills*. 2003 Dec; 97(3 Pt 1) pp: 867-72.

Division "Super Sixes competition were analyzed with the purpose of establishing which factors can predict the scoring of a goal using binary logistic regression analysis.

Seventy-two (22.6%) of the 319 observed penalty corners resulted in a goal. The strongest predictor of scoring a goal was taking the penalty corner from the goalkeeper’s right. Based on the odds ratio (OR), the odds of the attacking team scoring were 2.27 (confidence interval (CI) 1.41- 3.65) times higher with penalty corners taken from the goalkeeper's right as opposed to the left. Additionally, if the goalkeeper decided to rush to the edge of the circle, the odds of the attacking team failing to score were 2.19 (CI= 1.18-4.08) times higher compared to when the goalkeeper remained near the goal line. These results suggest that strategic decisions from the players and coaches have an important part to play in the success of penalty corners.

Jurimae (2005)\(^{36}\) had undertaken a study on relationships of anthropometrical parameters and body composition with bone mineral content or density in young women with different levels of physical activity. The aim of the study was to test the possible

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relationships of anthropometrical parameters, somatotype and body composition parameters with bone mineral content (BMC) and bone mineral density (BMD, total body, the dominant arm distal radius, antero-posterior lumbar spine-L2-L4, femoral neck) in strength. (n=33) and endurance. (n=32) trained and sedentary normal-weight (n=41) and overweight (n=23) young females. Their body height and mass were measured and BMI calculated. Nine skinfolds, thirteen girths, eight lengths and eight breadths/lengths were measured. Whole body fat percentage, lean body mass (LBM), BMC and BMD were measured by DXA. The relationship of different BMC and BMD values at each of the regions studied to the different anthropometrical and body composition parameters were analyzed by using a stepwise multiple regression analysis. In all groups, BMC is highly dependent on the body mass (31.5-81.2%, R2x100). In the endurance-trained females, BMD is dependent on LBM, especially in both weight-bearing sites (66.2% in L2-L4 and 35.3% in the femoral neck). LBM explained 77.0% of the total variance of BMC in this group. BMC in the strength-trained group is dependent on the lower body anthropometrical parameters-thigh skinfold (18.2%), calf-girth (25.2%), trochanter. on length (24.1%) and sitting height (51.4%) From the endurance-trained group, BMC
is dependent on hip girth (75.2%) or in combination with ankle girth (81.2%). From the length parameters, trochanter ion is the most important (55.8%) and from breadths/lengths, sitting height (571%). In the normal-weight females, BMC is dependent on the calf girth (31.1%), trochanter ion length (28.2%) and sitting height (29.8%). In the overweight group, only chest girth (20.1%) and bIAcrohial breadth/length (27.0%) had a relationship with BMC. From somatotype components, only ectomorphy explained MD in the endurance-trained females in the femoral neck (21.3%) and in the lumbar spine (20.9%), we can conclude that from the body composition parameters, LBM is a powerful predictor of BMC and BM Drom the anthropometrical parameters measured, lower body parameters are most important. Somatotype components (ectomorphy) had with BMD only in the endurance-trained group.

**Gabbett (2007)** had undertaken a study on relationship between physical fitness and playing ability in rugby league players. This study investigated the physiological, anthropometric, and skill characteristics of rugby league players and determined the relationship between physical fitness and playing ability in

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these athletes. Eighty-six rugby league players (mean +/- SD age, 22.5 +/- 4.9 years) underwent measurements of standard anthropometry (height, body mass, and sum of 4 skinfolds), muscular power (vertical jump), speed (10-, 20-, and 40-m sprint), agility (L run), and estimated maximal aerobic power (multistage fitness test). In addition, 2 expert coaches independently assessed the playing ability of players using standardized skill criteria. First-grade players had significantly greater (p < 0.05) basic passing and ball-carrying ability and superior skills under fatigue, tackling and defensive skills, and evasion skills (i.e., ability to beat a player and 2 verse 1 skills) than second-grade and third-grade players. While no significant (p > 0.05) differences were detected among playing levels for body mass; skin fold thickness; height:10-, 20-, or 40-m speed; agility; vertical jump height; or estimated maximal aerobic power, all the physiological and anthropometric characteristics were significantly (p < 0.05) associated with at least one measure of playing ability. These findings suggest that while physiological and anthropometric characteristics do not discriminate between successful and less successful rugby league players.
**Blackwell and Knudson (2002)**\(^{38}\) undertook a study on effect of type 3 oversize tennis ball on serve performance and upper extremity muscle activity. This study investigated the effect of the larger diameter (Type 3) tennis ball on performance and muscle activation in the serve. Sixteen male advanced tennis players performed serves using regular size and Type 3 tennis balls. Ball speed, surface electromyography, and serve accuracy were measured. There were no significant differences in initial serve speeds between balls, but accuracy was significantly greater (19.3\%) with the Type 3 ball in comparison to the regular ball. A consistent temporal sequence of muscle activation and significant differences in mean activation of different muscles were observed. However, ball type had no effect on mean arm muscle activation.

**Burr (2008)**\(^{39}\) had undertaken a study on relationship of physical fitness test results and hockey playing potential in elite-level ice hockey players. The primary purpose of this study was to determine the fitness variables with the highest capability for predicting hockey playing potential at the elite level as determined

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by entry draft selection order. He also examined the differences associated with the predictive abilities of the test components among playing positions. The secondary purpose of this study was to update the physiological profile of contemporary hockey players including positional differences. Fitness test results conducted by our laboratory at the National Hockey League Entry Draft combine were compared with draft selection order on a total of 853 players. Regression models revealed peak anaerobic power output to be important for higher draft round selection in all positions; however, the degree of importance of this measurement varied with playing position. The body index, which is a composite score of height, lean mass, and muscular development, was similarly important in all models, with differing influence by position. Removal of the goalies' data increased predictive capacity, suggesting that talent identification using physical fitness testing of this sort may be more appropriate for skating players. Standing long jump was identified as a significant predictor variable for forwards and defense and could be a useful surrogate for assessing overall hockey potential. Significant differences exist between the physiological profiles of current players based on playing position. Physical fitness measures and anthropometric data are valuable in helping to
predict hockey playing potential. Emphasis on anthropometry should be used when comparing elite-level forwards whereas peak anaerobic power and fatigue rate are more useful for differentiating between defenses.

**Strudwick and Reilly (2000)**[^40] had undertaken a study on anthropometric and physiological predispositions for elite soccer. The aims were to describe anthropometric and performance characteristics of elite players in two footballs codes and explore the differences between them. Data were compared by means of “t”-tests. The subject’s were 19 professional soccer players and 33 inter-county Gaelic football players. The measurements were made on members of a Premier League soccer team throughout their regular season, whilst the Gaelic footballers were members of the Mayo squad preparing for the 1999 All-Ireland championship. The variability in stature was significantly greater in the soccer players compared to the Gaelic footballers (p<0.01). Performances in the 10-m and 30-m sprints, and in vertical jump were superior in the soccer group compared to the Gaelic footballers (p<0.01). The intra-group variability on the anthropometric and performance measures

of the soccer players is likely to be due to the specificity of positional roles. The combined groups could be described as lean and muscular with a reasonably high level of capacity in all areas of physical performance. Anaerobic characteristics of the professional soccer players were superior to those of Gaelic football players. It is concluded that anthropometric and performance assessment of elite footballers using mean values masks the heterogeneity evident within the football codes.

**Green et.al (2006)** had undertaken a study on relationship of physiological profiles and ice performance of a National Collegiate Athletic Association Division hockey team. Ice hockey is a game that relies heavily on both aerobic and anaerobic energy production system as players perform in various game situations. However, we found no studies evaluating the relationship between a player's physical condition and individual success in games throughout a competitive hockey season. The purpose of this study was to determine the relationship between a player's aerobic fitness (VO2 max), blood lactate hockey and percent body fat to his total minutes played during a season (T min)and net scoring chances.

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(SCn). Players’ (N = 29) preseason VO2max, lactate at the fourth stage of an incremental treadmill test (Lac 4), and percent body fat values from the 1999-2001 National Collegiate Athletic Association Division I hockey seasons were archived and retrieved for this study. The players’ Tmin and SCn were used as the on-ice performance variables and were compared with their fitness measures. Lactate at 4th treadmill stage (r = 0.41, p < 0.03) and percent body fat (r = 0.39, p < 0.03) but not VO2max (r = 0.20, p < 0.24) were significantly related to Tmin. Both Lac 4 and percent body fat were entered into a stepwise regression model that accounted for 25% of the variance in Tmin among players (p < 0.02). Both VO2max (r = 0.41, p < 0.03) and Lac 4 (r = 0.33, p < 0.05) were significantly related to the players’ SCn, but percent body fat was not (r = 0.10, p < 0.57). Only VO2max significantly predicted the players’ SCn, accounting for 17% of the variance. These findings suggest a relationship between a player’s conditioning level and on-ice performance.

Bhanot (1983) undertook a study on maximal anaerobic power in Indian national hockey player’s anaerobic power in

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relation to field position. The players included 10 goalkeepers, 16 backs, 20 half-backs and 44 forwards. The goal keepers possess maximum and forwards possess minimum anaerobic power while in vertical velocity, the former are the fastest and the latter are the slowest. In body weight the backs are heaviest followed by half-backs, goalkeepers and forwards. Among backs, the lefts are heavier, faster and have more anaerobic power than rights. In half-line players, the center-half-backs are followed by left-half-backs and right-half-backs both in body weight and anaerobic power, while in vertical velocity, the left-half-backs are the fastest and center-half-backs are the slowest. Among forwards, the center-forwards are heaviest with maximum anaerobic power and are followed by inside-forwards and outside-forwards, whereas, in vertical velocity the inside-forwards are fastest followed by center-forwards and outside-forwards.

Silvestre (2006)\textsuperscript{43} had undertaken a study on body composition and physical performance during a National Collegiate Athletic Association Division I men’s soccer season. The purpose of this study was to examine changes in body composition (BC) and

physical performance tests (PT) resulting from a competitive season in soccer. Twenty-five male collegiate players (age = 19.9 +/- 1.3 years; height = 177.6 +/- 6.4 cm; body mass=77.6 +/-8.6 kg, and percentage body fat = 12.8 +/-5.2%) were tested before (pre) and after (post) the 2003-2004 National Collegiate Athletic Association season. The following tests were performed: BC (anthropometric and dual energy x-ray absorptiometry measurements), vertical jump (VJ), 9.1-m (9 m) and 36.5-m (36 m) sprint, lower-body power (LP), total body power (TP), and cardio respiratory endurance (VO2max). Training was divided into soccer-specific training: field warm-up drills, practices, games, and additional conditioning sessions. A daily, unplanned, nonlinear periodization model was used to assign session volume and intensity for strength sessions (total repetitions < or =96 and workload was > or =80% of 1 repetition maximum). For the entire team, body mass significantly increased by 1.5+/-0.4 kg from pre to post due to a significant increase in total lean tissue (0.9 +/- 0.2 kg). Regionally, lean tissue mass significantly increased in the legs (0.4 +/- 0.0 kg) and trunk (0.3 +/- 0.1 kg). Physical performance variables were very similar for the entire team at pre and post; VJ (cm) 619 +/-71 PRE vs. 63.3 +/- 8.0 POST, 9.1-m (s) = 1.7 +/-0.1 PRE and POST, 36.5-m (s) 5.0 +/-
0.2 pre and post, predicted VO2 max (ml. kg.min^{-1}) - 59.8 +/- 3.3 pre vs. 60.9 +/- 3.4 post. The only significant improvements across the season were for TP (17.3%) and for LP (10.7%). In conclusion, soccer athletes who begin a season with a high level of fitness can maintain, and in some cases improve, body composition and physical performance from before to after a competitive season. A correct combination of soccer-specific practices and strength and conditioning programs can maintain and develop physical performance, allowing a soccer athlete to perform optimally throughout pre-, in-, and postseason play.

Tahara (2006) had undertaken a study on physique, body composition and maximum oxygen consumption of selected soccer players of Kunimi High School, Nagasaki, Japan. This study evaluates the physical and physiological ability of selected soccer players of Kunimi High School in Nagasaki Prefecture, Japan. The Kunimi team is famous for its intensive training, and had won the championship of the All Japan High School Soccer Tournament six times by 2003. We play measured physique, body composition and maximal oxygen uptake of 72 members aged between 16 and 18.

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years old between 1986 and 1994. They consisted of 66 outfield players (12 forward players, 23 midfielders, 31 defenders) and 6 goalkeepers. Body density was measured by the under-water weighing method, and Brozek's equation was applied to calculate percentage body fat (%Fat), fat-free mass (FFM, kg), FFM height (FFM/Ht, kg. m (-1)), and FFM index (FFM/Ht (3), kg. m(-3)). The following results were obtained: The average of 66 outfield players was 172.7 cm of height, 64.6 kg of weight, 54.0 cm of girth of thigh, and 90.0 cm of girth of hip, 9.3% of %Fat, 58.6 kg of FFM, 33.9 kg. m (-1) of FFM/Ht and 113.8 kg. m (-3) of FFM index. The mean vital capacity was 4.25 L and total lung capacity was 5.58 L. The mean maximal ventilation was 138.7 L.min (-1), VO2 max was 3.95 L.min (-1), and VO2 max/Wt. was 61.4 ml.kg. min (-1).min (-1). 2. Goalkeepers were taller and heavier than outfielders, and had a smaller mean value of vo2max/Wt than outfielders (p<0.01). 3. For 23 out of the 72 players measured twice with an interval of about one year, FFM increased and Fat reduced significantly, while V (E) max, VO2 max and vo2 max wt did not change. Kunimi players of the present study had as large a VO2 max/Wt as local players, and a similar or slightly smaller VO, max/Wt national-level players. They had similar %Fat and a similar VO2max/Wt with professional
soccer players in England (Davis et al., 1992) than while they had much smaller physiques.

**Bale (1991)** had undertaken a study on anthropometric body composition and performance variables of young elite female basketball. The purpose of the study was to determine the physique and body composition of young female basketball players and to examine these variables in relation to their playing position. Eighteen members of the under seventeen England Basketball squad were measured on twenty different anthropometric sites from which somatotype and body composition were calculated. Four performance measures, vertical jump, anaerobic power, right and left grip strength and laterality were also measured. The variables of the basketball players grouped according to playing position were then compared statistically using ANOVA. Centers had the largest measures of physique and body composition followed by the forwards and then the guards. These differences were significant, particularly between the center and the guards. The centers were much taller, had longer limb lengths, hip widths and were more muscular.

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Cronin and Hansen (2005) conducted a study on the relationship between strength and power and measures of first-step quickness (5-m time), acceleration (10-m time), and maximal speed (30-m time). The correlations between the 3RM, drop jump, isokinetic strength measures, and the 3 measures of sport speed were non-significant. Correlations between the jump squat (height and relative power output) and countermovement jump height and 3 speed measures were significant. The squat and countermovement jumps heights as well as squat jump relative power output were the only variables found to be significantly greater in the fast players.

Ellenbecker (2006) conducted a study on isokinetic profile of wrist and forearm strength in elite female junior tennis players. In tennis, injuries to the elbow and wrist occur secondary to the repetitive nature of play and are seen at increasingly young ages. Iso-kinetic testing can be used to determine muscular strength levels, but dominant/non-dominant and agonist/antagonist relations are needed for meaningful interpretation of the results. To determine whether there was laterality differences in wrist

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extension/flexion (E/F) and forearm supination/pronation (S/P) strength in elite female tennis players. 32 elite female tennis players (age 12 to 16 years) with no history of upper extremity injury underwent bilateral isokinetic testing using a Cybex 6000 dynamometer. Peak torque and single repetition work values for wrist E/F and forearm S/P were measured at speeds of 90 degrees/s and 210 degrees/s, with random determination of the starting extremity. Repeated measures analysis of variance was used to determine differences between extremities for peak torque and single repetition work values. Significantly greater (p<0.01) dominant arm wrist E/F and forearm pronation strength was measured at speeds. Significantly less (p<0.01) dominant side forearm supination strength was measured at both testing speeds. Greater dominant arm wrist E/F and forearm pronation strength is common and normal in young elite level female tennis players. These strength relations indicate sport specific muscular adaptations in the dominant tennis playing extremity. The results of this study can guide clinicians who work with young athletes from this population. Restoring greater dominant side wrist and forearm strength is indicated after an injury to the dominant upper extremity in such players.
Wormgoor (2010) conducted a study on anthropometric, biomechanical, and iso-kinetic strength predictor of ball release speed in high-performance cricket fast bowlers. Fast bowling is fundamental to all forms of cricket. The purpose of this study was to identify parameters that contribute to high ball release speeds in cricket fast bowlers. We assessed anthropometric dimensions, concentric and eccentric iso-kinetic strength of selected knee and shoulder muscle groups, and specific aspects of technique from a single delivery in 28 high-performance fast bowlers (age 22.0 +/- 3.0 years, ball release speed 34.0 +/- 1.3 m s(-1)). Six 50-Hz cameras and the Ariel Performance Analysis System software were used to analyse the fast and accurate deliveries. Using Pearson's correlation, parameters that showed significant associations with ball release speed were identified. The findings suggest that greater front leg knee extension at ball release (r=0.52), shoulder alignment in the transverse plane rotated further away from the batsman at front foot strike (r=0.47), greater ankle height during the delivery stride (r=0.44), and greater shoulder extension strength (-0.39) contribute significantly to higher ball release speeds. Predictor variables failed to allow their incorporation into a multivariate

model, which is known to exist in less accomplished bowlers, suggesting that factors that determine ball release speed found in other groups may not apply to high-performance fast bowlers.

Riezebos (1983) had undertaken a study on relationship of selected variables to performance in women's basketball. Twenty women were measured on physiological, anthropometric, motor fitness and skill related variables in order to provide a current profile of elite female basketball players. Performance of each subject was evaluated firstly to determine the relationship between performance and selected variables and secondly to determine which variables best discriminated between the top and lower ranked performers. The profile of the elite female player had changed considerably subsequent to rule changes. The better basketball players exhibited a superior aerobic power and anaerobic capacity, were more accurate shooters and possessed less body fat. The factors which best discriminated between high and low performers were accuracy shooting, percent fat and VO\textsubscript{2} max. These variables could be used in a test battery to assist in the selection and development of potential basketball players.

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Loram (2005) had undertaken study on determinants of ball release speed in schoolboy fast-medium bowlers in cricket. The aim of Studies investigating determinants of ball release speed has examined the technique and anthropometry of fast bowlers with little work being done on muscular strength. The aim of our study was to determine whether knee biomechanics during bowling and strength of the shoulder and knee could predict ball release speed. Twelve cricketers aged 16.6+/-0.7 years, from schools in Johannesburg, South Africa, volunteered for the study. Subjects were fast-medium bowlers (mean ball release speed of 29.2+/-1.8 m.s(-1)) and had been bowling for at least 5 years. Three accurate deliveries were filmed on an outdoor cricket pitch, in the sagittal plane with a high-speed digital camera recording at 250 frames per second. The mean ball release speed, knee angle at ball release and knee angle at front foot strike were determined using simple two-dimensional kinematics. On a separate day, peak concentric isokinetic muscle torque was measured for both knees and the dominant shoulder. Ball release speed was positively correlated to a straight knee at front foot strike (r=-0.72, P=0.009) and at ball release (r=-0.71, P=0.011). No significant correlation was found between

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ball release speed and any of the peak torque values (knee extension peak torque, r= -0.11, knee flexion peak torque, r= -0.08, shoulder internal rotation peak torque, r=0.21 and shoulder external rotation, r=0.29, P>0.05). A multiple regression model using knee angle at front foot strike and at ball release, and the angle at which peak torque is generated during shoulder internal and external rotation, predicted ball release speed (Adj r2=0.85, P<0.002. We have confirmed that the angle of the front knee at the beginning and end of a delivery is an important correlate of ball release speed in schoolboy fast-medium bowlers. In addition we have also demonstrated that a multiple regression model based on knee kinematics and shoulder peak torque angles can be used to predict ball release speed.

Roca et al (2006)\(^{51}\) undertaken a study on the relationship between shoulder alignment and elbow joint angle in cricket fast-medium bowlers. The aim of this study was to examine the relationship between shoulder alignment and elbow angle during the delivery action of fast-medium bowlers. The elbow and upper trunk alignment were recorded for 13 high-performance bowlers (mean age 20 years) using a 12-camera Vicon motion analysis system.

system operating at 250 Hz. The three highest velocity trials for "good" and "short" length deliveries were analyzed. Results showed that bowlers with a more front-on shoulder alignment at back-foot impact and when the upper arm was horizontal to the ground experienced a significantly greater elbow flexion-extension range when compared with those who had a more side-on orientation at the same point in the delivery action. Bowlers with greater shoulder counter-rotation also recorded higher elbow flexion and subsequently extension during the period from upper arm horizontal to ball release. Shoulder alignment and elbow angles were similar for "short" and "good" length deliveries. It was concluded that bowlers with a more front-on shoulder orientation at back-foot impact demonstrated a higher elbow extension from upper arm horizontal to ball release and are therefore more likely to infringe Interactional Cricket Council elbow tolerance levels, compared with those who adopt a more side-on shoulder orientation at back-foot impact.

Vincent (1967)\(^{52}\) measured 37 college women enrolled in 8 physical education activities courses in attitude (Wear Attitude Inventory), strength (Right and left grips, push, pull, back and leg

strength using dynamometer), and efficiency (measured through the calculation of oxygen consumption, using an indirect closed circuit calorimetric technique). Partial and multiple correlation were calculated between these independent variables and success in physical education activities as measured by grades. Regression equations consisting of various combination of the three independent variables were formulated and tested by analysis of variance. All prediction batteries were significant in the prediction of the success in physical education activities. In following conclusion was drawn on the basis of data collected in this study: (1) success in physical education activities as measured by grades in a instructional courses can be predicted from the various items under consideration, (2) among the variables studied as possible contributors to success in physical education activities, the attitude measures were of the highest significance, with strength showing a positive relationship a efficiency a negative relationship, (3) the use of attitude item alone can be considered as adequate, while the inclusion of the strength item is desirable in the prediction of success in physical education activities.
Thomson et al (2013). Conducted a study to devise a valid performance analysis system for the assessment of the movement characteristics associated with competitive amateur boxing and to assess its reliability using analysts of varying experience of the sport and performance analysis. Key performance indicators to characterize the demands of an amateur contest (offensive, defensive and feinting) were developed and notated using a computerized notational analysis system. Data were subjected to intra- and inter-observer reliability assessment using median sign tests and calculating the proportion of agreement within predetermined limits of error. For all performance indicators, intra-observer reliability revealed non-significant differences between observations (P > 0.05) and high agreement was established (80-100%) regardless of whether exact or the reference value of ±1 was applied. Inter-observer reliability was less impressive for both analysts (amateur boxer and experienced analyst), with the proportion of agreement ranging from 33-100%. Nonetheless, there was no systematic bias between observations for any indicator (P > 0.05), and the proportion of

agreement within the reference range (±1) was 100%. A reliable performance analysis template has been developed for the assessment of amateur boxing performance and is available for use by researchers, coaches and athletes to classify and quantify the movement characteristics of amateur boxing.

**Greenokle (1977)**\(^{54}\) developed the prediction test battery for women’s gymnastics. Twenty Two enrolled in a physical education professionals gymnastics course et. L.U., participated in supplying the data for the study. The test battery of 17 physical fitness tests were administered to all subjects at the beginning of the semester. After eight weeks of instruction, subjects were rated on 10 different skill combinations and the wherry-Doolittle test selection was applied to develop the test battery. The final test battery provided a multiple correlation of \(r = .79\) with the ratings.

**Wettstone (1998)**\(^{55}\) a list of qualities which was thought that a good gymnast would possess was compiled by wettstone 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 chiming, dipping and thigh flexion), and the Burpe test which predicted potential ability in gymnasts with a multiple correlation of .79.

Hooks (1999) conducted this study to determine the relation of 29 selected structural and strength measures to success in the baseball skills of hitting, running, throwing, and fielding plus overall baseball ability. The structural measures tested have consistently low correlations with the criterion. The measures of strength tested have consistently high correlations with the criteria: .79, left shoulder flexion with hitting: 72; right shoulder flexion with throwing: and .67, left shoulder flexion with total ability. Left shoulder flexion is the best single measure found to predict baseball ability. Right shoulder flexion ranks second.

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Peterson (1980) conducted a study to predict the basketball performance by using psychomotor, cognitive and anthropometric measures. Forty three female members of the top four teams in the 1979 Missouri small college basketball tournament served as subjects. The contributions of GPA, anaerobic leg power, 15 yard dash, 30 yard dash, total body RT, TRT, height and weight to basketball performance was determined by a specially designated formula by H.K. Kay. Height (r = .388) was the only significant (p .05) predictor. The 15 yard dash, total body RT, and power were next. The R for the four top variables was .56 (p .01).

Battles (1980) conducted a study to develop a prediction equation for selection of women intercollegiate basketball team members. Thirty three females from three colleges in Florida acted as subjects. Each subject completed a personal data form, the Athletic Motivational Inventory, the konx basketball Text, Sargent Jump Test, and the Field Goal Speed Test. Selected anthropometric measurements were also obtained from each subject. Each head coach and each assistant was asked to rank each member of the

team in order of how each contributed to team success. Three different rankings such as head coach’s rankings, the assistant coach’s rankings, and the average rankings of the head and assistant coaches were included in the statistical analysis. Significant correlations (.05 level) were found to exist between the head coaches’ rankings and the age and college basketball experience; and between the average of the head and assistant coaches’ rankings and college basketball experience. Results of stepwise multiple regression indicated that players ranked high by head coaches tended to score high on a combination of physical and psychological variables such as college basketball experience, height, vertical jump, mental toughness, and the AMI total score. Assistant coaches tended to select players with high scores on psychological variables which included trust, responsibility, mental toughness, and aggression. The average ranking of the head coach and the assistant favored players with college basketball experience, responsibility, mental toughness, age and self-confidence.
Kushwant and Nandalal\textsuperscript{59} (2012) conducted a Study of Selected Anthropometric Physical and Physiological Parameters as Predictors of Performance in Female Volleyball Players the purpose of the present study was to determine the anthropometric, physical and physiological, parameters as predictors of performance in female volleyball players. The subjects for the study were fifty (N=50) female intercollegiate volleyball players from affiliated colleges of Punjab University, Chandigarh were selected randomly to serve as the subjects for the study. Twenty six anthropometric, physical, and physiological variables were chosen to serve as independent variables. Performance in volleyball was selected as the dependent variable. Performance score was obtained through a subject rating in playing ability for each player by a panel of three experts, who evaluated and rated each player on a scale of 5 broad areas of passing, serving, setting, blocking, and attacking. In case of women volleyball players height standing (0.376), height sitting (0.360), arm length (0.494), and leg length (0.457) speed (0.312), grip strength (R) (0.471), and power (0.314) as measure by vertical

\footnote{\textsuperscript{59} Dr. Kushwant Singh Gangta and Dr. Th. Nandalal Singh, “A Study of Selected Anthropometric Physical and Physiological Parameters as Predictors of Performance in Female Volleyball Players” \textit{Indian Journal of Movement Education and Exercises Sciences (IJMEES)}, Bi-annual Refereed Journal Vol. II No. 1 Jan.-July 2012 Online ISSN-2249-6246 pp. 148}
jump to volleyball playing ability showed significant positive correlation with volleyball playing ability.

**Helmi Chaabene (2007)** et al conducted a study of boxing is one of the oldest combat sports. The aim of the current review is to critically analyze the amateur boxer’s physical and physiological characteristics and to provide practical recommendations for training as well as new areas of scientific research. High-level male and female boxers show a propensity for low body fat levels. Although studies on boxer somatotypes are limited, the available information shows that elite-level male boxers are characterized by a higher proportion of mesomorphy with a well-developed muscle mass and a low body fat level. To help support the overall metabolic demands of a boxing match and to accelerate the recovery process between rounds, athletes of both sexes require a high level of cardio respiratory fitness. International boxers show a high peak and mean anaerobic power output. Muscle strength in both the upper and lower limbs is paramount for a fighter’s victory and is one of the keys to success in boxing. As boxing punches are brief actions

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and very dynamic, high-level boxing performance requires well-developed muscle power in both the upper and lower limbs. Albeit limited, the available studies reveal that isometric strength is linked to high-level boxing performance. Future investigations into the physical and physiological attributes of boxers are required to enrich the current data set and to help create a suitable training program.

**Warnick JE and Warnick K (2014)** Conducted a study of Compared to other sports, very little research has been conducted on which variables can predict victory in the sport of boxing. This investigation examined whether boxers’ age, weight change from their preceding contest, country of origin, total number of wins, total number of losses, performance in their preceding contest, or the possession of a championship title was predictive of a winning performance in a given bout. A 1-mo. sample of male professional boxing records for all contests held in the USA (N = 400) were collected from the BoxRec online database. Logistic regression analysis indicated that only boxers’ age, total number of wins and

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losses, and the performance in the preceding contest predicted significant variance in outcome.