CHAPTER II

REVIEW OF RELATED LITERATURE

A study of relevant literature is an inevitable and essential step to get full picture of what has been done with regard to the problem under study. Such a review brings about a deep and clear perspective of the overall field.

The investigator has traced out different types of research works like dissertations, thesis, journals, relevant studies, varieties of relevant books on physical education and sports sciences. The series of relevant studies related to the problem under study have been presented in this chapter under the following three categories:

1. Studies related to biomotor variables
2. Studies related to physiological variables
3. Studies related to skill variables.
4. Studies on Weight Training and Resistance Training Exercises

2.1. STUDIES RELATED TO BIOMOTOR VARIABLES

Zagorac N, et.al. (2008) assessed the effect of programmed physical education on biomotor changes in girls, and the impact of these changes on relations between the set of morphological and motor variables, and athletic
variables evaluating the sprint and throw abilities. Study sample included 310 six-
to eight-year-old girls, elementary school first-graders from the Split area, divided
into control group (n = 138) attending regular physical education classes and
experimental group (n = 172) attending programmed physical education classes
based on the elements of athletics, apparatus gymnastics, games and general
preparatory exercises. Relations between the predictor set of variables consisting
of 4 morphological measures and 6 motor tests, and the sprint and ball throw
criteria were determined by regression correlation analysis at the beginning and at
the end of the academic year. Both groups achieved favorable quantitative result
improvement between the two measurement points, however, the improvement
was considerably more pronounced in experimental group, especially in the motor
abilities of coordination, flexibility, movement frequency, and explosive, repetitive and static strength. On final measurement, the number of significant
predictors for the criterion variables of sprint and ball throw increased from the
initial measurement in both experimental and control group of subjects. In control
group, trunk strength, explosive strength and movement frequency as motor
abilities and body height as a morphological characteristic were found to be the
best result predictors in sprint. In experimental group, coordination, flexibility,
static arm strength and trunk strength as motor abilities were the best result
predictors in sprint. In the study sample as a whole, explosive strength and trunk
strength were identified as the best predictors of ball throw as a criterion variable.
In experimental group, it was accompanied by muscle mass development and adipose tissue reduction. Based on comparison of these results and those obtained in previous studies, a new model of work in the athletics events of sprint and throw in elementary school physical education is proposed.

Delas S, et.al. (2008) identified the biomotor systems that determine performance of competitive gymnastics elements in elementary school male sixth-graders, factor structures of morphological characteristics and basic motor abilities were determined first, followed by relations of the morphological-motor system factors obtained with a set of criterion variables evaluating specific motor skills in competitive gymnastics in 110 male children aged 12 years +/- 3 months. Factor analysis of 17 morphological measures produced three morphological factors: factor of mesoectoendomorphy (general morphological factor) and factor of pronounced endomorphy, i.e. excessive adipose tissue, along with low skeleton longitudinality. Factor analysis of 16 motor variables yielded four motor factors: factor of general motoricity; factor integrating leg flexibility and arm explosiveness; factor juxtaposing body flexibility and repetitive leg strength; and factor predominantly defining leg movement frequency. Three significant canonical correlations, i.e. linear combinations, explained the association between the set of six latent variables of the morphological and basic motor system, and five variables assessing the knowledge in competitive gymnastics. The first
canonical linear combination was based on the favorable and predominant impact of the general motor factor (a system integrating leg explosiveness, whole body coordination, relative arm and trunk strength, and arm movement frequency), along with unfavorable effect of morphological factors on the gymnastics elements performance, squat vault and handstand in particular. The relation of the second pair of canonical factors pointed to the effects of leg flexibility and arm explosiveness on the cartwheel and backward pullover mount performance, whereas the relation of the third pair of canonical factors showed a favorable impact of the general morphological factor and leg movement frequency regulator on the forward shoulderkip from increase, cartwheel and handstand performance.

Bavcević T, et.al. (2008) examined the influences of specially programmed physical education lessons on biomotor development in boys, as well as the influence of those changes on relations between the set of morphological and motor variables and athletic variables for the assessment of sprint and throw abilities. For this purpose, an overall sample of 325 primary school first grade pupils from the city of Split area, aged 6-8 years, was divided into control group of subjects (N=140) attending regular physical education lessons and experimental group attending specially programmed lessons based on athletics, sports gymnastics and games elements as well as on general preparatory exercises. The relations between the predictor set of variables composed of 4
morphological measurements and 6 motor tests with the criteria of sprint and ball throwing were established by the regression correlation analysis at the beginning and at the end of the academic year. Both groups of subjects achieved positive quantitative resultant shift between the two points of measurements, whereas this shift was more significant in the experimental group in relation to the control group, especially in motor abilities coordination of flexibility, movement frequency and of explosive, repetitive and static strength. The number of significant predictors for criteria variables of sprint and ball throwing increased in the final measurement in relation to the first one in both groups of subjects. While in the control group the best results predictor in sprint were the motor abilities of explosive strength and trunk strength, the best results predictor in sprint in the experimental group were coordination, trunk strength, flexibility and explosive strength. As far as the morphological characteristics are concerned muscle mass has a positive and body mass a negative effect on the sprint result. The best results predictor in ball throwing are explosive strength and trunk strength which, in the experimental group of pupils are additionally followed by coordination development as well as the overall body mass development. By comparison of these and the earlier obtained results, a new work model for the disciplines of sprint and throws within the athletic sport school, has been proposed.
Cavala M, et.al. (2008) identified biomotor structures in elite female handball players, factor structures of morphological characteristics and basic motor abilities, and of variables evaluating situation motor abilities of elite female handball players (n = 53) were determined first, followed by determination of differences and relations of the morphological, motor and specific motor space according to handball performance. Factor analysis of 16 morphological measures produced three morphological factors, i.e. factor of absolute voluminosity, i.e. mesoendomorphy, factor of longitudinal skeleton dimensionality, and factor of transverse hand dimensionality. Factor analysis of 15 motor variables yielded five basic motor dimensions, i.e. factor of agility, factor of throwing explosive strength, factor of running explosive strength (sprint), factor of jumping explosive strength and factor of movement frequency rate. Factor analysis of 5 situation motor variables produced two dimensions: factor of specific agility with explosiveness and factor of specific precision with ball manipulation. Analysis of variance yielded greatest differences relative to handball performance in the factor of specific agility and throwing strength, and the factor of basic motoricity that integrates the ability of coordination (agility) with upper extremity throwing explosiveness and lower extremity sprint (30-m sprint) and jumping (standing triple jump). Considering morphological factors, the factor of voluminosity, i.e. mesoendomorphy, which is defined by muscle mass rather than adipose tissue, was found to contribute significantly to the players' performance. Results of
regression analysis indicated the handball performance to be predominantly determined by the general specific motor factor based on specific agility and explosiveness, and by the morphological factor based on body mass and volume, i.e. muscle mass. Concerning basic motor abilities, the factor of movement frequency rate, which is associated with the ability of ball manipulation, was observed to predict significantly the handball players’ performance.

Vlahović L, et.al. (2007) determined quantitative and qualitative differences in the morphological-motor status between elementary school first-graders of both sexes in 1992 and 2002. A standard set of 11 variables currently used in the Croatian school system to evaluate the morphological, motor and functional status of school children was employed at the beginning of academic years in a sample of 635 children (325 male and 310 female) in 1992 and a sample of 850 children (430 male and 420 female) in 2002. The mean age of study children was 7 years (+/- 2 months). Results of canonic discriminative analysis revealed the male children enrolled in elementary school first grade in 2002 to show better performance on the tests of aerobic endurance, static strength and explosive strength, and to have greater mass of muscle tissue and less adipose tissue, while achieving poorer results on the test of movement frequency than their 1992 counterparts. Female children tested in 2002 showed better results on the test of aerobic endurance and all tests of strength factors, with greater mass of
muscle tissue and less adipose tissue, while yielding poorer results on the tests of flexibility, coordination and movement frequency as compared with their 1992 counterparts. Factor analysis in the morphological-motor system isolated three varimax factors each in children of both sexes tested in 1992 and 2002. First factor showed a pattern of a general morphological factor predominantly defined by body weight and volume in the children of both sexes from both study years. Second factor showed a pattern of a general motoricity factor predominantly defined by explosive strength, coordination and speed in children tested in 1992, whereas in their 2002 counterparts the general motoricity factor was predominantly defined by the factors of strength and endurance. Third factor was defined by flexibility in both 1992 and 2002 children. In female children tested in 1992, second factor mostly defined energy regulation with predominance of explosive and static strength, followed by coordination, whereas third factor was defined by movement frequency and aerobic endurance. In female children tested in 2002, second factor mostly defined energy regulation with predominance of explosive and repetitive strength, followed by aerobic endurance and coordination, whereas third factor was defined by movement frequency followed by muscle tone regulation.

Delas S, et.al. (2007) identified biomotor systems that determine performance of competitive gymnastics elements in elementary school female
sixth-graders, factor structures of morphological characteristics and basic motor abilities were determined first, followed by relations of the morphological-motor system factors obtained with a set of criterion variables evaluating specific motor skills in competitive gymnastics in 126 female children aged 12 years +/- 3 months. Factor analysis of 17 morphological measures yielded three morphological factors: factor of mesoendomorphy and/or adipose body voluminosity; factor of longitudinal body dimensionality; and factor of transverse arm dimensionality. Factor analysis of 16 motor variables produced four motor factors: general motoricity factor (motor system); general speed factor; factor of explosive strength of throwing type (arm explosiveness); and factor of arm and leg flexibility. Three significant canonical correlations, i.e. linear combinations, explained the association between the set of seven latent variables of the morphological and basic motor system, and five variables evaluating the knowledge in competitive gymnastics. The first canonical linear combination was based on a favorable and predominant impact of the general motor factor (a system integrating whole body coordination, leg explosiveness, relative arm strength, arm movement frequency and body flexibility) on performance of gymnastics elements, cartwheel, handstand and backward pullover mount in particular, and to a lesser extent front scale and double leg pirouette for 180 degrees. The relation of the second pair of canonical factors additionally explained the role of transverse dimensionality of arm skeleton, arm flexibility
and explosiveness in performing cartwheel and squat vault, whereas the relation of the third pair of canonical factors explained the unfavorable impact of adipose voluminosity on the performance of squat vault and backward pullover mount.

2.2 STUDIES ON PHYSIOLOGICAL VARIABLES ON HOCKEY PLAYERS

Durocher JJ, Leetun D.T, and Carter J.R. (2008) examined lactate threshold (LT) and maximal aerobic capacity with a sport-specific skating protocol throughout a competitive season in collegiate hockey players. We hypothesized that maximal aerobic capacity and skating velocity at LT would increase as the season progressed. Sixteen Division I college hockey players performed a graded exercise skating protocol to fatigue at 3 different times (pre-, mid-, and postseason). Subjects skated for 80 s during each stage, followed by 40 s of rest to allow for blood lactate sampling. Velocity at LT was similar during preseason (4.44 +/- 0.08 m.s^-1) and postseason (4.52 +/- 0.05 m.s^-1) testing, but was significantly elevated at midseason (4.70 +/- 0.08 m.s^-1; p < 0.01), compared with preseason. In contrast, LT as a percentage of maximal heart rate (HRmax) was unchanged throughout the season. HRmax remained constant throughout the season, at approximately 190 beats.min^-1. Preseason maximal aerobic capacity (48.7 +/- 0.8 mL.kg^-1.min^-1) was significantly higher than that at postseason (45.0 +/- 1.1 mL.kg^-1.min^-1; p < 0.01). In conclusion, skating velocity at LT
improved from pre- to midseason, but this adaptation was not maintained at postseason. Additionally, maximal aerobic capacity was reduced from pre- to postseason. These findings suggest a need for aerobic training throughout the college hockey season.

Quinney HA, et.al. (2008) examined the physiological profile of a National Hockey League (NHL) team over a period of 26 years. All measurements were made at a similar time of year (pre-season) in 703 male (mean age +/- SD = 24 +/- 4 y) hockey players. The data were analyzed across years, between positions (defensemen, forwards, and goaltenders), and between what were deemed successful and non-successful years using a combination of points acquired during the season and play-off success. Most anthropometric (height, mass, and BMI) and physiological parameters (absolute and relative VO2 peak, relative peak 5 s power output, abdominal endurance, and combined grip strength) showed a gradual increase over the 26 year period. Defensemen were taller and heavier, had higher absolute VO2 peak, and had greater combined grip strength than forwards and goaltenders. Forwards were younger and had higher values for relative VO2 peak. Goaltenders were shorter, had less body mass, a higher sum of skinfolds, lower VO2 peak, and better flexibility. The overall pre-season fitness profile was not related to team success. In conclusion, this study revealed that the fitness profile for a professional NHL ice-hockey team exhibited
increases in player size and anaerobic and aerobic fitness parameters over a 26 year period that differed by position. However, this evolution of physiological profile did not necessarily translate into team success in this particular NHL franchise.

Gabbett TJ. (2007) investigated the physiological and anthropometric characteristics of elite women rugby league players and developed physical performance standards for these athletes. Thirty-two elite women rugby league players underwent measurements of standard anthropometry (body mass, height, sum of 7 skinfolds), muscular power (vertical jump), speed (10-, 20-, and 40-m sprint), agility (505 test), glycolytic capacity (glycolytic agility test), and estimated maximal aerobic power (multistage fitness test). The skinfold thickness, speed, agility, vertical jump height, glycolytic capacity, and estimated maximal aerobic power results were 6.0-38.1% poorer than previously reported for elite women team sport athletes (e.g., rugby union, soccer, and hockey). Although no significant differences (p > 0.05) were detected between selected and nonselected players for any of the physiological or anthropometric characteristics, significant differences (p < 0.05) were detected between forwards and backs for body mass, skinfold thickness, 10-, 20-, and 40-m speed, and estimated maximal aerobic power. When data were analyzed according to positional similarities, it was found that the hit-up forwards positional group were heavier, had greater skinfold
thickness, and had lower 10-, 20-, and 40-m speed, muscular power, glycolytic capacity, and estimated maximal aerobic power than the adjustables and outside backs positional groups. The results of this study show that elite women rugby league players have slower speed and agility, lower muscular power, glycolytic capacity, and estimated maximal aerobic power, and greater body mass and skinfold thickness than previously reported for other elite women team sport athletes. These findings show the need to develop all physiological parameters to allow elite women rugby league players to more effectively tolerate the physiological demands of competition, reduce fatigue-related errors in skill execution, and decrease the risk of injury.

Stagno KM, et.al. (2007) modified the training impulse (TRIMP) method of quantifying training load for use with intermittent team sports, and to examine the relationship between this modified TRIMP (TRIMP(MOD)) and changes in the physiological profile of team sport players during a competitive season. Eight male field hockey players, participating in the English Premier Division, took part in the study (mean+/−s: age 26+/−4 years, body mass 80.8+/−5.2 kg, stature 1.82+/−0.04 m). Participants performed three treadmill exercise tests at the start of the competitive season and mid-season: a submaximal test to establish the treadmill speed at a blood lactate concentration of 4 mmol . l(−1); a maximal incremental test to determine maximal oxygen uptake ([V]O(2max)) and peak running speed;
and an all-out constant-load test to determine time to exhaustion. Heart rate was recorded during all training sessions and match-play, from which TRIMP(MOD) was calculated. Mean weekly TRIMP(MOD) was correlated with the change in [V]O(2max) and treadmill speed at a blood lactate concentration of 4 mmol x l(-1) from the start of to mid-season (P<0.05). The results suggest that TRIMP(MOD) is a means of quantifying training load in team sports and can be used to prescribe training for the maintenance or improvement of aerobic fitness during the competitive season.

Montgomery D.L. (2006) examined the size, strength, and aerobic fitness of players from a professional hockey team. Beginning in 1917, data on body size were obtained from historical records of the Montreal Canadiens. Body composition, strength, and VO2 max were obtained through physiological testing of Canadiens players between 1981 and 2003. Compared with players in the 1920s and 1930s, current players were an average of 17 kg heavier and 10 cm taller, with BMI increased by 2.3 kg/m2. The gain in BMI was not attributed to added fat mass, since percent body fat remained unchanged over the past 22 years. From 1992 to 2003, upper body strength was assessed using a bench press test. Predicted 1 repetition maximum (1 RM) for the 17- to 19-year-old group was 107.0 kg with the highest values attained by the 25- to 29-year-old age group (128.1 kg). Gains in body mass were associated with an increase in upper body
strength. VO2 max was measured annually on a treadmill between 1992 and 2003 with annual mean values ranging between 54.6 and 59.2 mL x (kg x min)(-1). Compared with values from players in the early 1980s, VO2 max has increased with the improvements independent of body mass; however, given the variability in the data, we are hesitant to infer that VO2 max has increased significantly during the 1990s.

Spencer M, et.al. (2005) documented that field-based team sports, such as soccer, rugby and hockey are popular worldwide. There have been many studies that have investigated the physiology of these sports, especially soccer. However, some fitness components of these field-based team sports are poorly understood. In particular, repeated-sprint ability (RSA) is one area that has received relatively little research attention until recent times. Historically, it has been difficult to investigate the nature of RSA, because of the unpredictability of player movements performed during field-based team sports. However, with improvements in technology, time-motion analysis has allowed researchers to document the detailed movement patterns of team-sport athletes. Studies that have published time-motion analysis during competition, in general, have reported the mean distance and duration of sprints during field-based team sports to be between 10-20 m and 2-3 seconds, respectively. Unfortunately, the vast majority of these studies have not reported the specific movement patterns of RSA, which
is proposed as an important fitness component of team sports. Furthermore, there have been few studies that have investigated the physiological requirements of one-off, short-duration sprinting and repeated sprints (<10 seconds duration) that is specific to field-based team sports. This review examines the limited data concerning the metabolic changes occurring during this type of exercise, such as energy system contribution, adenosine triphosphate depletion and resynthesis, phosphocreatine degradation and resynthesis, glycolysis and glycogenolysis, and purine nucleotide loss. Assessment of RSA, as a training and research tool, is also discussed.

2.3 STUDIES ON SKILLS IN HOCKEY

Bell GJ, et.al. (2008) selected twenty-four National Hockey League (NHL) goaltenders were observed to determine the types and frequency of their movements during actual games. A secondary purpose was to compare these movements across the 3 periods of game play and between 2 NHL seasons (2003-04 and 2005-06) as a result of several rule changes between seasons. The mean (+/ SD) age, height, body mass, and years of NHL experience of the goaltenders were 30 +/- 4 y, 85.4 +/- 4.4 kg, 184.0 +/- 3.8 cm, 6.6 +/- 4.0 y, respectively. The mean (+/- SD) number of times and type of movements used during a game in order of most frequent were vertical movement (43.7 +/- 10.3), moving laterally (39.7 +/- 12.7), moving into full-butterfly position (32.1), anterior-posterior
movement in front of goal crease (31.5 +/- 11.5), skating out of the goal area to play the puck (19.7 +/- 6.3), and using a half butterfly on a single leg pad (left = 5.2 +/- 1.9, right = 6.4 +/- 2.1). Goaltenders played the puck less frequently during the final period of the game than during the first 2 periods and more frequently between the 2 different NHL seasons after certain rule changes. It was concluded that NHL goaltenders move most frequently vertically, laterally, and out of the net to play the puck. In addition, goaltenders moved out of the goal area to play the puck less often in the third period but more frequently after several league rule changes designed to reduce this movement.

Beilock SL, et.al. (2008) stated that experience alters behavior by producing enduring changes in the neural processes that support performance. For example, performing a specific action improves the execution of that action via changes in associated sensory and motor neural circuitry, and experience using language improves language comprehension by altering the anatomy and physiology of perisylvian neocortical brain regions. Here we provide evidence that specialized (sports) motor experience enhances action-related language understanding by recruitment of left dorsal lateral premotor cortex, a region normally devoted to higher-level action selection and implementation—even when there is no intention to perform a real action. Experience playing and watching sports has enduring effects on language understanding by changing the neural
networks that subserve comprehension to incorporate areas active in performing sports skills. Without such experience, sport novices recruit lower-level sensory-motor regions, thought to support the instantiation of movement, during language processing, and activity in primary motor areas does not help comprehension. Thus, the language system is sufficiently plastic and dynamic to encompass expertise-related neural recruitment outside core language networks.

Memmert D., and Roth, K. (2007) examined the efficacy of various training approaches in team ball sports for the development of tactical creativity. Altogether, 135 children aged about 7 years took part in a 15-month field-based study. They participated either in non-specific treatment groups, a specific handball, soccer or field hockey group, or a control group. General and game-oriented tactical creativity were chosen as outcome measures. Our analysis of treatment-related effects showed that the non-specific groups displayed improvements in general creativity, whereas the specific groups showed improvements in the game-oriented creativity in which they were trained. Furthermore, clear transfer-related effects were observed. The analysis of group-related effects indicated no differences between the approaches. Only the soccer-specific group performed better in nearly all creative values. In conclusion, a non-specific concept appears to be a promising alternative to traditional specific
treatments. This is further substantiated by several pedagogical, psychological, and medical arguments.

Rinne MB, Miilunpalo SI, and Heinonen AO. (2007) documented there is a lack of knowledge of the motor abilities required in different exercise modes which are needed when counseling sedentary middle-aged people to start a physically active lifestyle. Nominal group technique was used to establish the consensus statement concerning motor abilities and physical fitness in 31 exercise modes. Walking, running, jogging, and calisthenics were regarded as the most suitable exercise modes for most people with no specific requirements. The most demanding exercise modes of evaluated exercise modes were roller skating, downhill skiing, and martial arts, requiring all five motor abilities. Four abilities were necessary in skating, jazz dance, and ice hockey. When exercising is target-oriented, endurance is trained evidently in 27 out of 31 and muscle strength in 22 out of 31 exercise modes. The consensus statement gives theoretical basis for the components of motor abilities and physical fitness components in different exercise modes. The statement is instructive in order to promote health-enhancing physical activity among sedentary people. This study completes the selection of the exercise modes more detailed than current PA recommendation and guidelines for public health. A variety of exercise modes with one or none motor requirements is available to start. When amount and intensity of exercise is
increased the training effects can be found in most components of motor ability and physical fitness.

Elferink-Gemser MT, et.al. (2007) identified performance characteristics that could help predict future elite field hockey players, we measured the anthropometric, physiological, technical, tactical, and psychological characteristics of 30 elite and 35 sub-elite youth players at the end of three consecutive seasons. The mean age of the players at the end of the first season was 14.2 years (s = 1.1). Repeated-measures analyses of covariance, with standard of performance and measurement occasion as factors and age as a covariate, showed that the elite players fared better than the sub-elite players on technical and tactical variables. Female elite youth players also scored better on interval endurance capacity, motivation, and confidence. Future elite players appear to have excellent tactical skills by the age of 14. They also have good specific technical skills and develop these together with interval endurance capacity better than sub-elite youth players in the subsequent 2 years. To verify our conclusions, we will be tracking these players into adulthood.

Hockey GR, Sauer J, and Wastell DG. (2007) examined the adaptability of different types of process control training across changes in task and environmental stress. The literature on training leads us to expect greater flexibility for system-based training, as opposed to procedure-based training.
However, the stress literature suggests that knowledge-based strategies (making use of executive control) may be more vulnerable under stress conditions. Two groups were given 6 hr of training on the Cabin Air Management System (CAMS), a complex, multilevel, PC-based process control task, emphasizing either system knowledge or use of procedures. They were then required to carry out the task for 3 hr (with noise during the middle 1 hr) across a range of both familiar and unfamiliar fault scenarios. For the primary control task, the system-trained group performed better, especially for less familiar and complex faults. However, for lower priority tasks requiring executive control, procedure-trained operators performed better and were less impaired by noise. System training was more effective for managing unexpected task events, whereas procedural training was better under noise. The results are interpreted in terms of the rationale for instructing operators in the range of strategies required for effective process skills in complex work environments. Training methodologies for safety critical applications should aim to develop skill in the use of both procedural and system knowledge strategies. Operators should be trained in the most effective deployment of these strategies during unfamiliar task events and environmental stress and given stress exposure training.

Gérin-Lajoie M, et.al. (2007) Many common activities such as walking in a shopping mall, moving in a busy subway station, or even avoiding opponents
during sports, all require different levels of navigational skills. Obstacle circumvention is beginning to be understood across age groups, but studying trained athletes with greater levels of motor ability will further our understanding of skillful adaptive locomotor behavior. The objective of this work was to compare navigational skills during fast walking between elite athletes (e.g. soccer, field hockey, basketball) and aged-matched non-athletes under different levels of environmental complexity in relation to obstacle configuration and visibility. The movements of eight women athletes and eight women non-athletes were measured as they walked as fast as possible through different obstacle courses in both normal and low lighting conditions. Results showed that athletes, despite similar unobstructed maximal speeds to non-athletes, had faster walking times during the navigation of all obstructed environments. It appears that athletes can process visuo-spatial information faster since both groups can make appropriate navigational decisions, but athletes can navigate through complex, novel, environments at greater speeds. Athletes' walking times were also more affected by the low lighting conditions suggesting that they normally scan the obstructed course farther ahead. This study also uses new objective measures to assess functional locomotor capacity in order to discriminate individuals according to their level of navigational ability. The evaluation paradigm and outcome measures developed may be applicable to the evaluation of skill level in athletic training and selection, as well as in gait rehabilitation following impairment.
Sunderland C, et.al. (2006) documented that high test retest reliability is essential in tests used for both scientific research and to monitor athletic performance. Thirty-nine (20 male and 19 female) well-trained university field hockey players volunteered to participate in the study. The reliability of the in house designed test was determined by repeating the test (3 - 14 days later) following full familiarisation. The validity was assessed by comparing coaches ranks of players with ranked performance on the skill test. The mean difference and confidence limits in overall skill test performance was 0.0 +/- 1.0 % and the standard error (confidence limits) was 2.1 % (1.7 to 2.8 %). The mean difference and confidence limits for the "decision making" time was 0.0 +/- 1.0 % and the standard error (confidence limits) was 4.5 % (3.6 to 6.2 %). The validity correlation (Pearson) was $r = 0.83$ and $r = 0.73$ for female players and $r = 0.61$ and $r = 0.70$ for male players for overall time and "decision making" time respectively. We conclude that the field hockey skill test is a reliable measure of skill performance and that it is valid as a predictor of coach-assessed hockey performance, but the validity is greater for female players.

Elferink-Gemser MT, et.al. (2004) determine the relationship between multidimensional performance characteristics and level of performance in talented youth field hockey players, elite youth players ($n = 38$, mean age 13.2 years, $s = 1.26$) were compared with sub-elite youth players ($n = 88$, mean age 14.2 years, $s$
= 1.26) on anthropometric, physiological, technical, tactical and psychological characteristics. Multivariate analyses with performance level and gender as factors, and age as the covariate, showed that the elite youth players scored better than the sub-elite youth players on technical (dribble performance in a peak and repeated shuttle run), tactical (general tactics; tactics for possession and non-possession of the ball) and psychological variables (motivation) (P < 0.05). The most discriminating variables were tactics for possession of the ball, motivation and performance in a slalom dribble. Age discriminated between the two groups, indicating that the elite youth players were younger than the sub-elite players. In the guidance of young talented players to the top as well as in the detection of talented players, more attention has to be paid to tactical qualities, motivation and specific technical skills.

Smeeton NJ, et.al. (2004) documented that the ability to recognize patterns of play is fundamental to performance in team sports. While typically assumed to be domain-specific, pattem recognition skills may transfer from one sport to another if similarities exist in the perceptual features and their relations and/or the strategies used to encode and retrieve relevant information. A transfer paradigm was employed to compare skilled and less skilled soccer, field hockey and volleyball players' pattern recognition skills. Participants viewed structured and unstructured action sequences from each sport, half of which were randomly
represented with clips not previously seen. The task was to identify previously viewed action sequences quickly and accurately. Transfer of pattern recognition skill was dependent on the participant's skill, sport practised, nature of the task and degree of structure. The skilled soccer and hockey players were quicker than the skilled volleyball players at recognizing structured soccer and hockey action sequences. Performance differences were not observed on the structured volleyball trials between the skilled soccer, field hockey and volleyball players. The skilled field hockey and soccer players were able to transfer perceptual information or strategies between their respective sports. The less skilled participants' results were less clear. Implications for domain-specific expertise, transfer and diversity across domains are discussed.

Ryan JP, et.al. (2004) determined similarities and differences in the performance of female and male athletes on neuropsychological measures of frontal lobe functioning. DESIGN: A cross-sectional study of male and female college-aged athletes involved in one of the following sports: hockey, basketball, softball, lacrosse, soccer, swimming, and track. A total of 262 athletes (male, n=157; female, n=105) participated in the study. Controlled Oral Word Association (letters F, A, S), Cognitive Assessment System (Planned Codes, Planned Connections, Number Detection), and WAIS-R-NI Vocabulary were administered to all athletes. MANCOVA was performed with gender and sport as
fixed factors. Female athletes displayed faster and more accurate performance on perceptual-motor tasks (P<0.01) and on one condition of a verbal fluency task (P<0.01) compared with male athletes. Male hockey athletes showed superior perceptual-motor speed and accuracy (P<0.01) compared with male athletes in the track/swimming group. Evaluators were naive to athletes' gender and sport. Gender- and sport-specific performances on perceptual-motor and verbal fluency tasks were found. Adding cognitive components to base functions eliminates gender- and sports-related distinctions, suggesting that existing differences are related to basic, fundamental skills, which are inherent and practiced within the respective sport. Understanding the differences and similarities across sports and gender on various neurocognitive measures is relevant for determining group differences in studies examining the consequences of mild traumatic brain injury among athletes.

2.4 STUDIES ON EFFECT OF WEIGHT TRAINING AND RESISTANCE TRAINING

Clutch et al.(2001) examined the effect of depth jumps and weight training on leg strength and vertical jump in two studies. The effects of depth jumping (plyometrics) and traditional weight training on performance of vertical jump and other measures of length are reviewed below:
Study 1:

Three jumping activities were compared

a) Maximum vertical jump

b) 0.3 m depth jump and

c) 0.75 m depth jump

These activities were preceded by three weeks of weight training. Weight training with jumping activities were conducted for twice in a week for four weeks. All groups demonstrated similar improvements on 1 RM squat strength, isometric knee-extension strength, and vertical jump. The lack of significant differences could have been due to the small group sizes. It restricted the statistical power of the analysis.

Study 2:

A weights alone group (N-14) was compared to weights plus depth jumping group (N=14). Training was performed twice per week for 16 weeks. The weight training group did not improve vertical jump although strength parameters improved. The weights plus jumping group did improve in the vertical jumping.
It was found that weights plus jumping produced no added beneficial performance improvement than the jumping alone group. The weight training programme did not provide added benefit.

Carpinett (2003) studied the effect of varied weight training programmes on strength. The evidence of this study was revived earlier by Bargar that a single set for maximal strength gains the validity and practical significance of Bargar’s strength training study questioned since this study came into existence with well controlled, methodologically sound studies that minimize confounding variables that was required to support the hypothesis that multiple sets of exercise elicit superior gains in strength.

Billy Graham (1985) conducted a study on the effect of various methods of resistance training on hitting ability in hockey. For that forty boys belonging to the Brindavan public School, Athur, Chingleput were selected. The initial performance of every subject in hitting for distance was recorded in meters. On the basis of their performance, they were divided into four equivalent group of equal strength. One group assigned as control group, another three were assigned as experimental groups. Each experimental group was given different specific resistance training. All the three groups were finally tested and the record of scores showed that all the three resistance training methods improved the hitting ability in hockey for distance.
Sankaran (2000) conducted a study on the effect of weight training exercises on the performance of scooping in hockey on sixty hockey players of Sivagangai District. Six weeks weight training was given to the students. During the six weeks training period, the subjects of experimental group were given weight training with the barbells. They were also asked to do the skill scooping. The result showed a highly significant improvement in the subjects of the experimental group after six weeks of training with specific weight training and exercises.

Mecklish (2001) conducted a study on the effect of resistance training programme on hitting ability for distance and shooting accuracy in Hockey on 30 students of YMCA College of Physical Education. Six weeks resistance training was given to the students. During the six weeks training period, the subjects of experimental group were given the resistance training with the addition of weights to their hockey stick and their forearms using sand bags. They were also asked to do the downward swinging action with proper stance against the resistance using wall pulley. The results showed a highly significant improvement in the subjects of the experimental group after six weeks of training with specific resistance training and exercise.

Soosai Siluvai Michael (1984) conducted a study on the effect of resistance training on hitting ability in hockey for distance on thirty women students of YMCA College of Physical Education. Six weeks resistance training
was given to the students. During the six weeks training period, the subjects of experimental group was given the resistance training with the addition of weight to their hockey stick and their forearms using sand bags. They were also asked to do the downward swing action with proper stance against the resistance using wall pulley. The result showed highly significant improvement in the subjects of the experimental group after six weeks of training with specific resistance training and exercises.

   It will be appropriate to state the word of Rasch, (2003), “He made a special mention that weight training has become extremely popular as a method of preparation for participation in Athletics, particularly among weight throwers, football players and swimmers.

   Three different resistance training programme on muscular strength and a absolute and relative muscular endurance were investigated by Anderson and Kearney (2002)

   Forty three male college students were randomly selected as subjects to his study. Three experimental group were formed. They were:

   1. High resistance low repetition group (N=15) performed three sets of 6 – 8 per session.

   2. The medium resistance medium repetition subjects (N=16) trained by doing two sets of 30 – 40 RM per session
3. The low resistance – high repetition group (N=12) used a single set of (100-150)RM.

All subjects were trained with the bench press exercise three times per week for nine weeks. At the end of the experimental period of nine weeks, the statistical analysis of pre and post test proved that the high resistance low repetition group showed poor improvement and the other two training programmes demonstrated significant improvement in muscular endurance.

Therefore in designing a resistance training programme one may adjust the resistance and repetitions used to optimize specific outcomes, so that concomitant gain will be made in muscular strength or muscular endurance.

2.5 SUMMARY OF RELATED LITERATURE

The investigator reviewed a lot of related literatures pertaining to her study. A lot of researchers conducted studies on weight training on improving the basic skills and the results of their study showed significant result. A lot of resistance training were also conducted by many research scholars on improving the basic skills. The investigator could find the positive results in those studies. So the investigator intended to conduct a study on the effect of weight training and resistance training on selected biomotor, physiological and skills variables in hockey.